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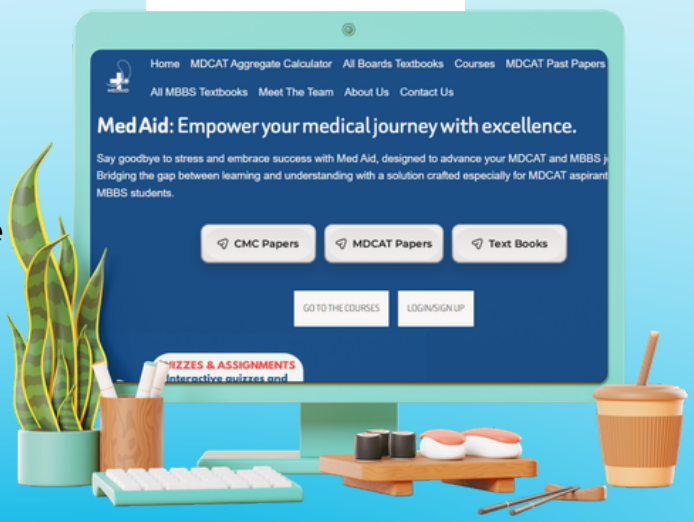

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UNIT # 01

ACELLULAR (VIRUS)

High Yield Content:

- Characteristics of Viruses (Living, Non-Living)
- History (Discovery, Scientists Contribution), Structure of Virus
- Classification of Virus (Genome, Host and Capsid Based)
- Bacteriophage (Lytic and Lysogenic Cycle)
- AIDS (Stages, Symptoms, Treatment)
- HIV (Structure, Life Cycle)

SCAN QR CODE to Watch MDCAT Lectures, Test Discussions, and Past Papers Discussion on

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Dr. Muhammad Sohail, PhD

Acellular Life (Viruses): KEY CONCEPTS

- Viruses are **non-cellular/Acellular.**
- **Exception** to the cell theory.
- Completely inert outside the host.
- **Obligate intracellular parasite.**
- Extremely small, ranging from **20 to 300 nanometres,** only seen under **electron microscope.**
- A virion is the **complete, mature and infectious form of a virus** outside a host cell.

SCIENTISTS CONTRIBUTIONS

- **Charles Chamberland (1884):** First evidence about existence of Viruses.
- **Adolph Mayor (1886):** First to study the Tobacco Mosaic Disease.
- **Dmitri Ivanovsky (1892):** Discovered TMV (Plant Virus).
- **Martinus Beijerinck (1898):** Investigation about the cause of TMD and reported that the pathogenic agent responsible was a "contagious living fluid".
- **Friedrich Loeffler and Paul Frosch (1898):** First animal virus, the Foot-and-Mouth Disease Virus.
- **Wendell Stanley (1935):** Crystallizing / Purification of the Tobacco Mosaic Virus (TMV).
- **Max Theiler (1937):** First Human Vaccine for a Viral Disease (Yellow fever).
- **David Baltimore (1971):** Viruses are classified into seven groups based on whether they use DNA or RNA as their genetic material. **Baltimore,** along with **Howard Temin (1970),** independently discovered the enzyme **reverse transcriptase** in retroviruses.

CHARACTERISTICS Of VIRUSES

- Considered between living and non-Livings.

Living Characteristics	Non-Living Characteristics
Replication (Reproduction)	Acellular entities
Genetic Material (Either DNA or RNA)	No Metabolism
Undergo Mutation & Evolution	No Energy Production
Adaptation to Host Environment	No Growth & Development
Interaction with Host Cells	Crystallization
Response to Environmental Cues	Inert outside the host
Pathogenic nature	No Homeostasis

Structure Of Viruses

Coat (Outer)	Core (Inner)
Capsid: Made of Protein, it can be helical, icosahedral, or complex. Capsid is made up of **capsomeres** (162 in Herpes and 252 in Adenovirus).	**Genome:** DNA or RNA, Single-stranded (ss) or double-stranded (ds), Linear or circular.
Envelope (Optional): Derived from host cell membrane (Lipoprotein), **More sensitive** to environmental conditions.	**Enzymes:** Reverse transcriptase, Integrase, protease.
The envelope contains viral **glycoproteins (Peplomers)** that are critical for binding to host cell receptors and initiating infection.	

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CLASSIFICATION OF VIRUSES

There are three bases of Classification of Viruses: 1- Host 2- Capsid 3- Genome

Host Based Classification

Animal Viruses (Zoophages)	Plant Viruses (Phytophages)	Bacterial Viruses (Bacteriophages)
• **Adenovirus**: Non-enveloped, double-stranded DNA (dsDNA) cause Respiratory infections, conjunctivitis, gastroenteritis. • **Human Papillomavirus (HPV)**: Non-enveloped (dsDNA) cause warts, cervical cancer. • **Rous Sarcoma: (ssRNA) Enveloped,** Cause cancer in animals • **Hepadnavirus:** Enveloped (dsDNA) cause Hepatitis B, liver cancer. • **Coronavirus:** Enveloped (ssRNA) cause **COVID-19**, Severe Acute Respiratory Syndrome **(SARS)**, Middle East Respiratory Syndrome **(MERS)**. • **Picornavirus:** Non-enveloped (ssRNA) cause Polio, Hepatitis A • **Flavivirus:** Enveloped, (ssRNA) cause Hepatitis C, dengue fever, Zika virus infection.	➢ More than 2000 type of viral plant diseases are known. ➢ **TMV (RNA Virus)**: Rod Shaped Capsid ➢ **Potato Yellow Dwarf Virus:** Yellowing of the leaves, stunted growth, and overall reduced yield. ➢ **Cauliflower Mosaic Virus (CaMv):** Mosaic or mottled pattern on the leaves, with alternating light and dark green patches.	➢ **T4 phage (dsDNA):** Infects *Escherichia coli* (E. coli) and follows a strict lytic cycle. ➢ **Lambda (λ) phage (dsDNA):** A well-studied temperate phage that infects *E. coli* and can undergo both lysogenic and lytic cycles. ➢ **M13 phage (ssDNA):** A filamentous phage that infects *E. coli* without causing cell lysis, allowing continuous release of progeny phages. ➢ **ΦX174 (Phi X174) phage (ssDNA):** A well-known bacteriophage that infects *E. coli*.

Capsid Based Classification

Shape of Capsid	Example
Helical or Rod-shaped Capsid	Tobacco mosaic Virus (TMV)
Polyhedron Capsid	Adenovirus
Enveloped Capsid with glycoprotein spikes	Influenza Virus
Complex Capsid with polyhedral head & tail	Bacteriophage
Spherical Capsid	Cauliflower Mosaic Virus (CaMv)
Conical Shaped Capsid	HIV

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Genome Based Classification (Baltimore Classification)

Viruses are classified into **Seven groups** based on whether they use **DNA** or **RNA** as their genetic material, and whether that genetic material is single- or double-stranded.

Genome	Examples
Group I: Double-stranded DNA viruses (dsDNA)	Adenovirus, Herpesvirus, Pox Virus
Group II: Single-stranded DNA viruses (ssDNA)	Parvovirus (mild rash)
Group III: Double-stranded RNA viruses (dsRNA)	Reovirus (Diarrhea)
Group IV: Positive-sense single-stranded RNA viruses (+ssRNA): **Serve as mRNA**	Togavirus (Rubella Virus), Poliovirus, Zika virus
Group V: Negative-sense single-stranded RNA viruses (-ssRNA): **Serve as template for mRNA**	Influenza virus (Orthomyxovirus)
Group VI: Single-stranded RNA viruses with reverse transcription (Rt-ssRNA): **Template for DNA Synthesis**	Retrovirus (HIV)
Group VII: dsDNA viruses with reverse transcription	Hepatitis B virus

BACTERIOPHAGE

- Such viruses that use Bacteria as Host, typically around **20-200 nanometers.**
- Discovered by **Frederick Twort (1915)** studying *Vaccinia virus* (the virus causing cowpox).
- **Felix D Herelle (1917)** rediscover the Bacteriophages while studying dysentery outbreaks. He **termed** the agent responsible for this phenomenon as a **"bacteriophage,"** meaning "bacteria eater" (from Greek: "phagein" meaning to eat).
- Most bacteriophages have a complex structure, usually consisting of a head and tail (Tadpole shaped).
- Head contain Both DNA and Protein while tail consists of protein only.
- Morphological **tail is more complex** than head.
- **T-phages** are the best studied phage virus that **infect E. coli** (a bacterium), among them **T_2 and T_4** are mainly used in phage studies.

Steps in life cycle of Bacteriophage

Landing → Attachment → Tail contraction → Penetration and unplugging → DNA Injection

1- Attachment/Adsorption:

- Phage attach to specific receptors on bacterial cell wall
- Weak chemical union between virion and receptor sites

2- Penetration:

- Contraction on sheath and **release of enzymes**
- Portion of bacterial cell wall digested
- Hollow core tube is pushed through bacterial cell wall and membrane

3- Injection

- Injection of viral DNA into bacterial cell
- Protein coat remains outside

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Replication Process	
Lytic Cycle (Master-Slave Relationship)	**Lysogenic Cycle (Host-Guest Relationship)**
- **Virulent** or lytic phage - Virus injects its nucleic acid into the host cell. - Host machinery is hijacked to replicate viral particles. - Both Viral components (DNA & Capsid) multiplied. - The host cell eventually bursts (lysis), releasing new viruses. - In **25 minutes, 200 new phages** are produced.	- **Non-virulent**, Lysogenic or temperate phage. - Viral DNA is incorporated into the host's genome **(Prophage)**. - It can remain dormant and replicate along with the host cell's DNA. - Only Viral DNA multiplied along with bacterial DNA. - Bacterial cell remains intact and continue to divide. - **Under stress conditions** (Desiccation, exposure to UV or ionizing radiation or exposure to mutagenic chemicals), it may switch to the lytic cycle **(Induction)**.

Importance of Bacteriophage

- Vector in genetic engineering (Lambda phage).
- Development of **genomic library.**
- **Phage therapy** where it kills the targeted pathogenic bacteria.
- Use as antibacterial **nanomedicines** where they serve as targeted **drug delivery vehicles.**
- **Transduction** is the process by which DNA is transferred from one bacterium to another by a **virus.**

Sub-Viral Infectious Entities		
Prions	**Viroids**	**Virusoids**
- **Infectious protein** comprises of **29 amino acids** with single disulphide bond. - Discovered by **Stanely B. Prusiner** and receive Nobel prize in 1997. - Cause disease such as **mad cow disease** in cattles, **mysterious brain infections** and **Alzheimer's disease** in humans.	- **Small single-stranded**, circular **RNAs** that are infectious pathogens, they have **no protein coating.** - Discovered by **O. Diener** in 1971. - Smallest viroid contains 220 nucleotides. - **Potato spindle tuber viroid** identified as first viroid. - Mainly cause **plant diseases**	- Virusoids are **essentially viroids** that have been encapsulated by a **helper virus coat protein.** - Single-stranded RNA **dependent on viruses for replication.** - Cause **Hepatis D** in humans.

VIRAL DISEASES

Smallpox

- Caused by pox virus **(DNA Enveloped)**
- **Ancient disease** occurred in epidemic form in China as early as 12th century B.C.
- Fluid filled vesicles raised on skin which become pustules later and form pitted scares called **Pocks.**
- **First ever vaccines** were discovered against smallpox by **Edward Jenner in 1796.**

Herpes Simplex (Oral Herpes)

- Caused by HSV-I **(DNA enveloped)**
- Vascular lesion / blisters on epithelial layers of ectodermal tissues like mouth, lips and skin sites.
- Transmitted by oral secretions or physical contact
- Treated by antiviral drugs

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Genital Herpes (STD)

- Caused by HSV-II **(DNA enveloped)**
- Soreness typically on penis, vagina, buttock or anus
- Transmitted by sexual contact
- Treated by antiviral drugs

Mumps and Measles

- Caused by paramyxovirus **(RNA Enveloped Virus)**
- Transmitted by Cough and sneezing
- **Mumps symptoms** are fever, muscle pain, headache, painful swelling of parotid gland (Salivary gland)
- **Measles symptoms** are fever, runny nose, cough, red eyes, red flat rashes on skin
- Prevented by autoimmunity and vaccination

Poliomyelitis (Infantile paralysis)

- Caused by Poliovirus/Enterovirus **(RNA non-enveloped virus)**
- It mainly affects children under 5 years of age
- **Smallest known virus (30nm)**
- Transmitted by Oro-fecal route
- Damage to motor neurons of spinal cord and leading to paralysis of limbs
- Symptoms are fever, loss of appetite, nausea, vomiting, jaundice
- Prevented by vaccination and good hygiene

Hepatitis A (Infectious Hepatitis)

- Caused by HAV **(RNA non-enveloped virus)**
- Transmitted by Oro-faecal route
- Acute infection, Fever, loss of appetite, nausea, vomiting and jaundice
- Prevented by vaccination and good hygiene

Hepatitis B (Serum Hepatitis)

- Caused by HBV **(DNA enveloped virus)**
- Transmitted by contaminated blood, sexual contact, mother to newborn
- **Acute infection:** Vomiting, yellowish skin, tiredness, dark urine, abdominal pain
- **Chronic infection:** Liver cirrhosis & liver cancer
- Prevented by vaccination, routine screening of blood and treated by **Alpha interferons** (interferons are group of signaling proteins made and released by host cells in response to the presence of several Viruses)

Hepatitis C (Infusion Hepatitis)

- Caused by HCV **(RNA enveloped Virus)**
- Transmitted by contaminated blood or blood product
- **Chronic infection:** occasional fever, dark urine, abdominal pain, yellow skin, **Liver cirrhosis & liver cancer**
- **High risk of liver damage** than other forms of hepatitis
- Prevented by blood screening, **no vaccination available**, Treated by **Alpha Interferons** and **Ribavirin** (an antiviral medication that works with other medications to treat hepatitis C.

Hepatitis D (Delta Hepatitis)

- Caused by **Viroid (especially Virusoid)**
- Transmitted by blood and serum
- Cause **Co-infection** with **Hepatitis B.**
- Cause **Superinfection** with **Chronic Hepatitis B.**
- It is a hybrid particle enclosed by surface proteins from the Hepatitis B Virus
- The routes of transmission of hepatitis D are similar to those for hepatitis B.

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- More severe than Hepatitis B.
- Vaccination against hepatitis B protects against hepatitis D.

Hepatitis E

- Caused by HEV **(RNA Non-enveloped Virus)**
- Transmitted by Oro-faecal route, like HAV
- Pig could be the source of hepatitis E **(Zoonosis).**
- Acute infection, nausea, vomiting, diarrhoea, jaundice
- No vaccines and no drugs available, good hygiene

Corona/Covid-19 (SARS, MERS, OC43)

- Caused by **RNA Enveloped virus**
- **COVID-19 pandemic** caused by severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2)
- Outbreak of COVID-19 in **Wuhan China**, in December 2019
- **Bats** are the vectors and host.
- Transmitted by **air born droplets**
- **Symptoms** are laboured breathing, pressure inside chest with pain, weakness, difficulty in speech, low oxygen level.
- Vaccines available

Dengue

- Caused by **flavivirus (RNA Enveloped)**
- Transmitted by mosquito ***Aedes aegypti*** (Vector)
- **Symptoms** are vomiting, rashes with pain, nausea, pain behind eyes and body

Chikungunya

- Caused by Alphavirus Chikungunya **(RNA Enveloped Virus)**
- Transmitted by mosquito ***Aedes aegypti*** and **non-human primates**
- Symptoms are Headache, body muscles and joint pain, nausea, vomiting, swollen gland and painful eyes

Ebola

- Caused by **Ebola virus (RNA Enveloped Virus)**
- Transmitted by canid animal's bats and dogs etc.
- Major symptom is **haemorrhage fever**

AIDS (ACQUIRED IMMUNODEFICIENCY SYNDROME)

- Caused by **HIV (Retrovirus, RNA Enveloped:** Having two RNA molecule which may be positive sense or negative sense).
- **Major Symptoms** are severe pneumonia, rare vascular cancer, swollen lymph nodes, loss of immunity.
- High risk of **opportunistic diseases** (Diseases that occur more often or are more severe in people with weakened immune systems than in people with healthy immune systems).
- Transmitted by contaminated blood and sexual contact.
- Vaccination not available yet, **ART (Antiretroviral Therapy)** use to control virus to increase life expectancy of person.
- **ELISA (Enzyme Linked Immunosorbent Assay):** Diagnostic test for AIDS
- AIDS was reported by some physicians in **1980s** in young homosexual males.
- Agent responsible the disease was identified in **1984** by researchers from the **Pasteur institute in France and National institute of health in USA.**
- Virus was named as HIV in **1986.**
- Virus infects and multiplies in **monkey** but does not cause disease which mean **HIV is host specific.**

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Structure of HIV

- Spherical in shape, 100 nm in diameter, ssRNA (two strands) enveloped virus.
- Size is about 60 times lesser than RBCs.
- HIV consists of 9 genes, 3 genes provide genetics information for capsid protein, enveloped protein and viral enzymes (Reverse transcriptase, Integrase & Protease). 6 are regulatory genes controlling functions such as uncoating of HIV genome and penetration of host cell.
- Envelope of HIV made of two layers of lipids with spike (peplomers) made up of glycoproteins.
- Spikes consists of outer Glycoprotein GP120 (needed to attach to the host with CD4 receptors) and transmembrane GP41 (critical for the cell fusion process).
- Matrix protein is lies between envelope and capsid.

Life cycle of HIV

Sequence of steps

Adsorption/Attachment ⟶ Entry by endocytosis ⟶ Uncoating ⟶ Reverse transcription ⟶ Integration ⟶ Provirus formation ⟶ Transcription ⟶ Translation ⟶ Assembling & maturation ⟶ Budding & Release

- Primary host of HIV are Helper T-Lymphocytes (major components of immune system).
- In addition, macrophages and certain brain cells may also be affected.
- Reverse transcriptase an enzyme that convert single stranded RNA into double stranded DNA (called complementary DNA).

Stages of AIDS

Asymptomatic Carrier	AIDS Related Complex (ARC)	Full blown AIDS
• Symptoms includes fever, chills, aches (continue pain), swollen lymph nodes and itchy rashes. • These symptoms disappears and no symptoms for 9 months or longer. • HIV blood test (ELISA) for presence of antibodies become positive during this stage.	➢ Most common symptoms are swollen lymph glands in neck, axilla (armpit) or groin (area between legs) that persist for months. ➢ Other symptoms include night sweat, persistent cough, flu and persistent diarrhea, loss of memory and depression.	➢ Final stage of AIDS. ➢ Severe weight loss, weakness due to persistent diarrhea. ➢ Attack of opportunistic diseases (skin cancer, Kaposi sarcoma, fungal infection, gastrointestinal diseases, respiratory diseases, nervous system and eye diseases).

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1. **Who first described an important disease of tobacco which he called tobacco mosaic disease:**
(A) Martinus Beijerinck (B) Adolf Mayer
(C) Chamberland (D) Iwanowski
2. **Tobacco mosaic virus was discovered by:**
(A) Stanely (B) Pasteur
(C) D-Herelle (D) Iwanowski
3. **First evidence about the existence of viruses was provided by:**
(A) Stanely (B) Pasteur
(C) Chamberland (D) Iwanowski
4. **Who proceeded with the investigation about the cause of TMD and reported that the pathogenic agent responsible was a "contagious living fluid":**
(A) Martinus Beijerinck (B) Adolf Mayer
(C) Chamberland (D) Iwanowski
5. **Who Classified viruses in seven different groups on the basis of their genome constitution:**
(A) David Baltimore (B) Adolf Mayer
(C) Chamberland (D) Robert Koch
6. **Identify the Phytovirus:**
(A) Rhino Virus
(B) Cauliflower mosaic virus
(C) T-Phages
(D) Covid-19
7. **Porcelain Chamberland filters have a pore size of _____ which small enough to remove all bacteria:**
(A) 0.1 µm (B) 100 µm
(C) 1 mm (D) 10 nm
8. **Which of these are found in all viruses?**
(A) Envelope, nucleic acid, capsid
(B) DNA, RNA and Protein
(C) Protein and nucleic acid
(D) Protein, Carbohydrates and lipids
9. **Which of the following statement is true for viruses:**
(A) Viruses carry with them with their own ribosomes for protein formation
(B) New viral ribosomes form after viral DNA enters the cell
(C) Viruses use the host ribosomes for their own need
(D) viruses do not need ribosomes for protein synthesis
10. **It is not true for viruses:**
(A) Viruses are non-cellular
(B) No independent metabolic activities
(C) Virus contains DNA, RNA and Protein
(D) Virus contains either DNA or RNA
11. **Which of the following are Living characteristics of virus:**
(A) Destroyed by UV rays
(B) Lack metabolic machinery
(C) Can be crystallized and stored
(D) None of the above
12. **The pathogenicity of virus depends on:**
(A) Immunity of the host cell
(B) The effectiveness of penetration of genome
(C) The capsid of the viruses
(D) Envelop of the viruses
13. **It is an ancient disease that is known to have occurred as epidemic in China as early as the twelfth century B.C:**
(A) Influenza (B) Measles
(C) Herpes simplex (D) Smallpox
14. **Most commonly this disease occurs in the mouth, On the lips and other skin sites:**
(A) Herpes simplex
(B) Measles and mumps
(C) Influenza
(D) Polio
15. **Poliomyelitis affects:**
(A) Motor neuron (B) Sensory neuron
(C) Brain (D) Muscle
16. **It is caused by enveloped RNA virus:**
(A) Herpes Simplex (B) Smallpox
(C) Polio (D) Influenza
17. **It is highly contagious, widespread, and seldom fatal:**
(A) Herpes simplex (B) Smallpox
(C) Measles (D) Mumps
18. **These are the smallest known viruses:**
(A) Herpes viruses (B) Polio viruses
(C) Influenza viruses (D) Paramyxoviruses
19. **AIDS was reported by some physicians in early 1980's in:**
(A) Young heterosexual females
(B) Young heterosexual males
(C) Young homosexual males
(D) Young homosexual females
20. **Cells in _____ can also be infected by HIV:**
(A) Central Nervous System
(B) Peripheral Nervous System
(C) Muscular System
(D) Endocrine System
21. **It is an inflammation of liver:**

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(A) AIDS (B) Hepatitis
(C) Herpes simplex (D) Polio

22. It is highly contagious, widespread, and seldom fatal:
(A) Pox virus (B) Herpes simplex
(C) Hepatitis B Virus (D) Mumps

23. Which of the following virus is having linear genome:
(A) Bacteriophages (B) Retrovirus
(C) Paramyxovirus (D) *Vibrio cholerae*

24. Which of the following virus is having maximum rate of replication:
(A) Herpes simplex virus (B) HIV
(C) Polio virus (D) Hepatitis A Virus

25. It is transmitted through the feces of infected persons:
(A) Hepatitis A (B) Hepatitis B
(C) Hepatitis E (D) Hepatitis A and E

26. It is a mild, short term and less virulent disease:
(A) Hepatitis A (B) Hepatitis B
(C) Hepatitis C (D) Serum hepatitis

27. Genetically engineered vaccine is available for:
(A) HAV (B) HBV
(C) HCV (D) Infusion Hepatitis

28. When viral DNA has been incorporated into the bacteria chromosome it is called as:
(A) Phage (B) Prophage
(C) Provirus (D) Viroid

29. Sometimes, the viral DNA gets detached from host's chromosome and lytic cycle starts. This process is called:
(A) Incorporation (B) Induction
(C) Synthesis (D) Assembling

30. Phage can exist harmlessly in:
(A) Lytic cycle
(B) Master – Slave relationship
(C) Virulent cycle
(D) Lysogenic cycle

31. The major cell infected by HIV is:
(A) B-lymphocyte
(B) T-lymphocyte
(C) Helper T-Lymphocyte
(D) Suppressor T lymphocyte

32. Tobacco mosaic virus was crystallized by:
(A) Stanley (B) Ivanowski
(C) Pasteur (D) Chamberland

33. Parvoviruses have a size of:
(A) 250nm (B) 20pm
(C) 20nm (D) 25µm

34. Which structure help viruses to recognize host cell:
(A) Envelope (B) Capsomeres
(C) Glycoprotein spikes (D) Genome

35. Which of following is a living feature of virus:
(A) Can be crystallized
(B) Acellular
(C) Destroyed by UV rays
(D) None of these

36. Which one is Retrovirus?
(A) HIV (B) Mumps
(C) Influenza (D) Herpes

37. The virus which has cancer causing genes:
(A) Oncovirus (B) Provirus
(C) Phage (D) Retrovirus

38. Which of the following can be found in all viruses?
(A) RNA
(B) Single stranded DNA
(C) Protein
(D) All of these

39. Which of following strand of virus serve as mRNA:
(A) ssDNA (B) +ssRNA
(C) dsDNA (D) -ssRNA

40. Which of the following is symptom of AIDS?
(A) Swollen lymph nodes (B) Weight loss
(C) Pneumonia (D) All of these

41. Oncoviruses are:
(A) Spherical (B) Rod shaped
(C) Cubical (D) Icosahedral

42. The nucleic acid of Even bacteriophages is mostly:
(A) Single stranded RNA
(B) Double stranded DNA
(C) Double stranded RNA
(D) Single stranded DNA

43. Rhabdovirus is:
(A) Tadpole shaped (B) Bullet shaped
(C) Spherical (D) Polyhedral

44. There are _____ capsomeres in herpes virus:
(A) 252 (B) 150
(C) 250 (D) 162

45. Which of the following structure of HIV is critical for cell fusion process:
(A) Matrix protein (B) gp41
(C) gp120 (D) all are correct

46. Which is derived from host cell?
(A) Nucleic acid (B) Envelope

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(C) Capsid (D) ALL of these

47. Which one is false about AIDS?
(A) HIV
(B) Acquired immunodeficiency syndrome
(C) Host specific
(D) B-lymphocyte

48. Enzyme used to incorporate viral DNA into host DNA:
(A) Reverse transcriptase (B) Integrase
(C) Proteases (D) DNA Polymerase

49. Viruses are _____ parasites:
(A) Intercellular obligate
(B) Intracellular obligate
(C) Facultative
(D) Unicellular

50. RNA retroviruses have a special enzyme which synthesizes the:
(A) Proteins (B) DNA
(C) RNA (D) DNA & RNA

51. Symptoms such as swollen lymph glands in neck, armpit and groin are found in which stage of AIDS:
(A) Asymptomatic carrier (B) Full blown AIDS
(C) AIDS-related complex (D) ART

52. Cells in _____ can also be infected by HIV in addition to Lymphocytes:
(A) Kidney (B) Lungs
(C) CNS (D) Spinal Fluid

53. HIV can't be transmitted by:
(A) Intimate sexual contact
(B) Mother to offspring
(C) Breathing
(D) Breast feeding

54. During the 1st step of reverse transcription which is used as template:
(A) DNA
(B) Single stranded RNA
(C) Double stranded RNA
(D) Both A & B

55. HIV infects and cause disease in:
(A) Monkeys (B) Birds
(C) Humans (D) Mammals

56. Once bound to the cell surface, the virus must enter:
(A) The genetic material into the cell
(B) The capsid into the host cell
(C) The envelope into the host cell
(D) All of these

57. Reverse transcription, carried out by retroviruses, is the process by which:
(A) RNA is duplicated
(B) DNA is duplicated
(C) RNA information is copied into DNA
(D) DNA information is copied into RNA

58. AIDS spread due to:
(A) Homosexuality
(B) Immoral way of life
(C) Infected needles and syringes
(D) All of the above

59. One important characteristic of viruses is that they:
(A) Can multiply outside a living cell
(B) Can be cultured in a cell-free medium
(C) Have an independent metabolism
(D) Do not have an independent metabolism

60. RNA particles causing symptoms like that of viral diseases are known as:
(A) Viral (B) Viroid
(C) Mycoplasma (D) Virion

61. Prions are:
(A) Infectious nucleic acids
(B) Infectious lipids
(C) Infectious protein
(D) Infectious nucleoproteins

62. The viral envelope is made of:
(A) Proteins (B) Lipids
(C) Carbohydrates (D) All of the above

63. Which of the following two Hepatitis viruses cause coinfection?
(A) Hepatitis A & B (B) Hepatitis B & D
(C) Hepatitis A & C (D) Hepatitis B & C

64. In some viruses, RNA is present instead of DNA indicating that:
(A) Their nucleic acid must be combined with host DNA before replication
(B) They cannot replicate
(C) There is no hereditary information
(D) RNA can act to transfer heredity

65. The large, enveloped RNA viruses cause:
(A) Polio
(B) Mumps and Measles
(C) Influenza
(D) Smallpox

66. The following is true about HIV EXCEPT:
(A) About 100nm in diameter
(B) Non-enveloped
(C) Enveloped in host plasma membrane

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(D) Spherical in shape

67. Most of the retroviruses can infect:
(A) Any cells of any organism
(B) Any cells of same organism
(C) Specific cell of any organism
(D) Specific cells with specific receptor site

68. Which of the following are of viral origin?

(A) 1,2,3,4 (B) 2,3,4,5
(C) 1,2,3,5 (D) 1,2,4,5

69. The AIDS was reported by some physicians in early 1980's in young homosexual males. They showed the following symptoms, EXCEPT:
(A) Severe pneumonia and a rare vascular cancer
(B) Rare pneumonia and severe vascular cancer
(C) Sudden weight loss and swollen lymph nodes
(D) Swollen lymph nodes and general loss of immune functions

70. Prions are pathogens that consists solely of:
(A) RNA (B) Proteins
(C) DNA (D) Lipids

71. Genetic material of retrovirus is:
(A) ssRNA (B) dsRNA
(C) ssDNA (D) dsDNA

72. RNA containing viruses belong to:
(A) Oncoviruses (B) Tumor viruses
(C) Retroviruses (D) All of them

73. Helical contractile sheath occurs in:
(A) Bacteria (B) Riboviruses
(C) Bacteriophage (D) Fungi

74. Bacteriophage is a:
(A) Virus which eats bacteria
(B) Bacterium which eats virus
(C) Virus which eats virus
(D) Stage in the bacterial life cycle

75. Mature and infectious particle which consist of nucleic acid and proteins:
(A) Virion (B) Capsid
(C) Viricide (D) Virusoids

76. The protein coat of viruses that enclose the genetic material is called _____:
(A) Virion (B) Capsid
(C) Peplomers (D) Capsomers

77. Which of the following statements are true about a virion?
(A) Lytic phage
(B) Lysogenic phage
(C) The viral capsid
(D) An infectious and fully formed viral particle

78. Which of the following is the genome of the virus?
(A) DNA (B) RNA
(C) DNA or RNA (D) DNA and RNA

79. Which of the following is the largest virus?
(A) Megavirus chilensis (B) Arbo virus
(C) Herpes virus (D) Mumps virus

80. Which of the following statements are true about the capsomeres?
(A) It is an individual unit of the capsid
(B) It is a viral protein for replication
(C) It is a unit of nucleic acid in viruses
(D) All of the above

81. Which of the following statements are true about the peplomers?
(A) It is an individual unit of capsids
(B) It is a spike-like projection on the enveloped viruses
(C) It is a projection on the viral membrane
(D) It is a spike-like projection on the capsids

82. An icosahedral capsid consists of_____:
(A) Hexagonal capsomeres
(B) Pentagonal capsomeres
(C) Triangular capsomeres
(D) Both A and B

83. Which of the following has a complex symmetry?
(A) T4 phage (B) Adenovirus
(C) Influenza virus (D) All of the above

84. Which of the following is a helical virus?
(A) TMV (B) T4 phage
(C) Poxvirus (D) Herpes virus

85. Which of the following statements are true about viruses?
(A) Free living
(B) Obligate parasites
(C) Ectoparasite
(D) Facultative parasite

86. Which of the following statements are true about the tobacco mosaic virus (TMV)?
(A) RNA virus (B) DNA virus

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(C) Voluntary muscles
(D) Both voluntary and involuntary muscles

112. This is a viral disease:
(A) Rickets (B) Measles
(C) Beri-Beri (D) Syphilis

113. This is a communicable disease:
(A) Rabies (B) Cancer
(C) Alkaptonuria (D) Phenylketonuria

114. Hydrophobia or rabies is a disease caused by:
(A) Protozoan (B) Nematode
(C) Virus (D) Helminth

115. Which part of plant is not affected by virus:
(A) Roots (B) Stem
(C) Leaves (D) Apical meristem

116. Viruses cannot replicate in:
(A) Blood plasma (B) Plant cell
(C) Skin cell (D) Hepatocytes

117. The genome of influenza virus is made up of:
(A) Single stranded RNA
(B) Double stranded DNA
(C) Single stranded DNA
(D) Double stranded RNA

118. Which of the following is ssDNA Virus:
(A) Adenovirus (B) Parvovirus
(C) Rubella virus (D) Reo virus

119. Identify the negative sense ssRNA Virus:
(A) Rhabdovirus (B) Orthomyxovirus
(C) Paramyxovirus (D) All of the above

120. Which of the following are positive sense ssRNA:
(B) Corona Virus (B) Rubella Virus
(C) Hepatitis C virus (D) All of the above

121. Which of the following is not RNA virus:
(A) Smallpox virus
(B) Influenza virus
(C) Mumps and measles virus
(D) Polio virus

122. Which of following virus cause polio and hepatitis-A:
(A) Paramyxovirus (B) Picorna virus
(C) Retrovirus (D) Oncovirus

123. The genome of most of animal viruses contains:
(A) DNA (B) RNA
(C) Both DNA & RNA (D) Protein

124. Among the following, _____enzyme is naturally found in human immunodeficiency virus?
(A) DNA polymerase (B) RNA polymerase
(C) Reverse transcriptase (D) Ligase

125. Which of the following is not related to enveloped virus:
(A) They survive for a longer time
(B) The envelope is sensitive to sunlight
(C) They are tolerant to antibodies
(D) Envelop is derived from host

126. Bacteriophage replicates only inside the:
(A) Animal cell (B) Plant cell
(C) Bacterial cell (D) Both A & B

127. The part of bacteriophage that enters the ho cell:
(A) Protein sheath (B) Protein coat
(C) Genome (D) Tail

128. Enzyme that is present in viruses also:
(A) Dehydrogenase (B) Lysozyme
(C) Urease (D) Arginase

129. Most commonly, lesions can be seen around mouth, lips and other skin sites:
(A) Influenza (B) Polio
(C) Mumps (D) Herpes

130. All of the following are viral diseases except:
(A) Influenza (B) Polio
(C) Mumps (D) Tetanus

131. Hepatitis A Virus is:
(A) ssRNA (B) ssDNA
(C) dsDNA (D) dsRNA

132. Viral inflammation of parotid gland is commo associated with:
(A) Mumps (B) Smallpox
(C) Herpes simplex (D) Influenza

133. HAV is transmitted through:
(A) Blood (B) Serum
(C) Oro-fecal route (D) Syringes

134. Viruses that attack on spinal cord is:
(A) Rabies (B) HIV
(C) Toga Virus (D) Polio virus

135. Hepatitis "C" is also known as:
(A) Infectious Hepatitis (B) Serum Hepatitis
(C) Infusion Hepatitis (D) Delta Hepatitis

136. Prions were discovered by:
(A) Stanely B. Prusiner (B) Theodor O. Dien
(C) W.M Stanely (D) Louis Pasteur

137. Which of following pair of disease is viral:
(A) Rabies and Measles
(B) Cholera and Tuberculosis
(C) Typhoid and Tetanus
(D) AIDS and Syphilis

138. Which of the following disease is caused by viroid's:

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(A) Hepatitis B (B) Hepatitis C
(C) AIDS (D) Hepatitis D

139. _____is known cause cancer in animals:
(A) Polio virus
(B) HIV
(C) HBV
(D) Rous sarcoma virus

140. It is act as template for reverse transcriptase:
(A) Viral DNA (B) Host DNA
(C) Viral RNA (D) T-Lymphocytes

141. The phenomena of transcription in HIV life cycle occurs in:
(A) Nucleus (B) Cytoplasm
(C) Inside viral capsid (D) On CD4 receptors

142. The attachment of HIV DNA with host DNA is done via action of:
(A) Integrase
(B) Protease
(C) Ligase
(D) Reverse transcriptase

143. Uncoating of HIV virion occurs:
(A) In nucleus of host cell
(B) Outside the host cell
(C) In cytoplasm of host cell
(D) On CD4 Receptors

144. Which of following cell does HIV mainly infect:
(A) T-killer lymphocytes
(B) T-helper lymphocytes
(C) T-Cytotoxic lymphocytes
(D) All of the above

145. Which one is not an opportunistic disease related to HIV infection:
(A) Destruction of body immune system
(B) Pulmonary tuberculosis
(C) Recurrent pneumonia
(D) Toxoplasmosis

146. Different medicines are used in combination to treat HIV. This method is called:
(A) ART (B) ELISA
(C) CT Scan (D) EEG

147. The drugs which are found remarkable results against AIDS:
(A) Rukobia (B) Descovy
(C) Truvada (D) All of above

148. Identify the final stage of AIDS where there is severe weight loss and weakness due to persistent diarrhea:
(A) Asymptomatic carrier (B) ARC
(C) Full blown AIDS (D) Both A and C

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149. Which one of the following diseases is caused by enveloped RNA virus and spread inepidemic form? (2011)
(A) Influenza (B) Polio
(C) Herpes simplex (D) Smallpox

150. In HIV viruses, reverse transcriptase converts single stranded RNA into doublestranded viral DNA. This process is called: (2012)
(A) Translation
(B) Replication
(C) Duplication
(D) Reverse transcription

151. Reverse transcriptase is used to make DNA copies of: (2013)
(A) Host RNA (B) Viral DNA
(C) Host DNA (D) Viral RNA

152. What are the sequence of steps in which a bacteriophage attacks bacteria and injects its DNA? (2014)
(A) Landing → Tail contraction → Penetration → DNA injection
(B) Penetration → Landing → Tail contraction → DNA injection
(C) Tail contraction → Landing → DNA injection → Penetration
(D) Landing → Penetration → Tail contraction → DNA injection

153. Which one of the following cells is mainly infected by HIV? (2014)
(A) T-killer lymphocytes (B) B-plasma cells
(C) T-helper lymphocytes (D) B-memory cells

154. HIV is classified as: (2015)
(A) Bacteriophage (B) Retrovirus
(C) Oncovirus (D) Icosahedral virus

155. All viruses can reproduce within living organisms only, so they are known as: (2016)
(A) Ectoparasites
(B) Endoparasites
(C) Obligate intracellular parasite
(D) Facultative intracellular parasites

156. Which one of the following is a non-cellular infectious entity? (2017)
(A) Mycoplasma (B) Herpes virus
(C) Escherichia coli (D) Diplococcus

157. The Phage viruses can reproduce: (2017)
(A) Without invading any cell
(B) By mitosis
(C) In bacterial cell

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(D) By meiosis

158. The life cycle in which phage kills the bacteria is known as: (2017)
(A) Transduction
(B) Lytic cycle
(C) Temperate phage cycle
(D) Lysogenic phage cycle

159. What is size range of viruses: (2017-Retake)
(A) 250nm to 200nm (B) 200nm to 20nm
(C) 250nm to 100nm (D) 250nm to 20nm

160. Reverse transcriptase is used to make DNA copies of: (2017-Retake)
(A) Host RNA (B) Viral DNA
(C) Host DNA (D) Viral RNA

161. In viruses combined structure formed by core (Nucleic acid) and capsid is: (2018)
(A) Nucleocapsid (B) Prion
(C) Envelope (D) Capsomere

162. Lysogenic viruses are also known as: (2018)
(A) Enveloped phage (B) Bacteriophage
(C) Prophage (D) Virulent phage

163. Capsid the protective coat of a virus is made up of _____ subunit known as capsomere: (2019)
(A) Lipid (B) RNA
(C) Protein (D) DNA

164. Which of the following is not related to enveloped viruses: (2020)
(A) They survive for a short time
(B) The envelope is sensitive to sunlight
(C) They are tolerant to antibodies
(D) Envelop is derived from host

165. Numerous opportunistic diseases might attack a person suffering from the following disease: (2020)
(A) Measles (B) Hepatitis A
(C) Influenza (D) AIDS

166. The complete mature infectious particle is known as: (2020)
(A) Venom (B) Virion
(C) Genome (D) Capsid

167. Which of the following is not true about HIV: (2020)
(A) It is retrovirus
(B) It does not cause AIDS
(C) It is surrounded by an envelope
(D) It causes the deficiency of human immune system

168. What does the term bacteriophage refer to: (2022)
(A) A virus that infect bacteria
(B) A bacterium that infect virus
(C) A virus which behaves as bacteria
(D) Combination of bacterium & virion

169. Which of the following virus contain single stranded DNA: (2022)
(A) Adenovirus (B) Parvo virus
(C) Herpes virus (D) Pox virus

170. How many tail fibers are attached to end plate of a bacteriophage: (2022)
(A) 2 (B) 8
(C) 6 (D) 10

171. The enzyme integrase, protease and reverse transcriptase found in which virus: (2022)
(A) Hepatitis A virus (B) Herpes virus
(C) Influenza virus (D) HIV

172. The provirus of HIV is structurally and chemically: (2023)
(A) ssRNA (B) dsRNA
(C) ssDNA (D) dsDNA

173. The molecule uses to control virus during infection of animal cells are: (2023)
(A) Interferon (B) Antigen
(C) Histone (D) Serum

174. Virus is what type of agent: (2023)
(A) Cellular agent
(B) Non-infectious agent
(C) Infectious agent
(D) Non-protein agent

175. Which of the following virus contains single stranded DNA: (2023)
(A) Adenovirus (B) Parvo virus
(C) Herpes virus (D) Pox virus

176. Example of viruses having a polyhedral capsid that is with 252 capsomeres is: (UHS 2024)
(A) Adenovirus (B) Influenza virus
(C) Tobacco Mosaic Virus (D) Bacteriophage

177. The complete, mature and infectious particle of virus is known as: (UHS 2024)
(A) Genome (B) Prion
(C) Capsomeres (D) Virion

178. The causative organism of measles is: (UHS 2024)
(A) Poxvirus (B) Picornavirus
(C) Paporivirus (D) Paramyxovirus

179. In the life cycle of bacteriophage, lysozymes are required in the following steps of infection process: (UHS 2024)
(A) Genome injection (B) Penetration

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(C) Penetration (D) Adsorption

180. _____ is transmitted through infected blood and hypodermal syringes: (UHS 2024)
(A) HIV (B) Morbilli virus (Measles)
(C) Influenza virus (D) Vibrio Cholerae (Cholera)

181. Which of the following is NOT true about viruses: (ETEA 2024)
(A) Contain DNA
(B) Can replicate on their own
(C) Can infect bacteria
(D) They have a sub-cellular structure

182. The genetic code of _____ is bound by a lipid membrane: (ETEA 2024)
(A) Enterovirus (B) Flu virus
(C) Hepatitis A virus (D) Polio virus

183. Viruses can NOT_____: (ETEA 2024)
(A) Crystalise (B) Excrete
(C) Infect bacteria (D) Mutate

184. Where are the enzymes required for the replication of HIV virus located: (ETEA 2024)
(A) In the protein spikes
(B) Surrounding the viral core
(C) Inside the capsid
(D) Outside the capsid

185. Corona Virus is enveloped virus. Hand sanitizers and surface cleaners were recommended to avoid covid epidemic. Which property of corona virus made these products effective: (NUMS 2024)
(A) pH Sensitivity (B) Heat Sensitivity
(C) ss RNA genome (D) Hypotonicity

186. Which of the following virus has a double standard DNA genome: (NUMS 2024)
(A) Rubella (B) Influenza
(C) HIV (D) Smallpox

187. Protein which causes disease in humans and animals is called: (DUHS 2024)
(A) Virions (B) Viroids
(C) Prions (D) Prophage

188. Which virus kills cancer cells and aids immunity: (DUHS 2024)
(A) Saccharomyces (B) Lactobacillus
(C) Lymphobacterium (D) Oncolytic

189. During which stage of bacteriophage replication, lysozyme is involved: (SZABMU 2024)
(A) Adsorption (B) Attachment
(C) Multiplication (D) Penetration

190. Who purified filterable agents for the first time: (SZABMU 2024)
(A) Charles Chamberland (B) Ivanowski
(C) Louis Pasteur (D) Stanley

191. The side of sheath attached to head region in bacteriophage is termed as: (SZABMU 2024)
(A) Capsid (B) Collar
(C) Core (D) End Plate

192. CD_4 receptors are found in all type of cells except: (IBA 2024)
(A) Helper T cells (B) MHCH
(C) Suppressor T cells (D) Brain cells

193. A Russian scientist discovered that the certain diseases could be transmitted by an agent that could pass through very fine filter: (IBA 2024)
(A) Bacteria (B) Fungi
(C) Algae (D) Virus

194. Example of reverse transcribing single stranded RNA virus are: (IBA 2024)
(A) Hepatitis B (B) HIV
(C) Rabies (D) Chicken Pox

195. Viruses are called non-cellular infectious entities because: (IBA 2024)
(A) They are pathogenic and cause infection
(B) They can replicate inside as well outside of the living cell
(C) They cause infections, and can only replicate inside the living cell
(D) They have capsid to infect the host

196. Viruses can be classified on the basis of: (BUMHS 2024)
(A) Shape (B) Nucleic acid
(C) Envelope (D) All of these

197. Poliomyelitis mostly occurs in: (BUMHS 2024)
(A) Childhood
(B) Adulthood
(C) In old age
(D) Difficult to say about

198. Symptoms of Hepatitis are: (BUMHS 2024)
(A) Loss of immunity
(B) Loss of helper T cells
(C) Blood Cancer
(D) None of the options given

199. The conversion of lysogenic cycle into lytic cycle is called: (BUMHS 2024)
(A) Conduction (B) Production
(C) Induction (D) None of these

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Answer Key

1. B	2. D	3. C	4. A	5. A	6. B	7. A	8. C	9. C	10. C
11. A	12. A	13. D	14. A	15. A	16. D	17. D	18. B	19. C	20. A
21. B	22. D	23. B	24. C	25. D	26. A	27. B	28. B	29. B	30. D
31. C	32. A	33. C	34. C	35. C	36. A	37. A	38. C	39. B	40. D
41. A	42. B	43. B	44. D	45. B	46. B	47. D	48. B	49. B	50. B
51. C	52. C	53. C	54. B	55. C	56. A	57. C	58. D	59. D	60. B
61. C	62. D	63. B	64. D	65. B	66. B	67. D	68. C	69. B	70. B
71. A	72. D	73. C	74. A	75. A	76. B	77. D	78. C	79. A	80. A
81. B	82. D	83. A	84. A	85. B	86. A	87. A	88. C	89. C	90. C
91. B	92. C	93. C	94. B	95. D	96. D	97. A	98. B	99. C	100. A
101. C	102. A	103. A	104. A	105. A	106. C	107. C	108. D	109. C	110. B
111. C	112. B	113. A	114. C	115. D	116. A	117. A	118. B	119. D	120. D
121. A	122. B	123. B	124. C	125. C	126. C	127. C	128. B	129. D	130. D
131. A	132. A	133. C	134. D	135. C	136. A	137. A	138. D	139. D	140. C
141. A	142. A	143. C	144. B	145. A	146. A	147. D	148. C	149. A	150. D
151. D	152. A	153. C	154. B	155. C	156. B	157. C	158. B	159. D	160. D
161. A	162. C	163. C	164. C	165. D	166. B	167. B	168. A	169. B	170. C
171. D	172. D	173. A	174. C	175. B	176. A	177. D	178. D	179. C	180. A
181. B	182. B	183. B	184. C	185. A	186. D	187. C	188. D	189. D	190. D
[illegible]	[illegible]	193. D	194. B	195. C	196. D	197. A	198. D	199. C	

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UNIT # 02

BIO-ENERGETICS

High Yield Content:

- Non-Cyclic & Cyclic Photophosphorylation
- Calvin cycle
- Chemiosmosis
- Glycolysis
- Krebs cycle
- Respiratory ETC

SCAN QR CODE to Watch MDCAT Lectures, Test Discussions, and Past Papers Discussion on "Bioenergetics"

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BIO-ENERGETICS: KEY CONCEPTS

- Quantitative study of energy relationship and energy conversion in biological systems.
- Biological energy transformation obeys the law of thermodynamics.
- Ultimate source of energy in ecosystem is solar energy.
- ATP is a chemical link between anabolism and catabolism.

Photosynthesis	Cellular Respiration
Energy capturing process	Energy releasing process
Anabolic process	Catabolic process
Occurs in plants, algae, and photosynthetic bacteria	Occurs in all living organisms (plants, animals, fungi, and microbes) except viruses
Convert light energy into chemical energy.	Converts chemical energy from glucose into usable energy (ATP).
Occurs in the chloroplasts (In eukaryotes). Photosynthetic Prokaryotes lack Chloroplast, but they do have unstacked photosynthetic membrane which work like thylakoids.	Occurs in the mitochondria (in eukaryotic cells) and cytoplasm. In prokaryotes take place in cell membrane.
Occurs only in the presence of light.	Occurs 24/7, both day and night.
Electron carrier: $NADP^+ \rightarrow NADPH$.	Electron carrier: $NAD^+ \rightarrow NADH$ and $FAD \rightarrow FADH_2$.
1. Light-dependent reactions (in thylakoid membranes). 2. Calvin Cycle (in stroma).	1. Glycolysis (in cytoplasm). 2. Oxidation of Pyruvate (in mitochondrial matrix). 3. Krebs Cycle (in mitochondrial matrix). 4. Electron Transport Chain (inner mitochondrial membrane).
Takes in CO_2 and releases O_2.	Takes in O_2 and releases CO_2.
Endothermic (requires energy input).	Exothermic (releases energy).
$6\,CO_2 + 12\,H_2O$ + light energy $\rightarrow C_6H_{12}O_6 + 6O_2 + 6\,H_2O$	$C_6H_{12}O_6 + 6\,O_2 \rightarrow 6\,CO_2 + 6\,H_2O + ATP$

PHOTOSYNTHESIS

- Redox process
- Energy poor inorganic compounds are converted into energy rich organic compound.
- Help to maintain carbon dioxide and oxygen balance in the atmosphere.
- Base of food chains by producing energy-rich compounds.
- About 10% of total photosynthesis is carried by terrestrial plants and the rest occurs in oceans, lakes and ponds.
- Compensation point: At dawn and dusk (low light intensity) rate of photosynthesis becomes equals to rate of respiration and no net gaseous exchange between plants and atmosphere.
- Oxygen release during photosynthesis comes from water not from carbon dioxide (Van Niels Hypothesis 1930s). The Niels hypothesis was based on his investigation into photosynthesis in bacteria. Later on, this is confirmed by Scientists (Samuel Ruben and Martin Kamen 1940s) by using isotopic tracer (O^{18}).

PHOTOSYNTHETIC PIGMENTS

- Pigments are the substances that absorb visible light (380-750nm in wavelength: Very small part of electromagnetic spectrum).
- Light which is absorbed has disappeared and is effective for photosynthesis.
- Spectrophotometer is an instrument to measure relative abilities of different pigments to absorb different wavelength.

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- Thylakoid (membrane in chloroplast) contains several kinds of pigments, but chlorophylls are the main photosynthetic pigments.

Chlorophylls

- Insoluble in water but soluble in organic solvent.
- Four types of chlorophylls (a, b, c, d) are found in eukaryotes (Plants and algae).
- Cyanobacteria (Prokaryote) also contains Chlorophyll-a.
- Bacteriochlorophyll is found in photosynthetic bacteria (green sulfur bacteria, purple sulfur and purple non- sulfur bacteria).
- Chlorophylls mainly absorb violet blue and orange red wavelength, green and yellow are least absorbed.

Features	Chlorophyll-a	Chlorophyll-b
Color	Blue green	Yellow green
Molecular Formula	$C_{55}H_{72}O_5N_4Mg$	$C_{55}H_{70}O_6N_4Mg$
Functional group	$-CH_3$ (on 2nd pyrrole ring)	-CHO (on 2nd pyrrole ring)
Forms	Differ slightly in their red absorbing peaks e.g. 670,680,690,700	No Such different forms
Absorption Peak Wavelengths	430–450 nm (Violet-blue) 660–700 nm (Red)	450–500 nm (Blue) 620–660 nm (Orange-Red)
Pigment	Chlorophyll-a is the primary photosynthetic pigment	Chlorophyll-b is the accessory pigment
Presence	It is universally present in all photosynthetic organisms except bacteria.	It is present only in green algae and in the plants.

- Chlorophyll-c ($C_{36}H_{28}O_7N_4Mg$) found in brown algae, diatoms and dinoflagellates.
- Chlorophyll-d ($C_{54}H_{70}O_6N_4Mg$) is present only in red algae and cyanobacteria.

Structure Of Chlorophylls	
Head	**Tail**
- Hydrophilic (polar) - Flat, square, light absorbing part composed of porphyrin ring with Mg^{2+} in a Centre. - Porphyrin, made of 4 pyrrole rings (Tetrapyrrole). - Each pyrrole contains 4 carbon and 1 nitrogen. - Nitrogen of each pyrrole interact with central Mg^{2+} atom. - Head of chlorophyll exposed on surface of thylakoid membrane.	- Hydrophobic (non-polar) - Two side chains of chlorophyll are called tail. One side chain consists of long chain terpenoids alcohol Phytol ($C_{20}H_{39}$) and linked with 4th pyrrole ring. - The other side chain consists of methyl ester (CH_3) and linked between 3rd and 4th pyrrole ring. - Tail of chlorophyll embedded in the hydrophobic core of thylakoid membrane.

Carotenoids: Accessory Pigments

- Carotenoids are chemically terpenoids (Lipids) categorized into two classes Carotene and Xanthophylls.
- Accessory pigments broaden the range of light absorption for photosynthesis.
- Protect chlorophyll from intense light.
- Attract insects, bird and other animals for pollination and seed dispersal.
- Color of Carotenoids: Yellow, Orange, Red
- Wavelength strongly absorbed by Carotenoids: 400-500 nm
- Strongly absorbed Colors by Carotenoids: Blue, Green
- Anthocyanin: Water soluble pigment in plant

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Types of Carotenoids	
Carotene	**Xanthophylls**
Orange to Red in color.	Yellow to Orange in color.
The most important and widespread form is **β-carotene ($C_{40}H_{56}$).**	The most important and widespread forms are **Lutein and Zeaxanthin ($C_{40}H_{56}O_2$).**
Found in plants and fruits, **especially carrots** and colorful vegetables.	Lutein and Zeaxanthin are found in **green leafy vegetables** and other food like eggs.
β-carotene is a Provitamin-A compound, converting in the body to **retinol (vitamin A)** which protects eyes.	The **yellow color of leaves** in autumns is due to **Lutein.** The xanthophylls of **brown algae** are called **Fucoxanthin.**

Order of energy transfer in pigments

Carotenoids ⟶ Chlorophyll-b ⟶ Chlorophyll-a

ROLE OF LIGHT

- Light behaves as waves as well as sort of particles called **Photons.**
- **Only 1%** of light falling on the leave surface is absorbed.
- **Visible light spectrum** (380-750nm Wavelength) is the segment of the electromagnetic spectrum that the human eye can view.
- **Colors of Visible light Spectrum:** Violet, Indigo, Blue, Green, Yellow ,Orange, Red **(VIBGYOR).**
- Red light has the **longest wavelength** while violet light has the **shortest wavelength.**

Types of Spectra	
Absorption Spectrum	**Action Spectrum**
- Graph shows relative **absorption of different wavelength.** - Peaks of chlorophyll graph are narrower and valley broader and deep. - **Chlorophyll "a" and "b"** shows more absorption in **violet-blue (400nm-470nm)** and **orange-red (630-670nm)** - **Carotenoids** show more absorption at **430-500nm).** - **The least absorbed** colors are **Green and yellow (500-600nm wavelength).**	- Graph shows **relative effectiveness** of different wavelength of light in driving photosynthesis. - Peaks of chlorophyll graph are broader and deep, and valley is narrower and not deep. - **First action spectrum** obtained by **T.W Engelmann in 1883** while working in **spirogyra (Filamentous green alga).** - It is indicated that **blue (430nm)** and **red (670nm)** wavelengths are **most effective for photosynthesis.** - When **equal intensities** of light are given, there is **more photosynthesis in red part.**

ROLE OF CARBON DIOXIDE

- Act as carbon source for synthesis of organic compounds.
- In **Dark reaction** (Light independent phase), there is the **reduction of CO_2** and formation of carbohydrates take place.
- Photosynthesis on land utilizes atmospheric **CO_2 (0.03-0.04 % in air)**
- Photosynthesis in water **(Aquatic organisms)** utilizes **CO_2** dissolved in water, in the form of **bicarbonates and carbonates.**
- CO_2 enters plants through stomata (1-2% of leaf surface) that are regulated by guard cells.

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PHOTOSYSTEMS

- Clusters of photosynthetic pigments are called photosystem.
- These pigments are organized on thylakoids membranes for absorption and utilization of solar energy.
- There are two components of photosystem: **1- Antenna Complex 2- Reaction Centre**
- **Antenna Complex** is the **peripheral part** of Photosystem and consists of **chlorophyll-a, chlorophyll-b and carotenoids.** This part absorbs light energy and channelizes it to reaction center by **resonance.**
- **Reaction Centre** is the **central part of photosystem** and is constituted by **chlorophyll-a** along with **associated protein** Primary electron acceptor.

Types of Photosystems

Photosystem-I (P_{700})	Photosystem-II (P_{680})
Chlorophyll-a molecule in reaction center absorbs a maximum light of **700nm.**	Chlorophyll-a molecule in reaction center absorbs a maximum light of **680nm.**
Located on the **outer surface** of the thylakoid membrane.	Located on the **inner surface** of the thylakoid membrane.
Iron-sulfur type reaction Centre.	**Quinone** type reaction Centre.

MECHANISM OF PHOTOSYNTHESIS

- Photosynthesis is a **redox process** (Both Reduction and Oxidation take place).

Reactions of Photosynthesis

Light Reaction	Dark Reaction
Light dependent phase / **Z-Scheme**	Light Independent reaction / **Calvin Cycle / C_3 Pathway** (First stable compound is **3-carbon PGA**).
Occurs in **thylakoid membrane**	Occurs in **stroma** of chloroplast
Products are ATP (**Assimilating Power:** Source of chemical energy) & NADPH (**Reducing Power:** Store energized electrons) and **Oxygen.**	**3-Phase: 1**-Carbon Fixation, **2**-Reduction, **3**-Renegeration of CO_2 acceptor
Photolysis of water take place.	Utilization of light reaction products (ATP & NADPH)
Chemiosmosis: ATP Producing Mechanism.	Synthesis of sugar (**G_3P: A triose**)
Passage of electrons PS-II → PEA → Pq → Cytochrome Complex (b6f) → Pc → PS-I → PEA → Fd → $NADP^+$	Equation $CO_2+6NADPH+9ATP \rightarrow (CH_2O)_3+6NADP^++9ADP+9Pi+3H_2O$

Photophosphorylation (ADP+Pi → ATP)

Non-Cyclic	Cyclic
Occurs under **normal conditions.**	Occurs in **certain condition** (ATP deficiency and NADPH accumulation).
Electrons flow in a linear pathway, they are not reused	Electron are reused.
The first **electron donor is water.**	The first **electron donor is PS-I.**
Involve both photosystems(PS-I & PS-II).	It involves only PS-I.
Produces **both ATP and NADPH.**	It generates **only ATP.**
Photolysis occurs and release of oxygen.	**No splitting of water.**
It is a **long pathway.**	**It is a short circuit.**
The last electron acceptor is **$NADP^+$.**	**The last electron acceptor** is P_{700}

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CHEMIOSMOSIS

- The **production of ATP** by the movement of **proton (H^+)** across **thylakoid membrane** is called **Chemiosmosis.**
- In the first step, **proton pumps that move protons from the stroma into the thylakoid lumen (Active Transport).**
- The **energy** used for this **pumping** comes from **electrons** moving through ETC. This energy is transformed into **potential energy** stored in the form of **proton (H^+) gradient** (higher concentration inside the lumen than in the stroma).
- In the second step, protons **flow back into the stroma by facilitated Diffusion** through **ATP synthase** enzyme which acts as a channel.
- As protons pass through **ATP synthase**, their kinetic energy drives the conversion of **ADP and inorganic phosphate (Pi)** into **ATP.**

CELLULAR RESPIRATION

- Cellular Respiration is **Universal Chemical process** in which organism **acquire energy** by the **breakdown of glucose.** This is essentially an **oxidation process.**
- **External Respiration:** Exchange of gases between organism and environment.
- **Internal Respiration:** Gas exchange occurs at the level of body tissues.

Types of Cellular Respiration

Aerobic	Anaerobic (Fermentation)
Occurs in the presence of oxygen	Occurs in the absence of oxygen
Complete breakdown of glucose	Incomplete breakdown of glucose
Yield maximum energy **(Total 40 ATP)**, Net **36 ATP** (In Eukaryotes) & **38 ATP** (In Prokaryotes).	Yield only small amount of energy **(Total 4 ATP)**, **Net 2 ATP** (Both in Prokaryote & Eukaryotes).
Started in cytoplasm (Glycolysis) and **completed in Mitochondria** (Eukaryotes) and **Cell membrane** (Prokaryotes).	Started in Cytoplasm **(Glycolysis)** and completed in Cytoplasm **(Alcoholic and Acidic fermentation).**

Types of Fermentation (Anaerobic)

Acidic Fermentation	Alcoholic Fermentation
Occurs in **anaerobic bacteria and muscles cells.**	Occurs **in yeast** (Unicellular fungus)
Glycolysis followed by **reduction** of pyruvate by NADH **to lactic acid.**	Glycolysis is followed **by decarboxylation** of pyruvate to acetaldehydes and then **reduction** of acetaldehyde by NADH to **ethanol/ ethyl alcohol.**
Lactic acid (accumulation cause muscle fatigue) in skeletal muscles is converted back to glucose by **Cori cycle** (in Liver).	
$2(C_3H_4O_3) \xrightarrow{2NADH_2 \rightarrow 2NAD} 2(C_3H_6O_3)$ Pyruvate → Lactate	$2(C_3H_4O_3) \xrightarrow{2NADH_2 \rightarrow 2NAD} 2(C_2H_5OH) + 2CO_2$ Pyruvate → Ethyl Alcohol

MECHANISM OF AEROBIC RESPIRATION

- It is completed in **four phases**
  1. **Glycolysis (EMP Pathway)**
  2. **Pyruvic acid oxidation (Link Reaction)**
  3. **Krebs Cycle / Citric acid Cycle / Tricarboxylic acid cycle (TCA)**
  4. **Respiratory Electron Transport Chain (ETC)**

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GLYCOLYSIS (EMP PATHWAY)

- Breakdown of glucose into **two molecules of pyruvates.**
- Occurs in **cytosol (Cytoplasm)**
- **Common step** in aerobic and anaerobic respiration.
- Occurs in presence as well as absence of oxygen.
- There are **two phases** in glycolysis.

Preparatory phase (Investment)	Oxidative phase (payoff)
Comprises of step **1-5 of glycolysis.** **Two molecules** of ATP consumed. The **end product** is two molecules of trioses (G_3P & DHAP).	Comprises of step **6-10 of glycolysis.** **Four molecules of ATP** are produced by **substrate level Phosphorylation.** Two molecules of **NADH** are produced

Steps of Glycolysis

STEP #	Reaction	Enzyme
01	Glucose converted into Glucose 6-phosphate. A molecule of ATP used	Hexokinase
02	Glucose 6-phosphate converted into Fructose 6-phosphate	Phosphohexose isomerase
03	Fructose 6-phosphate converted into Fructose 1-6 bisphosphate. A molecule of ATP used	Phosphofructokinase
04	Fructose 1-6 bisphosphate break into G_3P and DHAP	Aldolase
05	DHAP converted into another molecule of G_3P	Triose phosphate isomerase
06	2 molecules of G3P oxidized into 2 molecules of 1-3 bisphosphoglycerate by addition of an inorganic phosphate. 2 molecules of NAD converted into 2 molecules of NADH	Glyceraldehyde 3-phosphate dehydrogenase
07	2 molecules of 1-3 bisphosphoglycerate converted into 2 molecules of 3-phosphoglycerate. 2 ATP molecules are produced	Phosphoglycerate kinase
08	2 molecules of 3-phosphoglycerate converted into 2 molecules of 2-phosphoglycerate.	Phosphoglycerate mutase
09	2 molecules of 2-phosphoglycerate converted into 2 molecules of phosphoenolpyruvate (PEP). 2 molecules of water removed.	Enolase
10	2 molecules of phosphoenolpyruvate (PEP) converted into 2 molecules of Pyruvate. 2 ATP molecules are produced	Pyruvate kinase

OXIDATION OF PYRUVATE (LINK REACTION)

- Pyruvate is produced in cytoplasm, and it must **enter mitochondria** by **active transport** through **Pyruvate translocase** (Transport protein in inner membrane of mitochondria).
- In mitochondrial matrix, Pyruvate converted into **acetyl Co-A** by oxidative decarboxylation.
- **Two molecules of NADH** are produced.
- **No ATP production** by substrate level phosphorylation.

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1. **Molecular formula of chlorophyll "a" is:**
   (A) $C_{55}H_{72}O_5N_4Mg$ (B) $C_{55}H_{70}O_6N_4Mg$
   (C) $C_{55}H_{70}O_5N_4Mg$ (D) $C_{54}H_{70}O_6N_4Mg$
2. **Chlorophyll "a" itself exists in several forms differing slightly in their:**
   (A) Blue absorbing peaks
   (B) Green absorbing peaks
   (C) Red absorbing peaks
   (D) Violet absorbing peaks
3. **Carotenoids absorb strongly the:**
   (A) Violet-Yellow range
   (B) Orange-Red range
   (C) Blue-Violet range
   (D) Red-Violet range
4. **An absorption spectrum of chlorophyll has:**
   (A) Narrow peaks
   (B) Narrow valley
   (C) Broad peaks
   (D) Narrow peak, broad valley
5. **Pick up the one that provides energized electrons:**
   (A) ATP
   (B) Assimilatory power
   (C) $NADPH_2$
   (D) ADP
6. **The high energy electrons from the reaction center of photosystem are trapped by:**
   (A) Primary electron acceptor
   (B) Electron transport chain
   (C) Oxidized coenzyme
   (D) Accessory pigments
7. **The electron "hole" of the oxidized chlorophyll of PS-II is filled by the electrons which are extracted from:**
   (A) PS-I
   (B) PS 700
   (C) Water
   (D) Reduced coenzyme
8. **The copper containing electron carrier in photosynthetic electron transport chain is:**
   (A) PQ (B) PC
   (C) Cytochrome b (D) Cytochrome f
9. **As electrons move down the photosynthetic electron transport chain, their energy goes on:**
   (A) Increasing (B) Decreasing
   (C) Fluctuating (D) Stabilized
10. **During non-cyclic electron flow of photosynthesis all of the following are generated EXCEPT:**
    (A) ATP (B) NADPH
    (C) Oxygen (D) Water
11. **The number of electrons required to reduce $NADP^+$ is:**
    (A) One (B) Two
    (C) Three (D) Four
12. **In cyclic electron flow, the electrons cycle back from primary electron acceptor to:**
    (A) PS-I
    (B) Ferredoxin
    (C) Cytochrome complex
    (D) Plastocyanin
13. **The energy of these compounds is used in the formation of carbohydrates from CO_2:**
    (A) FADH, NADH (B) ATP, NADH
    (C) ATP, NADPH (D) ATP, FADH
14. **Pick up the choice not true with respect to dark reaction of photosynthesis:**
    (A) It requires darkness
    (B) It is formation of carbohydrates
    (C) It may occur in light as well
    (D) It involves reduction of carbon dioxide
15. **In Calvin cycle, initial incorporation of CO_2 into organic material is called:**
    (A) Reduction of CO_2
    (B) Fixation of CO_2 acceptor
    (C) Fixation of CO_2
    (D) Regeneration of RuBP
16. **When a molecule of Ribulose bisphosphate is condensed with a molecule of CO_2 in Calvin cycle, the product is:**
    (A) Highly unstable six carbon intermediate
    (B) 3 Phosphoglycerate
    (C) 1,3 Bisphosphoglycerate
    (D) Glyceraldehyde 3 phosphate
17. **The first stable compound formed in Calvin cycle is:**
    (A) Highly unstable six carbon intermediate
    (B) 3 Phosphoglycerate
    (C) 1,3 Bisphosphoglycerate
    (D) Glyceraldehyde 3 phosphate
18. **The number of CO_2, $NADPH_2$ and ATP molecules required to synthesize one glucose molecule from the output of C_3 pathway is respectively:**
    (A) 3,6,9 (B) 6,12,18

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(C) 12,24,36 (D) 24,48,72

19. **The most common fuel used by the cell to provide energy by cellular respiration is:**
(A) Glyceraldehyde 3 phosphate
(B) Glucose
(C) Sucrose
(D) Pyruvate

20. **It is not an accessory pigment of photosynthesis:**
(A) Carotenes (B) Chlorophyll-b
(C) Chlorophyll-a (D) Xanthophylls

21. **All of the following are involved in cyclic electron flow during light reaction except:**
(A) Plastocyanin
(B) Primary electron acceptor
(C) NADP reductase
(D) Ferredoxin

22. **The use of ATP and NADPH during one Calvin cycle is in proportion:**
(A) 12 ATP and24NADPH
(B) 10 ATP and 12NADPH
(C) 9 ATP and 6NADPH
(D) 6 ATP and 9NADPH

23. **All of the following are products of light reactions of photosynthesis except:**
(A) ATP (B) Glucose
(C) O_2 (D) NADPH

24. **Which of the following provides energized electrons and chemical energy during dark reaction respectively?**
(A) NADH and ATP (B) $NADPH_2$ and ATP
(C) ATP and NADPH (D) Glucose and H_2O

25. **Correct sequence of flow of electrons during light reaction of photosynthesis:**
(A) Cytochrome complex, Plastoquinone, Plastocyanin
(B) Cytochrome complex, Plastocyanin, Plastoquinone
(C) Plastoquinone, Cytochrome complex, Plastocyanin
(D) Plastoquinone, Plastocyanin, Cytochrome complex

26. **The fixation of CO_2 requires an acceptor molecule:**
(A) RuBP (B) Oxaloacetate
(C) Rubisco (D) Citrate

27. **Which is the correct order of energy transfer from accessory pigments to main photosynthetic pigment?**
(A) Carotenoids → chlorophyll a → chlorophyll b
(B) Chlorophyll a → carotenoids → chlorophyll b
(C) Carotenoids → chlorophyll b → chlorophyll a
(D) Chlorophyll b → carotenoids → chlorophyll a

28. **Pick the correct order of respiratory chain:**
(A) Coenzyme-Q → Cytochrome-a → Cytochrome-c → Cytochrome-a_3 → Cytochrome-b
(B) Cytochrome-a_3 → Coenzyme-Q → Cytochrome-c → Cytochrome-b → Cytochrome-a
(C) Cytochrome-c → Cytochrome-b → Cytochrome-a → Cytochrome-a_3 → Coenzyme-Q
(D) Coenzyme-Q → Cytochrome-b → Cytochrome-c → Cytochrome-a → cytochrome-a_3

29. **In which step of Krebs cycle decarboxylation occurs:**
(A) Citrate to isocitrate formation
(B) α-ketoglutarate to isocitrate formation
(C) Fumarate to malate formation
(D) Isocitrate to α-ketoglutarate formation

30. **Chlorophylls are attached to thylakoid membranes through:**
(A) Hydrophilic head (B) Hydrophilic head
(C) Hydrophobic head (D) Hydrophobic tail

31. **In glycolysis, which of the following molecules splits into dihydroxyacetone phosphate and glyceraldehyde 3-phosphate:**
(A) Fructose 1,3-bisphosphate
(B) Fructose 1,6-bisphosphate
(C) Fructose 6-phosphate
(D) Glucose 6-phosphate

32. **The widely distributed xanthophylls which are responsible for yellow color of foliage in autumn:**
(A) Carotene (B) Lutein
(C) Chlorophyll (D) Gelatin

33. **A chemical reaction in which one molecule loses electrons, while another molecule simultaneously gains electrons is called:**
(A) Oxidation reduction reactions
(B) Oxidation reactions
(C) Reduction reactions

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(D) Hydrogenation dehydrogenation

34. Some electrons from the second primary acceptor may pass back to cytochrome molecule by electron carrier system yielding ATP. This process is called:
(A) Phosphorylation
(B) Non-cyclic photophosphorylation
(C) Photophosphorylation
(D) Cyclic photophosphorylation

35. Which part of chlorophyll molecule absorbs light?
(A) Phytol
(B) Pyrrole
(C) Porphyrin ring
(D) Thylakoid membrane

36. The first event in photosynthesis is:
(A) Synthesis of ATP
(B) Photolysis of water
(C) Photo excitation of chlorophyll and ejection of electron
(D) Release of oxygen

37. Unidirectional flow of e- in non-cyclic phosphorylation is:

(A)	PS-II	e	PS-1	e	NADP	e	Water
(B)	Water	e	PS-II	e	PS-1	e	NADP
(C)	S-1	e	NADP	e	Water	e	PS-II
(D)	Water	e	Water	e	PS-II	e	NADP

38. Calvin cycle utilize for fixation of 3 molecules of CO_2:
(A) 9 ATP and 6 $NADPH_2$
(B) 8 ATP and 8 NADPH
(C) 9 ATP and 3 $NADPH_2$
(D) 6 ATP and 6 $NADPH_2$

39. All of the following are products of light reactions of photosynthesis except:
(A) ATP (B) Glucose
(C) O2 (D) NADPH

40. Which of the following provides energized electrons and chemical energy during dark reaction respectively?
(A) NADH and ATP (B) $NADPH_2$ and ATP
(C) ATP and NADPH (D) Glucose and H2O

41. Formula representing the chlorophyll-b:
(A) $C_{55}H_{72}O_5N_4Mg$ (B) $C_{55}H_{69}O_5N_4Mg$
(C) $C_{55}H_{70}O_6N_4Mg$ (D) $C_{55}H_{70}O_5N_4Mg$

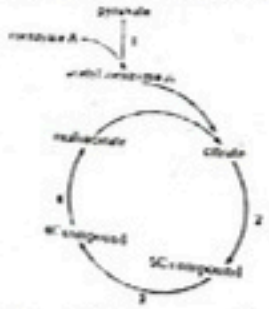
42. Correct sequence of flow of electrons during light reaction of photosynthesis:
(A) Cytochrome complex, Plastoquinone, Plastocyanin
(B) Cytochrome complex, Plastocyanin, Plastoquinone
(C) Plastoquinone, Cytochrome complex, Plastocyanin
(D) Plastoquinone, Plastocyanin, Cytochrome complex

43. All of the following are involved in cyclic electron flow during light reaction except:
(A) Plastocyanin
(B) Primary electron acceptor
(C) NADP reductase
(D) Ferredoxin

44. The use of ATP and NADPH during one Calvin cycle is in proportion:
(A) 12 ATP and 24NADPH
(B) 10 ATP and 12NADP
(C) 9 ATP and 6NADPH
(D) 6 ATP and 9NADPH

45. If thylakoids are removed and kept in culture medium having CO_2 and H_2O and exposed to light; they cannot form hexose sugars as product because:
(A) Light trapping device absent
(B) Pigments P-700 and P-680 not linked
(C) CO_2 assimilating enzymes absent
(D) CO_2 assimilation cannot occur in light

46. The diagram shows the Krebs cycle:



At which numbered stages does decarboxylation take place?
(A) 1 and 2 (B) 1,2 and 3
(C) 1,3 and 4 (D) 1,2, 3 and 4

47. Enzyme which fixes carbon in Calvin cycle
(A) NADPH reductase
(B) Phosphofructokinase
(C) Ribulose bis phosphate
(D) Rubisco

48. In glycolysis, which of the following molecules splits into dihydroxyacetone phosphate and glyceraldehyde3-phosphate:
(A) Fructose1,3-bisphosphate
(B) Fructose1,6-bisphosphate

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(C) Fructose6-phosphate
(D) Glucose6-phosphate

49. During light phase of photosynthesis _____ is oxidized and _____ is reduced:
(A) CO_2 and Water (B) Water and CO
(C) Water and NADP (D) $NADPH_2$ and CO_2

50. The quantitative study of energy relationships and energy conversions in biological systems is called:
(A) Biotechnology (B) Biochemistry
(C) Bioenergetics (D) Bio physiology

51. Which of the following instruments is used to measure relative absorb abilities of different pigments to absorb different wave lengths of light:
(A) Heliotropic chamber
(B) Spectrophotometer
(C) Clinostat
(D) Incubator

52. A graph plotting absorption of light of different wave lengths by a pigment is called:
(A) Action spectrum
(B) Absorption spectrum
(C) Visible spectrum
(D) Photo-spectrum

53. Which of the following are accessory photosynthetic pigments:
(A) Chlorophylls
(B) Xanthophyll
(C) Carotenes
(D) Xanthophyll + Carotenes

54. Chlorophylls absorb mainly:
(A) Green – yellow – indigo wavelength
(B) Violet – blue – indigo wavelengths
(C) Orange – red – blue wavelengths
(D) Violet – blue – orange – red wavelengths

55. Chlorophyll molecule has two parts, one flat square, light absorbing hydrophilic head and a hydrophobic:
(A) Central part (B) End part
(C) Tail part (D) Middle part

56. Chlorophyll "a" is found in all the photosynthetic organisms except in photosynthetic:
(A) Bacteria (B) Mosses
(C) Liverworts (D) Ferns

57. Head in chlorophyll molecule is a complex porphyrin ring which is made up of 4 joined smaller pyrrole rings with central:
(A) Calcium atom (B) Magnesium atom
(C) Carbon atom (D) Iron atom

58. Haem portion of haemoglobin is also a porphyrin ring but differs from a chlorophyll molecule in having _____ atom instead of magnesium atom:
(A) Calcium (B) Sulphur
(C) Iron (D) Phosphorous

59. Long hydrocarbon tail attached with one of the pyrrole rings in chlorophyll molecule is called:
(A) Porphyrin (B) Phytol
(C) Haem (D) Cytol

60. $C_{55}H_{72}O_5N_4Mg$ is the molecular formula of:
(A) Chlorophyll 'b' (B) Chlorophyll 'd
(C) Chlorophyll 'c' (D) Chlorophyll 'a'

61. Magnesium deficiency causes yellowing in plants as it is an essential component of:
(A) Chlorophyll (B) Glucose
(C) Cell sap (D) Protein

62. All the green plants and green algae contain chlorophylls:
(A) a & b (B) c & d
(C) b & c (D) all a,b,c,d

63. Which chlorophyll is the most abundant and most important photosynthetic pigment:
(A) Chlorophyll 'a' (B) Chlorophyll 'b'
(C) Chlorophyll 'c' (D) Chlorophyll 'd'

64. Chlorophyll 'b' is:
(A) Yellow - green (B) Orange – green
(C) Blue - green (D) Violet – green

65. Absorption spectrum of chlorophyll indicates that absorption is maximum in:
(A) Red and green parts
(B) Green and yellow parts
(C) Orange and violet parts
(D) Blue and red parts

66. The plot showing relative effectiveness of different wavelengths of light in driving photosynthesis is:
(A) Action spectrum
(B) Visible spectrum
(C) Absorption spectrum
(D) Light spectrum

67. Photosynthetic pigments in thylakoid membranes are organized into clusters called:
(A) Antenna complex (B) Electron acceptor
(C) Reaction center (D) Photosystems

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68. Chlorophyll is found embedded in the _____ membranes:
(A) Stroma (B) Thylakoid
(C) Grana (D) None of these

69. In which wavelength of light photosynthesis is maximum:
(A) Red light (B) Blue light
(C) Green light (D) Ultra-violet light

70. Chlorophyll consists of:
(A) A head of phytol and tail of four pyrrole rings
(B) A head of linked carbons and tail of our pyrrole rings
(C) A head of four pyrrole rings and tail of linked nitrogen
(D) A head of four pyrrole rings and an alcoholic phytol tail

71. The following is correct sequence of energy transfer between photosynthetic pigments:
(A) Chl-"a" > Chl-"b" > Carotenoids
(B) Chl-"b" > Chl-"a" > Carotenoids
(C) Carotenoids > Chl-"b" > Chl-"a"
(D) In any direction

72. The most abundant protein in chloroplast
(A) Rubisco (B) RUBP
(C) ATP Synthase (D) NADP Reductase

73. Conversion of light energy into chemical energy is function of:
(A) Mitochondria
(B) Cytoplasm
(C) Stroma of chloroplast
(D) Grana

74. All of the following are differences between chl-"a" and "b" except:
(A) Chl-"a" has different types while chl-"b" has single type
(B) Chl-"a" have functional group-CHO but chl-"b" have $-CH_3$
(C) Chl-"a" is necessary pigment but chl-"b" is accessory pigments
(D) Chl-"b" is present in antenna complex while chl-"a" is in reaction center

75. Haem portion of the haemoglobin is:
(A) Phytol (B) Acetyl
(C) Porphyrin (D) ketone compound

76. Chlorophyll a shows absorption peak at:
(A) 430nm, 670nm (B) 350nm, 600nm
(C) 400nm, 700nm (D) none of these

77. Carotenoids are also present in:
(A) Skin (B) Liver
(C) Eye (D) All of these

78. Engelmann used which of these to estimate the amount of O_2 evolved:
(A) Pigments (B) Indicators
(C) Photo spectrometer (D) Bacteria

79. Which is red to orange and yellow:
(A) Chlorophyll-a (B) Carotenoids
(C) Chlorophyll-b (D) Xanthophylls

80. Which is found in all photosynthetic organisms except bacteria:
(A) Chl-d (B) Chl-a
(C) Chl-b (D) Carotenoids

81. The splitting of water in light reaction of photosynthesis that releases oxygen is called:
(A) Hydrolysis (B) Haemolysis
(C) Photolysis (D) Electrolysis

82. The process of ATP production by the use of sunlight is called:
(A) Chemo phosphorylation
(B) Oxidative phosphorylation
(C) Photophosphorylation
(D) Phosphorylation

83. The enzyme ribulose biphosphate carboxylase is also known as:
(A) Ribica (B) RuBP
(C) Rubisco (D) Ribulose

84. NADPH and ATP are used to:
(A) Fixation of CO_2
(B) Fixation of $CO_2 + O$
(C) Fixation of O_2
(D) Convert the PGA to PGAL

85. The Calvin cycle is also known as:
(A) C_4 cycle (B) C_5 Pathway
(C) C_3 Pathway (D) C_6 Pathway

86. Where does the Dark reaction of photosynthesis take place?
(A) Thylakoid membranes of chloroplast
(B) Stroma of chloroplast
(C) Inter grana of chloroplast
(D) Outer membrane of chloroplast

87. Each photosystem consists of a light gathering antenna complex and:
(A) Action center (B) Spectrum center
(C) Reaction center (D) Light center

88. Which of the following is produced during the conversion of 3PGA to 1,3 BPGA?
(A) ATP (B) NADP
(C) ADP (D) NADPH

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89. In non-cyclic phosphorylation which of the following is the correct sequence of electron flow between Photosystem –II to Photosystem-I:
(A) Primary acceptor > cytochromes complex > plastoquinone
(B) Plastocyanin > cytochrome complex > plastoquinone > primary acceptors
(C) Primary acceptors > plastoquinone > cytochrome complex > plastocyanin
(D) Cytochrome complex > plastoquinone > plastocyanin > primary acceptor

90. Light energy is converted into chemical energy through the formation of:
(A) $NADPH_2$ (B) ATP & $NADPH_2$
(C) ATP (D) RuBP

91. Photophosphorylation during photosynthesis consists of:
(A) Cyclic and non-cyclic phosphorylation
(B) Oxidative phosphorylation
(C) Substrate phosphorylation
(D) Both A & B

92. The by-product of photosynthesis is:
(A) Organic compound (B) CO_2
(C) Oxygen (D) Energy

93. Stroma is the ground matrix of:
(A) Lysosomes (B) Ribosomes
(C) Oxysomes (D) Chloroplast

94. Source of protons within the chloroplasts is:
(A) Water (B) Carbon dioxide
(C) Excited chlorophyll (D) Rubisco

95. Dark reactions of carbon assimilation occur in:
(A) Cytoplasmic matrix (B) Leucoplasts
(C) Mitochondria (D) Chloroplasts

96. NADPH is produced in photosynthesis during:
(A) Dark reaction
(B) Oxidative phosphorylation
(C) Non-cyclic photophosphorylation
(D) Cyclic photophosphorylation

97. The number of carbon atoms present in ribulose:
(A) 6 (B) 4
(C) 5 (D) 3

98. ATP molecules requirement for the synthesis of a glucose molecule in a Calvin Benson cycle are:
(A) 36 (B) 12
(C) 38 (D) 18

99. Photophosphorylation is synthesis of:
(A) ADP from ATP
(B) ATP from ADP
(C) Glucose 6-phosphate from glucose
(D) $NADP^+$ from NAD^+

100. Photosynthesis is:
(A) Oxidation process (B) Redox process
(C) Reduction process (D) Aerobic process

101. For fixing one molecule of CO_2 in Calvin cycle the requirement is:
(A) 3ATP + 1$NADPH_2$ (B) 2ATP + 3$NADPH_2$
(C) 3ATP + 2$NADPH_2$ (D) 3ATP + 3$NADPH_2$

102. The following is obtained during cyclic photophosphorylation:
(A) ATP (B) $NADPH_2$
(C) O_2 (D) $NADP^+$

103. How many molecules of ATP are required to convert three molecules of RuP into RuBP during Calvin cycle?
(A) 1 (B) 2
(C) 3 (D) 6

104. RUBP is a 5 carbon:
(A) Keto sugar (B) Glycoprotein
(C) Protein (D) Aldo-sugar

105. PGA is _____ to G_3P:
(A) Reduced (B) Hydrolyzed
(C) Oxidized (D) Isomerized

106. Out of _____ molecules of G3P only one leaves the Calvin cycle:
(A) 6 (B) 5
(C) 4 (D) 8

107. The action spectrum is.
(A) A graph showing amount of light absorbed
(B) A graph showing rate of photosynthesis
(C) A graph showing absorption of light
(D) A graph showing amount of CO_2 released

108. To produce 3 glucose molecules ____ATP and ____ $NADPH_2$ molecules are required:
(A) 54,36 (B) 54,30
(C) 36,60 (D) 18,12

109. In the thylakoid membranes, what is the main role of the antenna pigment molecules?
(A) Split water and release oxygen to the reaction center chlorophyll
(B) Harvest photons and transfer light energy to the reaction center chlorophyll
(C) Synthesize ATP from ADP and Pi
(D) Transfer electrons to ferredoxin and then NADPH

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110. The product of photosynthesis in green plants:
(A) $C_6H_{12}O_6 + 6O_2$
(B) $(CH20)_n + H_2O + 2S$
(C) $C_6H_{12}O_6 + 6O_2 + H_2O$+Energy
(D) $C_6H_{12}O_6 + 6O_2 + H_2O$

111. Oxygen which is liberated during photosynthesis comes from:
(A) Carbon dioxide (B) Water
(C) Chlorophyll (D) Light

112. Van Neil hypothesis about the production of oxygen during photosynthesis was based the study and investigation on photosynthetic:
(A) Bacteria (B) Algae
(C) Spirogyra (D) Cyanobacteria

113. Which of the following does not use water as proton donor:
(A) Cyanobacteria
(B) Plants
(C) Algae
(D) Green Sulphur bacteria

114. Air contains _____% of carbon dioxide:
(A) 0.04-5.4 (B) 0.1-0.2
(C) 0.06-0.08 (D) 0.03-0.04

115. Name the scientist who pointed out the importance of different wavelengths of light using green algae and aerobic bacteria:
(A) Priestley (B) Melvin Calvin
(C) Hans Krebs (D) Englemann

116. Photosynthesis is:
(A) Oxidative, exergonic, catabolic
(B) Redox-reaction, endergonic, anabolic
(C) Reductive, exergonic, anabolic
(D) Reductive, endergonic, catabolic

117. About _____% of light falling on the leaf surface is absorbed:
(A) 25% (B) 1%
(C) 50% (D) 99%

118. Which one of the following pigments does not occur in the chloroplast?
(A) Carotene (B) Xanthophyll
(C) Chlorophyll "b" (D) Anthocyanin

119. Which pigment is water soluble:
(A) Chlorophyll (B) Carotene
(C) Anthocyanin (D) Xanthophyll

120. Chlorophyll is present:
(A) In the grana of chloroplast
(B) On the surface of chloroplasts
(C) Dispersed throughout the chloroplast.
(D) In the stroma of chloroplasts

121. Chlorophyll consists of:
(A) A head of phytol and tail of four pyrrole rings
(B) A head of linked carbon and tail of four pyrrole rings
(C) A head of four pyrrole rings and tail of linked nitrogen
(D) A head of four pyrrole rings and phytol tail

122. Location of Phytol tail of chlorophyll "b" is:
(A) Stroma
(B) Thylakoid surface
(C) Thylakoid membrane
(D) Thylakoid lumen

123. Connecting link between light phase and dark phase of photosynthesis is:
(A) Only ATP (B) Only NADPH (H^+)
(C) Only NADH + H^+ (D) ATP & NADPH (H^+)

124. Location of photosynthetic pigments in purple Sulphur bacteria:
(A) Stroma (B) Thylakoid
(C) Grana (D) Cytoplasm

125. Which color of light gives maximum absorption peak by chlorophyll 'a':
(A) Blue light (B) Green light
(C) Violet light (D) Red light

126. Which of the following chlorophyll is lack of phytol tail:
(A) Chl "a" (B) Chl "b"
(C) Chl "c" (D) Chl "d"

127. Which of following statement is correct for Chlorophyll "a":
(A) Having carbonyl as functional group
(B) Its color is yellow green
(C) Found in all photosynthetic organism except bacteria
(D) All are correct

128. Which of the following is not a function of carotenoids:
(A) Protect chlorophyll
(B) Protect human eyes
(C) Convert light energy into chemical energy
(D) Transfer energy

129. Where does the light reaction of photosynthesis take place:
(A) Stroma
(B) Chloroplast
(C) Thylakoid membrane
(D) Leucoplast

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130. Products of light reaction are produced in:
(A) Thylakoid membrane
(B) Lumen of thylakoid
(C) Stroma of chloroplast
(D) Cytoplasm of cell

131. In photosystem-I, the first electron acceptor is:
(A) Plastocyanin
(B) An iron-Sulphur protein
(C) Ferredoxin
(D) Cytochrome

132. Which one is Cu^{++} containing complex:
(A) Ferredoxin (B) Plastocyanin
(C) Plastoquinone (D) Cytochrome

133. The process that makes important difference between C_3 and C_4 plants is:
(A) Photosynthesis (B) Photorespiration
(C) Transpiration (D) Glycolysis

134. In Hatch and Slack pathway, the primary CO2 acceptor is:
(A) Oxaloacetic acid
(B) Phosphoglyceric acid
(C) Phosphoenol pyruvate
(D) RuBisCO

135. Which of the following is not a product of light reaction of photosynthesis:
(A) ATP (B) NADH
(C) NADPH (D) Oxygen

136. The term "Assimilating power" and Reducing power refers to_____ respectively:
(A) NADH & ATP (B) ATP & $NADPH_2$
(C) $NADPH_2$ & ATP (D) ATP & ADP

137. During splitting of H_2O, H^+ is ultimately captured by:
(A) Chlorophyll (B) NAD
(C) O_2 (D) Cytochrome

138. Each photon of light excites how many electrons:
(A) 1 (B) 2
(C) 4 (D) 6

139. The Final acceptor of electron during non-cyclic electron pathway is:
(A) PS-I (B) PSII
(C) ATP (D) $NADP^+$

140. The product of light reaction of photosynthesis, which is not common between cyclic and non-cyclic photophosphorylation and is not utilized in Calvin cycle, is:
(A) O_2 (B) ATP
(C) $NADPH_2$ (D) O_2 and ATP

141. Which of following is a correct sequence for the movement of electrons during non-cyclic phosphorylation:
(A) P680-P700-Water-$NADP^+$
(B) Water- P700- P680- $NADP^+$
(C) Water- P680- P700- $NADP^+$
(D) P680- P700-$NADP^+$- Water

142. The common feature between non-cyclic and cyclic photophosphorylation is:
(A) Proton gradient formation
(B) Release of O_2
(C) Formation of NADPH + H^+
(D) Photolysis of water

143. In photosynthesis during ATP formation accumulation of protons occurs:
(A) In lumen of thylakoid
(B) In stroma of chloroplast
(C) In periplastidial space
(D) At outer surface of thylakoid

144. ATP Synthesis during light reaction takes place by chemiosmosis when proton moves from:
(A) Stroma to lumen (B) Lumen to stroma
(C) Stroma to stroma (D) Lumen to lumen

145. In photosynthesis, the light-independent reactions take place at:
(A) Stromal matrix (B) Thylakoid lumen
(C) Photosystem-I (D) Photosystem-II

146. For the synthesis of one molecule of sucrose, how many ATP molecules are required in reduction step of Calvin cycle:
(A) 24 ATP (B) 18 ATP
(C) 2 ATP (D) 12 ATP

147. In dark reaction, the first reaction is the:
(A) Carboxylation (B) Decarboxylation
(C) Dehydrogenation (D) Reduction

148. How many Calvin cycles would generate one molecule of glucose/hexose?
(A) One cycle (B) Two cycles
(C) Three cycles (D) Six cycles

149. A biochemical process which occurs within a cell to break down complex compounds to produce energy is called:
(A) Respiration
(B) Oxidation reduction
(C) Photosynthesis
(D) Photophosphorylation

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150. The end product of anaerobic respiration in humans and other animals is:
(A) Pyruvic acid (B) Lactic acid
(C) Ethanol (D) Glucose

151. The way glucose is metabolized depends on:
(A) The availability of water
(B) The availability of oxygen
(C) The availability of carbon dioxide
(D) The availability of enzymes

152. The reaction occurs in almost all cells of organisms:
(A) Oxidation of pyruvate
(B) Kreb's cycle
(C) Glycolysis
(D) TCA cycle

153. The steps of glycolysis which yield ATP is/are:
(A) 1st (B) 2nd
(C) 7th and 10th (D) 1st and 3rd

154. The step(s) of glycolysis carried out by an enzyme hexokinase:
(A) Step#1 (B) Step#10
(C) Step#7 and 10 (D) Step# 1 and 3

155. The end product of glycolysis is:
(A) ADP (B) Citric acid
(C) Reduced FAD (D) Pyruvate

156. Each NADH produces 3-ATPs in ETC and each $FADH_2$ produces 2-ATPs then, total amount of ATP produced in Krebs's cycle are:
(A) 24 (B) 32
(C) 1 (D) 2

157. One molecule of $FADH_2$ is produced in Kreb's cycle during conversion of:
(A) Fumarate → Malate
(B) Malate→ Oxaloacetate
(C) Succinate → Fumarate
(D) α-Ketoglutarate→ Succinate

158. The ATP molecule is used by cells as a source of energy for various functions, EXCEPT:
(A) Active transport
(B) Muscular contraction
(C) Nerve condition
(D) Passive transport

159. Biological oxidation involves the:
(A) Addition of hydrogen
(B) Addition of CO_2
(C) Addition of water
(D) Removal of hydrogen

160. All the enzymes associated with various steps of glycolysis are found:
(A) On cristae of mitochondria
(B) On F_1 particles
(C) Dissolved in cytoplasm
(D) Dissolved in matrix of chloroplast

161. The phase of glycolysis that involves breakdown of glucose and consumption of energy is called:
(A) Preparatory phase
(B) Oxidative phase
(C) Reductive phase
(D) Decarboxylation phase

162. Final acceptor of electrons in respiratory chain is:
(A) Cytochrome-a (B) Cytochrome-a_3
(C) Oxygen (D) Cytochrome-c

163. Every molecule of NADH fed into electron transport chain produces:
(A) 6 ATP (B) 4 ATP
(C) 2 ATP (D) 3 ATP

164. Oxidative phase of glycolysis starts with dehydrogenation of:
(A) Glucose
(B) Glyceraldehyde 3-phosphate
(C) Fructose 6-phosphate
(D) NADH

165. Which one of the following is the stage of cellular respiration for which oxygen is not essential?
(A) Glycolysis
(B) Kreb's cycle
(C) Pyruvate oxidation
(D) Electron transport chain

166. Pyruvate, the end product of glycolysis, moves from cytosol to mitochondrial matrix where it is oxidized into _____ producing CO_2 as a by-product:
(A) Acetic acid (active) (B) NAD
(C) Citrate (D) FAD

167. A process that uses membranes to couple redox reactions to ATP synthesis is called:
(A) Osmosis (B) Active transport
(C) Chemiosmosis (D) Kreb's cycle

168. Net production of ATP in a eukaryotic cell when a glucose molecule is completely oxidized is:
(A) 34ATP (B) 38ATP
(C) 36ATP (D) 40ATP

169. Fumarate is converted into malate by:
(A) Hydration (B) Dehydration

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(C) Oxidation (D) Reduction

170. Cytochrome-a complex is oxidized in respiratory electron transport chain by:
(A) An atom of oxygen (B) Cytochrome-C
(C) Coenzyme-Q (D) NADH

171. The most electronegative substance in respiratory electron transport chain is:
(A) Coenzyme-Q (B) Cytochrome-C

(B) Photophosphorylation
(C) Oxidation phosphorylation
(D) Non-cyclic phosphorylation

174. Glycolysis is activated by activation of phosphofructokinase through feedback mechanism by deficiency of:
(A) Malate (B) α-ketoglutarate
(C) Citrate (D) Succinate

175. The breaking of the terminal phosphate of the ATP, to convert it into ADP, releases about:
(A) 7.0 Kcal. (B) 7.3 Kcal.
(C) 7.0 Cal. (D) 7.3 Cal.

176. NAD stands for:
(A) Niacin adenine diphosphate
(B) Nicotine adenine dinucleotide
(C) Nitrogen acid diphosphate
(D) Nicotinamide adenine dinucleotide

177. Glycolysis produces a net amount of:
(A) 4 ATP (B) 6 ATP
(C) 2 ATP (D) 8 ATP

178. Fructose 1, 6 biphosphate splits into how many fragments?
(A) 2 (B) 3
(C) 4 (D) 6

179. Most CO_2 from catabolism is released during:
(A) Glycolysis
(B) The kreb's cycle
(C) Lactate fermentation
(D) Electron transport

180. Pyruvic acid is the end product of:
(A) Calvin cycle (B) Glycolysis
(C) kreb's cycle (D) Urea cycle

181. Which metabolic pathway is common to both fermentation and cellular respiration:
(A) Kreb's cycle
(B) Glycolysis (EMP Pathway)
(C) Electron transport chain
(D) Reduction of pyruvate to lactate

182. In the eukaryotic cell, most of the enzymes of the Kreb's cycle are located in the:

183. Most of the ATP made during cellular respiration is generated by:
(A) Glycolysis

184. ATP are consumed during:
(A) Glycolysis
(B) Krebs cycle
(C) Light dependent phase
(D) Respiratory chain

185. Pyruvate → Acetyl CoA:
(A) $FAD^+ \rightarrow FADH$
(B) $NADH \rightarrow NAD^+ + H^+$
(C) $NAD^+ \rightarrow NADH$
(D) $FADH \rightarrow FAD + H^+$

186. What are the economically important products of fermentation of grape juice:
(A) Lactic acid and NAD^+
(B) ATP and CO_2
(C) ATP and ethanol
(D) CO_2 and ethanol

187. Oxaloacetic acid reacts with acetyl-COA to form:
(A) Malate (B) Citrate
(C) Pyruvate (D) Succinate

188. Synthesis of ATP is the presence of oxygen is called:
(A) Reductive phosphorylation
(B) Oxidative phosphorylation
(C) Photophosphorylation
(D) Hydro-phosphorylation

189. Conversion of oxaloacetate into citrate required:
(A) Water (B) ATP
(C) CO_2 (D) NADH

190. ATP terminal phosphate released energy:

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(D) There are three points in the cycle where NAD⁺ is reduced to NADH + H⁺

225. Final Decarboxylation in Krebs cycle occur between:
(A) Citric acid and a ketoglutaric acid
(B) α-ketoglutaric acid and succinic acid
(C) Succinic acid and malic acid
(D) Malic acid and oxalo acetic

226. Which of the following is common in both between glycolysis and Krebs cycle:
(A) Reduction
(B) Formation of $NADH_2$
(C) Site of the process
(D) Dehydrogenation

227. How many NADH are formed in the portion of Krebs cycle:
(A) Two (B) Three
(C) Four (D) Five

228. The net gain of energy from one molecule of glucose during aerobic respiration is:
(A) 36 ATP (B) 38 ATP
(C) 36 ATP (D) 38 ATP

229. In a single Krebs cycle, how many times both oxidation and decarboxylation occur simultaneously:
(A) 1 (B) 2
(C) 3 (D) 4

230. Biological oxidation involves the removal of hydrogen, linked with specific enzyme, and is catalyzed by:
(A) Carboxylase (B) Hydrogenase
(C) Dehydrogenase (D) Catalase

231. The stage of cellular respiration produced maximum energy:
(A) Glycolysis
(B) Oxidation of pyruvate
(C) Krebs cycle
(D) Chemiosmosis

232. During respiratory chain of cellular respiration, cytochrome "C" oxidize:
(A) Cytochrome "b" (B) Cytochrome "a"
(C) Cytochrome "a³" (D) All of above

233. Deamination of amino acid take place in:
(A) Liver (B) Kidney
(C) Pancreas (D) Gall bladder

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234. Oxidative phosphorylation takes place in:
(A) All types of cells (B) All primitive cells
(B) All anaerobic cells (D) All aerobic cells

235. Glycolysis is the breakdown of glucose into two molecules of: (2011)
(A) Glycerate (B) Pyruvate
(C) Acetic acid (D) Succinate

236. Before entering the Krebs cycle, pyruvate is first decarboxylated and combined with: (2011)
(A) Coenzyme A
(B) Glycerate
(C) Citric acid
(D) Acetic acid

237. Some electrons from the coenzyme NADH acceptor may pass back to cytosolic molecule by electron carrier system and ATP. This process is called: (2011)
(A) Phosphorylation
(B) Non-cyclic photophosphorylation
(C) Pharmacophosphorylation
(D) [illegible]

(A) Non-cyclic photophosphorylation
(B) Substrate level phosphorylation
(C) Cyclic photophosphorylation
(D) Oxidative phosphorylation

239. The product (s) of cyclic photophosphorylation is/are: (2012)
(A) ATP (B) $NADPH_2$ and ATP
(C) $NADP^+$ (D) $NADPH_2$, ATP & O_2

240. Total NADH formed by one glucose molecule during Krebs cycle are: (2012)
(A) 6 (B) 2
(C) 3 (D) 18

241. The terminal electron acceptor in electron transport chain is: (2012)
(A) Hydrogen (B) Cytochrome
(C) Iron (D) Oxygen

242. The end product of glycolysis is: (2012)
(A) ADP (B) Citric acid
(C) Reduced FAD (D) Pyruvate

243. One molecule of $FADH_2$ is produced in Krebs cycle during conversion of: (2012)
(A) Fumarate to Malate
(B) Malate to Oxaloacetate
(C) Succinate to Fumarate
(D) α-Ketoglutarate to Succinate

244. Which part of chloro[illegible]
[illegible]

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(A) Phytol
(B) Pyrrole
(C) Porphyrin ring
(D) Thylakoid membrane

245. A biochemical process which occurs within a cell to breakdown complex compounds to produce energy is called: (2013)
(A) Respiration
(B) Oxidation reduction
(C) Photosynthesis
(D) Photophosphorylation

246. The end product of anaerobic respiration in humans and other animals is: (2013)
(A) Pyruvic acid (B) Lactic acid
(C) Ethanol (D) Glucose

247. Final acceptor of electrons in respiratory chain is: (2013)
(A) Cytochrome-a (B) Cytochrome-a_3
(C) Oxygen (D) Cytochrome-c

248. Every molecule of NADH fed into electron transport chain produces: (2013)
(A) 6 ATP (B) 4 ATP
(C) 2 ATP (D) 3 ATP

249. Oxidative phase of glycolysis starts with dehydrogenation of: (2014)
(A) Glucose
(B) Glyceraldehyde 3-phosphate
(C) Fructose 6-phosphate
(D) NADH

250. In one turn, the Krebs cycle produces one molecule of ATP, one molecule of $FADH_2$ & _____molecule/s of NADH: (2014)
(A) 1 (B) 3
(C) 2 (D) 4

251. Which one of the following is the stage of cellular respiration for which oxygen is not essential? (2014)
(A) Glycolysis
(B) Kreb's cycle
(C) Pyruvate oxidation
(D) Electron transport chain

252. Pyruvate, the end product of glycolysis, moves from cytosol to mitochondrial matrix where it is oxidized into_____producing CO_2 as a by-product: (2014)
(A) Acetic acid (active) (B) NAD
(C) Citrate (D) FAD

253. Pyruvate ⟶ Acetyl CoA: (2014)
(A) $FAD^+ \rightarrow FADH_2$ (B) $NADH \rightarrow NAH + H^+$
(C) $NAD^+ \rightarrow NADH$ (D) $FADH \rightarrow FAD + H^+$

254. In light independent stage of photosynthesis, the CO_2 combines with_____to form an unstable 6-carbon intermediate: (2015)
(A) Ribulose bisphosphate
(B) Glycerate-3-phosphate
(C) Hexose sugar
(D) Glyceraldehyde-9-phosphate

255. In glycolysis, glycerate 1, 3-bispohosphate is converted into glycerate-3-phosphate by losing__phosphate molecules: (2015)
(A) 3 (B) 1
(C) 2 (D) 4

256. Malate is oxidized by____to oxaloacetate in Krebs cycle: (2015)
(A) ATP (B) NAD
(C) NADP (D) FAD

257. In electron transport chain, the electron from NADH and FADH2 are passed to: (2015)
(A) Cytochrome a (B) Co-enzyme c
(C) Cytochrome a3 (D) Co-enzyme Q

258. Carriers of the respiratory chain are located on: (2015)
(A) Matrix of mitochondria
(B) Inner membrane of mitochondria
(C) Outer membrane of mitochondria
(D) Cytoplasmic matrix

259. Each___consists of a light gathering antenna complex and reaction center. (2016)
(A) Chlorophyll (B) Photon
(C) Photosystem (D) Electron

260. Photosystem 'I' has chlorophyll 'a' molecule which absorb maximum light of: (2016)
(A) 680 nm (B) 700 nm
(C) 780 nm (D) 580 nm

261. Cyclic flow or C_4 photosynthesis produces: (2016)
(A) ATP and CO_2 (B) Only CO_2
(C) ATP (D) Only oxygen

262. Immediate product formed after CO2 fixation in Calvin cycle is: (2016)
(A) Unstable 6-carbon compound
(B) Unstable 4-carbon compound
(C) Unstable 5-carbon compound
(D) Unstable 3-carbon compound

263. Functional group of chlorophyll 'a' is: (2016)
(A) $-CH_3$ (B) -COOH
(C) -CHO (D) -OH

264. Chlorophyll molecule contains: (2017)

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(A) Mg^{++} (B) K^{+}
(C) Ca^{++} (D) Na^{+}

265. The tail of chlorophyll molecule is embedded in: (2017)
(A) Membrane of mitochondria
(B) Thylakoid membrane
(C) Membrane of smooth endoplasmic reticulum
(D) Membrane of rough endoplasmic reticulum

266. Carotenoids absorb light of: (2017)
(A) Yellow-orange range (B) Orange-red range
(C) Yellow-red range (D) Blue-violet range

267. Chlorophyll a and chlorophyll-b differ from each other in only one of the functional group chlorophyll a has: (2017)
(A) —CHO (B) —CH3
(C) —OH (D) —NH2

268. Glycerate 3-phosphate in the presence of ATP and reduced NADP from light dependent stage is reduce to: (2017)
(A) 3 carbon compound
(B) 5 carbon compound
(C) Ribulose bisphosphate
(D) 6 carbon compound

269. Calvin cycle occurs in: (2017)
(A) Grana of chloroplast
(B) Chlorophyll (reaction center
(C) Stroma of Chloroplast
(D) Roots of plant

270. Pick the characteristic of tail of chlorophyll: (2017-Retake)
(A) Hydrophilic (B) Present in stroma
(C) Hydrophobic (D) $C_{20}H_{20}$

271. Splitting of water in sunlight is called: (2017-Retake)
(A) Lysis (B) Photolysis
(C) Condensation (D) Hydrolysis

272. Which of the following color is maximum absorbed by chlorophyll: (2017-Retake)
(A) Red (B) Yellow
(C) Green (D) Indigo

273. Graph showing effectiveness of absorbed light is called: (2017-Retake)
(A) Absorption spectrum
(B) Light spectrum
(C) Action spectrum
(D) Dark spectrum

(A) Rubisco (B) RuP
(C) RuBP (D) G_3P

275. Glycolysis is conversion of: (2017-Retake)
(A) Glucose to Acetyl CoA
(B) Glucose to pyruvate
(C) Glucose to G_3P
(D) Glucose to Serine

276. Acceptor of acetyl CoA in Kreb's cycle is: (2017-Retake
(A) Oxaloacetate (B) Succinate
(B) Citrate (D) Fumarate

277. The enzymes required for Krebs cycle are found in: (2018)
(A) F_1 Particle (B) Cytoplasm
(C) Lysosomes (D) Matrix

278. _____ is the sight of light independent reaction: (2018)
(A) Thylakoid membrane
(B) Stroma
(C) Thylakoid space
(D) Grana

279. Which of the following statement is correct for the respiratory pigments: (2018)
(A) Myoglobin and haemoglobin have higher affinity for nitrogen
(B) Cyanide and haemoglobin have low affinity for oxygen
(C) Myoglobin has more affinity for oxygen as compared to haemoglobin
(D) Albumin, globulin and globin pigments are present in respiratory chain

280. Which statement is correct for mitochondria and chloroplast: (2018)
(A) Number of mitochondria and chloroplast are same in all cells
(B) Chloroplast and mitochondria are single membranous structures
(C) Chloroplast and mitochondria cannot live independently
(D) 70S ribosomes are attached to inner membrane

281. In aerobic respiration: (2018)
(A) Pyruvate is completely oxidized to form carbon dioxide and water
(B) Pyruvate carboxylate to produce citrate
(C) Pyruvate is completely oxidized to form oxygen and water

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282. At the last step of glycolysis which of the following compound is formed: (2018)
(A) Pyruvic acid
(B) Ethyl alcohol
(C) Lactic acid
(D) Fructose 6 phosphate

283. NADP, nicotinamide adenine dinucleotide phosphate is a carrier of: (2018)
(A) -OH group (B) Hydrogen
(C) O_2 group (D) Phosphate

284. When we extract carotenoids from its sources, we seen that: (2018)
(A) Voilet in color
(B) Yellow green in color
(C) Blue green in color
(D) Yellowish orange red in color

285. In chemiosmosis, proton (H^+) pump moves from _____: (2019)
(A) Stroma to lumen
(B) Lumen to stroma
(C) Stroma to cytoplasm
(D) Cytoplasm to stroma

286. The photosynthetic pigments of plants are arranged as clusters in thylakoids membrane. The reaction center of these clusters consists of _____ molecules: (2019)
(A) ATP (B) Glucose
(C) Chlorophyll (D) Carotenoids

287. Glycolysis takes place in the _____ of cell: (2019)
(A) Golgi complex (B) Cytoplasm
(C) Nucleus (D) Mitochondria

288. [illegible] molecules of ATP would be [illegible] phosphorylation of one glucose molecule during glycolysis: (2019)
(A) One (B) Two
(C) Three (D) Four

289. [illegible] of the following [illegible] involved [illegible]
(C) PS-III (D) PS-I & PS-II

290. The following flow chart depicts the steps of Calvin cycle. Which option according to you fit in as the correct answer of missing step? (2019)

(A) Hydrogenase (B) RuBP
(C) Oxaloacetate (D) Pyruvate

291. First stable compound during Calvin cycle is: (2020)
(A) 3-Phosphoglycerate
(B) Glyceraldehyde 3 Phosphate
(C) 1-3 Bis phosphoglycerate
(D) Ribulose bisphosphate

292. What is the function of Ribulose? (2020)
(A) Intermediate in photosynthesis
(B) Respiratory fuel
(C) Intermediate in cellular respiration
(D) Component of DNA and RNA

293. Which of the following process does not needs pyruvate as a substrate: (2020)
(A) Alcoholic fermentation
(B) Calvin cycle
(C) Aerobic respiration
(D) Lactic acid fermentation

294. Which of the following is copper containing protein in electron transport chain: (2020)
(A) Plastocyanin (B) Cytochrome C
(C) [illegible] (D) Ferredoxin

295. In electron Transport chain ATP synthesis takes place when electron moves from: (2020)
(A) Cytochrome to plastocyanin
(B) Plastoquinone to Cytochrome
(C) [illegible]

296. The end product of glycolysis [illegible] respiration: (2020)
(A) Ethanol and CO_2 (B) Pyruvate
(C) Lactate (D) Acetyl CO-A

297. Which of the following is copper containing protein in electron transport chain: (2020)
(A) Plastocyanin (B) Cytochrome C
(C) Plastoquinone (D) Ferredoxin

298. Which of the following is correct order of electron transport in photosynthesis: (2021)

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(A) H_2O, PS-I, PS-II (B) H_2O, NADPH, ATP
(C) H_2O, PS-I, PS-II (D) PS-I, PS-II, H_2O

299. A link between Carbohydrates, Protein and Lipid metabolism: (2021)
(A) Glucose (B) Acetyl Co-A
(C) Citrate (D) Oxaloacetate

300. What is the end product by yeast in anaerobic respiration: (2022)
(A) Ethanol & O_2 (B) Ethanol & CO_2
(C) Ethanol & H_2O (D) Lactic acid & CO_2

301. Each carrier in ETC is first_____ and then _____: (2022)
(A) Broken down, regenerate
(B) Generated, broken down
(C) Oxidize, Reduced
(D) Reduced, oxidize

302. Electron Transport Chain explains: (2022)
(A) Phosphorylation
(B) Z-Scheme
(C) Photolysis
(D) Mechanism of ATP synthesis

303. What is the color of chlorophyll b molecule: (2022)
(A) Bluish green (B) Yellowish green
(C) Dark green (D) Reddish green

304. Which of the following is used in baking: (2023)
(A) Aerobic respiration
(B) External respiration
(C) Anaerobic respiration
(D) Internal respiration

305. Which is the major event in ETC: (2023)
(A) ATP synthesis (B) Decarboxylation
(C) Substitution (D) Isomerization

306. Out of 36 ATP, how many are produced in electron transport chain: (2023)
(A) 28 (B) 32
(C) 30 (D) 34

307. Which is the major event in ETC: (2023)
(A) ATP synthesis (B) Decarboxylation
(C) Substitution (D) Isomerization

308. The major enzyme involved in transfer of phosphate group from ATP to glucose: (2023)
(A) Isomerase (B) Decarboxylation
(C) Dehydrogenase (D) Kinase

309. In the Calvin cycle CO_2 reacts with RuBP to produce_____: (UHS 2024)
(A) 3-PGA
(B) G_3P
(C) 6-Carbon unstable intermediate
(D) 1,3 bisphosphoglycerate

310. Which option is correct about chlorophyll molecule: (UHS 2024)
(A) Chemical formula with N_2Mg
(B) Porphyrin ring with nitrogen in centre
(C) Methyl group on second pyrrole ring
(D) Aldehyde group on second pyrrole ring

311. In the journey of electrons from photosystem-II to photosystem-I is reduced by: (UHS 2024)
(A) Plastoquinone
(B) Cytochrome complex
(C) P_{700}
(D) Primary electron acceptor of PS-I

312. Enzyme NADP reductase is responsible for: (UHS 2024)
(A) Reducing $NADP^+$ (B) Oxidizing $NADP^+$
(C) Reducing ferredoxin (D) Reducing P_{700}

313. The PS-II during light reactions receives electrons from splitting of: (UHS 2024)
(A) Water (B) Plastoquinone
(C) Plastocyanin (D) Ferredoxin

314. The production of energy is _____: (ETEA 2024)
(A) Faster in anaerobic respiration
(B) Faster in aerobic respiration
(C) Same in both types of respiration
(D) Not associated with respiration

315. The pathway to the breakdown of glucose, carried out by micro-organisms, is called: (ETEA 2024)
(A) Fatty acid metabolism
(B) Alcoholic fermentation
(C) Cellular respiration
(D) None of the above

316. The process of ATP synthesis through a combination of electrochemical and osmotic events is known as: (ETEA 2024)
(A) Fermentation
(B) Glycolysis
(C) Oxidative phosphorylation
(D) Oxidation of pyruvate to acetyl Co-A

317. Which mechanism would be compromised in the absence of cytochrome complex during light reaction of photosynthesis: (NUMS 2024)
(A) Reduction of reaction center chlorophyll
(B) Photolysis of water
(C) Oxidation of primary electron receptor

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(D) establishment of proton gradient across thylakoid membrane

318. During glycolysis, isomerization take place in the formation of: (NUMS 2024)
(A) Dihydroxyacetone phosphate and 2-phosphoglycerate
(B) G3P and fructose 6 phosphate
(C) PEP and pyruvate
(D) Fructose 6 phosphate and 3 phosphoglycerates

319. Presence of PEP carboxylase in C4 plants enables them to avoid photorespiration due to: (NUMS 2024)
(A) Presence of enzyme in high concentration
(B) Absence of Rubisco
(C) PEP carboxylase being strictly carboxylase
(D) High yield of enzyme

320. Fats and proteins can be used as respiratory fuel. Which of the following serves as common molecule produced through their catabolism: (NUMS 2024)
(A) Acetyl CoA (B) Pyruvate
(C) G3P (D) Lactate

321. Which reaction is also known as Z-scheme: (DUHS 2024)
(A) Oxidative Phosphorylation
(B) Cyclic photophosphorylation
(C) Non-cyclic oxidative phosphorylation
(D) Non-cyclic photophosphorylation

322. Plants oxidize sugar in chloroplasts during daytime without production of energy. This process is called: (DUHS 2024)
(A) Photorespiration
(B) Cyclic photophosphorylation
(C) Non-cyclic oxidative phosphorylation
(D) Lactic acid fermentation

323. Which one of the following is the end product in electron transport chain taking place at inner mitochondrial membrane: (SZABMU 2024)
(A) Carbon dioxide (B) NADPH
(C) Oxygen (D) Water

324. At which of the following reactions of glycolysis, ATP is NOT involved directly: (SZABMU 2024)
(A) When 1,3-Bisphosphoglycerate is converted into 3-phosphoglycerate
(B) When Fructose 6-phosphate is converted into fructose 1,6-bisphosphate
(C) When glucose is converted into glucose 6-phosphate
(D) When glyceraldehyde 3-phosphate is converted into 1,3-Bisphosphoglycerate

325. In Cyclic Photophosphorylation, one of the following processes of light dependent reaction of photosynthesis is NOT included: (SZABMU 2024)
(A) Absorption of light
(B) ATP synthesis
(C) Photoexcitation
(D) Photolysis of water

326. Which one of the following types of phosphorylation occurs in electron transport chain, when NADH transfer electrons to coenzyme Q in inner mitochondrial membrane: (SZABMU 2024)
(A) Cyclic-Phosphorylation
(B) Non-cyclic Phosphorylation
(C) Oxidative Phosphorylation
(D) Substrate level phosphorylation

327. Which one of the following is the first electron accepter from $FADH_2$ during electron transport chain: (SZABMU 2024)
(A) Coenzyme Q (B) Cytochrome b
(C) Cytochrome a (D) Cytochrome c

328. What is the range of carbon dioxide in the air: (SZABMU 2024)
(A) 0.003-0.004% (B) 0.03-0.04%
(C) 0.3-0.4% (D) 3-4%

329. In Calvin Cycle, the conversion of 5 molecules of Glyceraldehyde 3-phosphate into 3 molecules of Ribulose 1-5, bisphosphate by utilization of ATP is termed as: (SZABMU 2024)
(A) CO_2 Fixation (B) Phosphorylation
(C) Reduction (D) Regeneration

330. Photosynthesis is: (BUMHS 2024)
(A) Reduction process (B) Redox process
(C) Oxidation process (D) None

331. Following are the products of Photosynthesis: (BUMHS 2024)
(A) Glucose and water
(B) Oxygen and Glucose
(C) Oxygen, Glucose and Water
(D) None of the given option

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Answer Key

1. A	2. C	3. C	4. D	5. C	6. A	7. C	8. B	9. B	10. D
11. B	12. C	13. C	14. A	15. C	16. A	17. B	18. B	19. B	20. C
21. C	22. C	23. B	24. B	25. C	26. A	27. C	28. D	29. D	30. D
31. B	32. B	33. A	34. D	35. C	36. C	37. B	38. A	39. B	40. B
41. C	42. C	43. C	44. C	45. C	46. B	47. D	48. B	49. C	50. C
51. B	52. B	53. D	54. D	55. C	56. A	57. B	58. C	59. B	60. D
61. A	62. A	63. A	64. A	65. D	66. A	67. D	68. B	69. A	70. D
71. C	72. A	73. D	74. B	75. C	76. A	77. D	78. D	79. B	80. B
81. C	82. C	83. C	84. D	85. C	86. B	87. C	88. C	89. C	90. C
91. A	92. C	93. D	94. A	95. D	96. C	97. C	98. D	99. B	100. B
101. C	102. A	103. C	104. A	105. A	106. A	107. B	108. A	109. B	110. D
111. B	112. A	113. D	114. D	115. D	116. B	117. B	118. D	119. C	120. A
121. D	122. C	123. D	124. D	125. A	126. C	127. C	128. C	129. C	130. C
131. B	132. B	133. B	134. C	135. B	136. B	137. B	138. A	139. D	140. A
141. C	142. A	143. A	144. B	145. A	146. A	147. A	148. D	149. A	150. B
151. B	152. C	153. C	154. A	155. D	156. A	157. C	158. D	159. D	160. C
161. A	162. C	163. D	164. B	165. A	166. A	167. C	168. C	169. A	170. A
171. D	172. C	173. B	174. C	175. B	176. D	177. C	178. A	179. B	180. B
181. B	182. C	183. B	184. A	185. C	186. D	187. B	188. B	189. A	190. A
191. A	192. B	193. B	194. D	195. C	196. B	197. B	198. B	199. B	200. D
201. D	202. C	203. B	204. B	205. D	206. D	207. D	208. B	209. C	210. C
211. A	212. C	213. C	214. B	215. D	216. B	217. D	218. A	219. B	220. A
221. A	222. B	223. D	224. C	225. B	226. D	227. B	228. D	229. B	230. C
231. D	232. A	233. A	234. D	235. B	236. D	237. D	238. A	239. A	240. A
241. D	242. D	243. C	244. C	245. A	246. B	247. C	248. D	249. B	250. B
251. A	252. A	253. C	254. A	255. B	256. B	257. D	258. B	259. C	260. B
261. C	262. A	263. A	264. A	265. D	266. D	267. B	268. A	269. C	270. C
271. B	272. A	273. C	274. C	275. B	276. A	277. D	278. B	279. C	280. C
281. A	282. A	283. B	284. D	285. A	286. C	287. B	288. B	289. A	290. B
291. A	292. A	293. B	294. A	295. A	296. D	297. A	298. C	299. B	300. B
301. D	302. D	303. B	304. C	305. A	306. B	307. A	308. D	309. C	310. C
311. B	312. A	313. A	314. A	315. B	316. C	317. D	318. B	319. C	320. A
321. D	322. A	323. D	324. D	325. D	326. C	327. A	328. B	329. D	330. B
331. C									

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UNIT # 03

BIOLOGICAL MOLECULES

High Yield Content:

- Functions of proteins, Carbohydrates, and Lipids.
- Classification of Lipids
- Structure of Proteins
- Structure of DNA
- Conjugated molecules

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BIOLOGICAL MOLECULES: KEY CONCEPTS

- **Biochemistry** is the branch of biology which deals with the study of chemical components and chemical process in living organisms.
- **Basic knowledge** of biochemistry is essential for understanding **anatomy and physiology.**
- **Metabolism:** Sum of all chemical reactions in living organism.
- **Anabolism:** It is the constructive phase of metabolism where smaller molecules combine to form larger, more complex molecules.
- **Catabolism:** It is the destructive phase of metabolism where larger, complex molecules are broken down into smaller, simpler molecules, often releasing energy.

Chemical component of protoplasm

- Out of **92 naturally** occurring elements, about **25 elements** are found in living organisms called **Bioelements.** The human body contains **16** of these Bioelements.
- Out of 16, **6 are major bioelements** which make up **99% of body mass** and the remaining **1%** is formed by **10 minor bioelements.**
- **Trace elements** required in very small quantity **(<0.01% of protoplasm).**

Bioelements	Amount	Bioelements	Amount
Oxygen	65%	Chlorine	0.15%
Carbon	18%	Sodium	0.15%
Hydrogen	10%	Magnesium	0.05%
Nitrogen	3%	Iron	0.004%
Calcium	2%	Copper	Trace
Phosphorous	1%	Manganese	Trace
Potassium	0.35%	Zinc	Trace
Sulphur	0.25%	Iodine	Trace

Chemical Component	Bacterial Cell	Mammalian Cell
Water	70%	70%
Protein	15%	18%
Carbohydrates	3%	4%
Lipids	2%	3%
DNA	1%	0.25%
RNA	6%	1.1%
Other organic molecules (enzymes, hormones, metabolites)	2%	2%
Inorganic ions	1%	1%

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Hydrolysis	Condensation (Dehydration synthesis)
A reaction where a **water molecule is used** to break down a larger molecule into smaller units.	A reaction where two smaller molecules combine to form a larger molecule, releasing a **water molecule as a byproduct.**
Water splits into a hydrogen ion (H^+) and a hydroxide ion (OH^-), which then interact with the larger molecule, **breaking its bonds.**	One molecule contributes to a hydrogen ion (H^+), and the other contributes a hydroxide ion (OH^-), which **combined to form water.**
Example: Digestion of food involves hydrolysis, such as the breakdown of carbohydrates into simple sugars.	**Example**: The formation of proteins from amino acids or the synthesis of disaccharides from monosaccharides.

IMPORTANCE OF WATER

- Varies from **65 to 89%** in different organisms.
- Water in Human Tissues: **Bone cells: 20%, Brain: 85%, Blood: 90%.**
- **Jelly fish** has exceptionally large amount of **water (99%).**
- **Raw material in photosynthesis.**
- **Act as lubricant**, reduce friction in joints, cushion around organs and protect eyes.
- Involved in **hydrolysis.**
- Provide **aqueous medium** for enzymatic action.

High Polarity

- **Water is a polar molecule** that makes it an excellent universal solvent for polar substances (NH_3,SO_2,H_2S).
- **Ionic compounds** or electrolytes dissociate into their ions in water and become reactive.
- **Non-ionic substances** also dispersed in water.
- **Non-polar substances** cannot dissolve in water so **maintain the structural integrity of cellular membranes.**

Heat capacity

- Water has great ability to **absorb heat with minimum change in its own temperature.**
- This is due to **hydrogen bonding** in water molecules.
- **Specific heat capacity:** Number of calories required to raise the temperature of 1g of water from 15-16°C is 1 **(4.184 joules).**
- Due to high heat capacity, water work as **temperature stabilizer** against sudden thermal change.

Heat of vaporization

- Calories require per gram vaporization of water.
- Specific heat of vaporization of water is **574 kcal/kg.**
- Evaporation of only 2ml out of 1 liter of water lower the temperature of remaining 998ml by 1°C.
- It provides **cooling effect** to plant (**Transpiration**) and animals (**Perspiration**).
- Play important role in **thermoregulation.**

Hydrophobic exclusion

- Tendency of nonpolar (hydrophobic) molecules to aggregate in an aqueous (water-based) environment.
- Reduction of **contact area between water and hydrophobic substances** which are placed in water.
- **Phospholipids in cell membranes** have hydrophobic tails and hydrophilic heads, leading to the formation of bilayers where the tails are shielded from water and the heads face the water.
- **For example**, if few drops of oils are placed on surface of water solution, the oil drops tend to aggregate into single clump.

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Cohesion and Adhesion

- **Cohesion** refers to the **attraction between** molecules of the **same substance**. In the case of water, this is the force that holds water molecules together.
- This property gives water a **high surface tension**, which allows it to form droplets and enables small insects, like water striders, to walk on the surface of water without sinking.
- **Adhesion** is the **attraction between** molecules of **different substances**. For water, this means it can stick to other polar or charged surfaces.
- Adhesion is crucial for processes like capillary action, where water can move against gravity through narrow spaces, such as the **xylem in plants**. This allows water and nutrients to travel from the roots to the rest of the plant. Cellulose also has affinity for water molecules **(Imbibition)**.

Ionization of water

- The ionization of water refers to the process in which water molecules dissociate into ions.
- Water may behave as acid or base **(Amphoteric in nature)**.
- $H_2O \rightleftharpoons H^+ + OH^-$
- The ionization of water provides a baseline for the pH scale, which ranges from **0 to 14**.
- At **25°C**, the concentration of each H^+ & OH^- ions in pure water is about **10^{-7} mole/liter**.

Anomalous behavior of water / Density of water

- Water shows different behavior **below 4°C**.
- Due to hydrogen bond in water, it expands **below 4°C** which decreases its density so at **0°C** water expands maximally in **ice condition**.
- The low-density water in ice becomes lighter and comes above the surface of high-density water of liquid **(Ice Float on water)**.
- It makes **life possible under frozen water**.
- It forms a **barrier** and **insulating layer** between the warmer underlying water and the colder air above a lake.

CARBOHYDRATES: HYDRATED CARBONS

- Composed of **C, H, and O**. Mostly hydrogen and oxygen found in same ratio as water **(2:1)**.
- Chemically, carbohydrates are **polyhydroxy aldehyde or polyhydroxy ketones** or complex substance which on hydrolysis yield polyhydroxy aldehyde and ketones.
- General formula **$C_x(H_2O)_y$**, where "x" is the whole number from **three to many thousands** whereas "y" may be same or different whole number.

Importance of carbohydrates

- **Primary Energy Source**: Especially glucose, which fuels brain activity, muscle contraction, and cell metabolism.
- **1g** of carbohydrates provide about **3.8 Kcal energy**.
- **Energy Storage**: Carbohydrates can be stored in the body as **glycogen in the liver and muscles**, providing a quick energy reserve during high-demand activities.
- **Structural Function**: Some carbohydrates serve as structural components; for example, **cellulose in** plant cell walls provides rigidity, and **chitin strengthens exoskeletons** in insects and **fungal cell wall**.
- **Component of DNA and RNA**: Carbohydrates are part of the structure of **nucleotides** in DNA (Deoxyribose sugar) and RNA (Ribose Sugar), which are essential for **genetic information storage and transfer**.
- **Combined with proteins and lipids** to form glycoprotein and glycolipids respectively. These compounds are conjugated molecules and serve as **constituent of cellular membranes**.

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Classification of Carbohydrates		
Monosaccharides	**Oligosaccharides**	**Polysaccharides**
Simple sugar (Monomers)	Complex than monosaccharides and made up of **2-10 monosaccharides.**	Highly Complex (Branched/ Unbranched) is made up of **more than 10 monosaccharide units,** often thousands.
Sweet in taste and soluble in water	Less sweet and less soluble	Tasteless and sparingly soluble.
Cannot be hydrolyzed	Can be hydrolyzed	Can be hydrolyzed
$(CH_2O)_n$ / $C_nH_{2n}O_n$ / $C_n(H_2O)_n$	$C_n(H_2O)_{n-1}$ (for disaccharides)	$C_x(H_2O)_y$
Examples: Glucose, Fructose, Galactose, Ribose, Deoxyribose, Mannose, **Xylose (Sugar first isolated from wood).**	**Examples:** Sucrose, Lactose, Maltose and **Trehalose (1,1-glycosidic bond between two α-glucose units)**	**Examples:** Starch, Glycogen, Cellulose, Chitin, **Dextrin (low molecular weight polysaccharide),** Heparin, Agar, Pectin

MONOSACCHARIDES (Greek word "SACKRON" means Sugar)

- Monosaccharides contain **3-7 carbon atoms.**
- All **carbon atoms** except **one have hydroxyl group.** This exception is carbon of aldehyde or ketone group.
- In water, most monosaccharides are converted into ring structure.
- **Furanose**: five corner ring structure (i.e. Ribfuranose and fructofuranose).
- **Pyranose**: six corner ring structure (i.e. Glucopyranose).
- Mannitol is **sugar alcohol.**

Classification of Monosaccharides			
Type	**Aldo form**	**Keto form**	**Functions**
Trioses ($C_3H_6O_3$)	Glyceraldehyde	Dihydroxyacetone	➢ Intermediate in photosynthesis & respiration.
Tetroses ($C_4H_8O_4$)	Erythrose	Erythrulose	➢ Intermediate in photosynthesis in bacteria.
Pentoses ($C_5H_{10}O_5$)	Ribose Deoxyribose ($C_5H_{10}O_4$) Xylose Arabinose	Ribulose Xylulose	➢ **Ribose** is found in **RNA Nucleotide and ATP,** while **deoxyribose** is found in **DNA Nucleotide.** ➢ **Ribulose** is the **initial reactant in Calvin cycle.** ➢ **Xylose** is abundantly present in hemicellulose sources.
Hexoses ($C_6H_{12}O_6$)	Glucose **(Grapes Sugar)** Galactose **(Brain sugar)** Mannose	Fructose **(Fruit sugar)** Sorbose Psicose	➢ **Glucose** is a primary energy source. For synthesis of **10g of glucose requires 717.6 Kcal** of solar energy. **Human blood** contains **0.08% glucose.** ➢ **Fructose** is found in many fruits, honey, and root vegetables; it is used as a **natural sweetener.** ➢ **Mannose** is important in **human metabolism,** especially in the **glycosylation of certain proteins.**
Heptoses ($C_7H_{14}O_7$)	Glucoheptose	Sedoheptulose	➢ Intermediate in photosynthesis in bacteria.

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Stereoisomerism in Monosaccharides

- Isomers in which hydrogen and hydroxyl group are arranged in different to the asymmetric atoms called **Stereoisomers.**
- An **asymmetric carbon** atom is that which makes bond with four different atoms/groups around it.

Types of Stereoisomerism in Monosaccharides

Enantiomers

- Enantiomers are a type of stereoisomer where two molecules are **non-superimposable mirror images** of each other. For example, **D-glucose and L-glucose are enantiomers.**

Diastereomers

- Diastereomers are stereoisomers that do not mirror images of each other.
- For example, **D-glucose** and **D-galactose** are diastereomers, as they have different configurations at one or more chiral centers but are not mirror images.

Epimers

- Epimers are a specific type of diastereomer where two monosaccharides differ only in the configuration around one specific chiral carbon.
- **D-glucose** and **D-mannose** are epimers, differing only at the **C-2 position**, while **D-glucose** and **D-galactose** are epimers at the **C-4 position.**

Anomers

- Anomers are a type of stereoisomerism that occurs **specifically in cyclic forms** of monosaccharides.
- When monosaccharides form **rings, they create a new chiral center** at the anomeric carbon.
- The two configurations are known as **alpha (α) and beta (β) anomers.**
- For example, **α-D-glucose and β-D-glucose are anomers**, differing in the orientation of the hydroxyl group at the anomeric carbon.

OLIGOSACCHARIDES

- Monosaccharides are combined by **glycosidic linkages** to form various polymers.
- Most common oligosaccharides are **disaccharides ($C_{12}H_{22}O_{11}$).**
- **Raffinose**: A **trisaccharide ($C_{18}H_{32}O_{16}$)** made up of one molecule each of **glucose, galactose,** and **fructose.** It's found in many seeds, including beans, cabbage, broccoli.

Classification of Disaccharides

Type	Monomers	Glycosidic bond	Functions
Sucrose (Cane sugar) Non-Reducing Sugar	Glucose + Fructose	α-1, β-2	➢ It is commonly known as **table sugar.** ➢ Used as a **sweetener in foods** and beverages. ➢ **Plant transports** their sugar in the form of **sucrose** by phloem.
Maltose (Malt sugar)	Glucose + Glucose	α-1-4	➢ Found in **germinating grains** and is used in brewing and baking to add mild sweetness and aid in **fermentation.**
Lactose (Milk Sugar)	Glucose + Galactose	β-1-4	➢ Lactose is found in **dairy products** and is a key **energy source for infants.**
Cellobiose	Glucose + Glucose	β-1-4	➢ It can be obtained by **enzymatic or acidic hydrolysis of cellulose** and cellulose-rich materials such as cotton, jute, or paper.

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POLYSACCHARIDES

- **Homopolysaccharides** are formed by the condensation of only **one kind of monosaccharide**. e.g. starch, glycogen, cellulose, chitin and dextrin.
- **Heteropolysaccharides** are formed by the condensation of **different kind of monosaccharide**. e.g. agar, pectin, peptidoglycan, hemicellulose.
- **Storage Polysaccharides** are starch (Plants) and glycogen (Animals).
- **Structural Polysaccharides** are cellulose (plants cell wall) and chitin (fungal Cell wall).
- Inulin (a polysaccharide) is **polymer of fructose.**

Type	Glycosidic bond	Explanations
Starch Amylose Amylopectin	 α-1-4 α-1-4 & 1-6	➢ Storage form of carbohydrates in **plants, algae and some fungus.** ➢ Main **source of carbohydrates for animals.** ➢ Founds in fruits, grains, seeds and tubers. ➢ Made up of **α-glucose molecules.** ➢ **Amylose (Unbranched)** soluble in hot water, **Amylopectin (Branched)** insoluble, are two forms of starch. ➢ Give **blue color** with iodine test.
Glycogen	α-1-4 & 1-6	➢ Storage form in **animals, fungi and prokaryotes.** ➢ Abundant in liver and muscles of animals (Animal starch). ➢ **Branched** and insoluble in water. ➢ Made up of **α-glucose molecules** ➢ Give **red color** with iodine test.
Cellulose	β-1-4	➢ Found in **plants, green algae** and a main continent of cell wall. ➢ Most abundant carbohydrates, **not digested by human gut.** ➢ Cotton is a pure form of cellulose. ➢ Made up of **β-Glucose molecules.** ➢ **Unbranched** and highly insoluble in water. ➢ **No color change** with iodine test.
Chitin $(C_8H_{13}O_5N)n$ Nitrogen containing polysaccharide	β-1-4	➢ Found in **arthropods (Exoskeleton) and fungi (Cell wall).** ➢ More resistant to decay. ➢ Made up of **N-acetyl glucosamine** (an amide derivative of the monosaccharide glucose). ➢ **Unbranched**, insoluble in water ➢ **No color change** with iodine test.

Reducing Sugars	Non-Reducing sugars
➢ Reducing sugars have a **free aldehyde or ketone group.**	➢ Non-reducing sugars **do not have a free aldehyde or ketone group, so they cannot act as reducing agents.**
➢ Reaction with **Benedict's/Fehling's Solutions** (Test for detection of carbohydrates) and give **positive results** (Color change).	➢ Non-reducing sugars do not react with Benedict's/Fehling's Solutions **unless hydrolyzed.**
➢ **Examples**: All monosaccharides, Lactose and Maltose. ➢ **Ketoses** must first **tautomerize** to aldoses before they act as **reducing agents.**	➢ **Example: Sucrose** and trehalose and all **polysaccharides.**

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PROTEINS

- **Most abundant** organic compounds, comprising over **50% of their dry weight.**
- Polymer of amino acids, Containing **C, H, O, N** and few contains **Sulfur** as well.
- **Nitrogen** is the basic element of proteins.

Amino acids

- A total of **170 types** are found in cell or tissues, out of which **25 are constituents of proteins** but **most of the proteins** are made up of **20 amino acids.**
- An amino acid contains a **central atom** called alpha carbon to which four groups are attached: a **hydrogen atom**, an **amino group (-NH_2)**, a **carboxylic group (-COOH)** and a **variable R group.**
- Amino acids are linked together by **peptide linkage (C-N)** to form polypeptides.
- Glycine is the **smallest and simplest amino acid** with low molecular weight.
- **Tryptophan** is the most complex amino acid.
- **Phenylalanine, tryptophan, tyrosine** and **histidine** amino acids have **aromatic (Cyclic) ringed R group.**
- **Proline** consists of unusual cyclic structure; it **does not** possess free **amino and carboxylic group**, so this is actually **imino acid.**
- **Methionine and cysteine** are **Sulfur** containing amino acid.
- **Tyrosine** amino acid gives rise to **dopamine, melanin, thyroxine, adrenaline and nor-adrenaline.**

Functions of Proteins

Functional class	Examples	Role
Structural Proteins	Collagen, Elastin, Keratin, Histone, Fibroin	➢ Collagen is the most abundant protein in body. ➢ Elastin provides resilience and elasticity to tissues. ➢ Keratin found in hairs, skin, nails, horn and hooves, feather and tooth enamel.
Enzymes	Amylase, Trypsin, Catalase, Ribonuclease, Cytochrome oxidase **(Metalloprotein)**	➢ Accelerate (Speed up) the biochemical processes.
Regulatory Proteins	Insulin, Growth Hormones, Parathormones	➢ Hormones regulate metabolic process.
Contractile Proteins	Actin, Myosin, Tubulin, Titin, Kinesin	➢ Actin, Myosin helps in muscle contraction, and Tubulin cause movement of chromosomes during anaphase. ➢ Titin is a giant protein that provides elasticity and structure to muscles and is the largest protein in the human genome. ➢ Kinesins are ATP-dependent motor proteins that can generate force and displacement along microtubules.
Transport Proteins	Haemoglobin **(Metalloprotein)** Serum albumin	➢ Serum albumin (Blood albumin) helps transport small molecules and regulates osmotic pressure.
Storage Proteins	Ovalbumin, Casein, Ferritin	➢ Ovalbumin represents 54% to 58% of the egg white protein by weight. ➢ Casein is a milk protein. ➢ Ferritin is a protein that stores iron.
Clotting Proteins	Fibrinogen, Prothrombin	➢ Fibrinogen convert into fibrin to clot blood. ➢ Prothrombin act as catalyst in blood clotting.
Protective Proteins	Immunoglobulin (Ig), Interferons	➢ Antibodies neutralize, and eliminate pathogens like bacteria, viruses, and toxins.

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Structure of Proteins			
Primary	**Secondary**	**Tertiary**	**Quaternary**
Number & sequence of amino acids.	Structural conformation (Form or shape) e.g. **coil or helix**	Bending & folding of polypeptide chain. **3D or globular structure**	Aggregation of tertiary structure by hydrophobic interactions.
Maintain **by peptide bond.**	Maintain by **hydrogen bond.**	Maintain by **Ionic, Hydrogen and Disulphide bridges.**	Maintain by Ionic, Hydrogen and hydrophobic interactions.
Example: Insulin	**Example:** α-helix & β-pleated sheath	**Example:** Myoglobin	**Example:** Hemoglobin

- F. Sanger was the first scientist to determine the **primary structure** of insulin.
- **Insulin** contains **51 amino acids** in two chains. **α-chain 21 amino** and **β-chain 30** amino acids.
- Sequence of amino acids in protein is determined by the order of nucleotide in DNA.
- **Hemoglobin** contains **574 amino acids** with four chains **(2 α and 2 β).** Each α-chain contains 141 amino acids, and each β-chain contains 146 amino acids.
- **In Sickle hemoglobin, glutamic acid** is replaced by **valine** at **position 06** from N-terminus of β-chain.

Classification of Proteins	
Fibrous Protein	**Globular Protein**
Polypeptide chains in **fibril form**	Polypeptide chains in **spherical or ellipsoidal form**
Secondary structure is important in them	**Tertiary Structure** is important in them
Insoluble, non-crystalline and elastic	Soluble, Crystallized and inelastic
Play **structural role**	Play **functional role**
More stable	**Less stable**
Examples: Silk protein, Myosin tail, Tropomyosin Fibrin, Keratin, Collagen, Elastin, Fibroin, F-actin	**Examples:** Enzymes, Antibodies, Hormones, Hemoglobin, Myoglobin, Albumin, G-actin, Ferritin, Histones

LIPIDS

- **Heterogenous group** of organic compounds are mostly related to fatty acid.
- Insoluble in water but **soluble in organic solvents** (Ether, chloroform, alcohol, benzene).

Importance of lipids

- Provide double amount of energy **(1g 9 Kcal)** due to the **high proportion** of C & H and very low proportion of oxygen.
- Serve as an **insulating layer** (waxes in exoskeletons of insects, cutin in leave fruit and seeds).
- Act as **water barrier** in organisms.
- Structural **component of cellular membranes** due to hydrophobic nature.
- Some lipids, such as cholesterol, are precursors to **steroid hormones** like estrogen, testosterone, and cortisol.
- Lipids aid in the absorption of **fat-soluble vitamins** (A, D, E, and K).

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FATTY ACIDS (R-COOH)

- Organic compound containing one **carboxylic acid group** attached to a **hydrocarbon chain**.
- Contains even number of carbon atoms **(2-30)**.
- The **solubility** of fatty acid, hydrophobic nature and melting point depends upon number of carbon ato and double bonds.
- Lighter than water and specific gravity is **0.08**.

Types of fatty acids

Saturated (Fats)	Unsaturated (Oils)
Have only **single bonds** between carbon atoms in the hydrocarbon chain.	Contain **up to double bonds** in the hydrocarbon chain
Linear **straight chain** structure.	Have **kinks** due to double bonds, ringed or branched.
Obtained mostly from **animals** and some tropical oils (e.g., coconut oil).	Obtained mostly from **plant** (e.g., olive oil, flaxseed oil) and **fish (fish oil)**.
Higher melting points due to tight packing, often **solid** at room temperature.	**Lower melting points**, generally **liquid** at room temperature.
Excess intake can contribute to cardiovascular diseases due to increased **LDL** (bad cholesterol).	Unsaturated fats (especially **omega-3s**) can be beneficial for heart health and reduce inflammation.

Saturated Fatty acid	No. of Carbon	Formula	Metling Point	Source
Acetic acid	4	$C_2H_4O_2$	16.6 °C	Vinegar
Butyric acid	6	$C_4H_8O_2$	-8 °C	Butter fat
Capric acid	10	$C_{10}H_{20}O_2$	31.6 °C	Coconut oil, palm kernel oil
Lauric acid	12	$C_{12}H_{24}O_2$	44 °C	Coconut oil, palm kernel oil
Myristic acid	14	$C_{14}H_{28}O_2$	54.4 °C	Nutmeg butter, coconut oil
Palmitic acid	16	$C_{16}H_{32}O_2$	63.1 °C	Palm oil, animal fats
Stearic acid	18	$C_{18}H_{36}O_2$	69.6 °C	Beef fat, cocoa butter

Unsaturated Fatty acid	Double Bonds	Formula	Metling Point	Source
Palmitoleic acid	1	$C_{16}H_{30}O_2$	-0.5 °C	Macadamia nuts, sea buckthorn oil
Oleic acid	1	$C_{18}H_{34}O_2$	14 °C	Olive oil, avocado, nuts
Linoleic acid	2	$C_{18}H_{32}O_2$	-5 °C	Sunflower oil, soybean oil
Linolenic acid	3	$C_{18}H_{30}O_2$	-11 °C	Soybean oil, canola oil
Arachidonic acid	4	$C_{20}H_{32}O_2$	-49.5 °C	Animal fats, liver, eggs
Eicosapentaenoic acid (EPA)	5	$C_{20}H_{30}O_2$	-55 °C	Fish oil, algae oil
Docosahexaenoic acid (DHA)	6	$C_{22}H_{32}O_2$	-44 °C	Fish oil, algae oil

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CLASSIFICATION OF LIPIDS

Simple lipids	Complex lipids	Derived lipids
Simple Lipids are made of **fatty acids and alcohols only.**	It contains other groups like **phosphates, sugars, or proteins in addition to alcohol and fatty acids.**	Derivatives from the **breakdown or modification of simple and complex lipids.**
Examples: Acylglycerol and waxes	**Examples:** Phospholipids, glycolipids, lipoproteins, Sphingolipids	**Examples:** Terpenes, steroids, prostaglandin and cholesterol

Acylglycerol

- Most abundant lipids in living organisms.
- Provide energy for metabolic activity **(Dietary lipids).**
- Esters of glycerol and fatty acids.
- Most common and biologically important acylglycerol is **triacylglycerol / Triglycerides /Neutral lipids.**
- **Saturated acylglycerol (Fats)** do not contain any double bond.
- **Unsaturated acylglycerol (Oils)** contains up to six double bonds

Waxes

- Highly **hydrophobic compounds**
- Esters of long chain fatty acids and long chain alcohols
- Natural waxes are chemically inert and resistant to decay **(Bee wax, Cutin wax).**
- Waxes are used by plants and animals to create a **protective layer** that prevents water loss (e.g., on leaves, feathers, and skin).
- **Synthetic waxes** (Paraffin wax) are derived from **petroleum or polyethylene.**

Phospholipids

- **Derivatives of phosphatidic acid** by addition of one of nitrogenous base (Choline, Serine, Ethanolamine).
- Most common and biologically important phospholipids are **phosphatidylcholine (Lecithin).**
- Phospholipid is **amphipathic compound** (having both hydrophilic and hydrophobic parts).
- **Head is hydrophilic** and consists of Glycerol, phosphate group and nitrogenous base.
- **Tail is hydrophobic** and consists of **2 fatty acid chains** (1- saturated and 1-unsaturated).
- Phospholipids are **associated with biological membranes** and form lipid bilayer.

Terpenoids

- Made up of repeating Isoprenoid units (C_5H_8).
- Examples are **Terpenes, Steroids, carotenoids and Prostaglandin.**

I. Terpenes

- Two isoprene units form **monoterpenes** (Menthol), four units form **diterpenes** (Vitamin A) & six units form **triterpenes** (Ambrein).

II. Steroids

- Type of terpenoids, made up of isoprenoids units.
- Contain **17 carbon atoms** arranged in **four attached rings. Three** of them are **hexagonal** and **one is pentagonal in shape.**
- **Cholesterol** is one of type of steroid which serve as precursor for the synthesis of other steroids such as **Testosterone, progesterone and estrogen. It is also found in cell membranes (maintain fluidity).**

III. Carotenoids

- It is a **polyterpenes, consisting of long chain of isoprenoid unit which contain isoprenoid rings at both or at one terminal.**
- These are **pigments producing red, orange, yellow and brown color in plants.**
- **Some important carotenoids α-Carotene, β-carotene, β-cryptoxanthin,** lutein, zeaxanthin, and lycopene.

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Structure of tRNA

- tRNA folds into a **cloverleaf shape in two-dimensional representation**. This structure has **four main arms (or loops)**, each serving a specific function.
- **5'- end** always terminates in **guanine bases** while **3'- end** always terminates with the base sequence c **CCA**.
- **Acceptor Arm**: Contains a **3' end** where an amino acid is attached.
- **D-loop** recognizes the activation enzyme.
- **Theta loop**: Recognizes the specific place on the ribosome for binding during protein synthesis.
- **Middle Loop**: Composed of **7 bases**, the **middle three** are **anticodon loop** which are complementary t specific codon on the mRNA during translation.

Conjugated Molecules

Molecule	Role
Glycoprotein (Mucoid)	➢ Formed by combination of carbohydrates and proteins. ➢ Part of **egg albumin** and **gonadotrophin**. ➢ **Cell secretions** are glycoprotein in nature (Mucus). ➢ Integral part of biological membranes ➢ Serve as **transport protein, structural protein, receptors** and **enzymes**. ➢ **Act as markers on the cell surface**, helping the immune system recognize self from non-self-cells. ➢ Some **hormones**, like follicle-stimulating hormone **(FSH)** and luteinizing hormone **(LH)**, are glycoproteins and regulate key processes. ➢ **Blood groups (A, B, AB, and O)** are determined by glycoproteins on red blood cells.
Glycolipids (Cerebrosides)	➢ Conjugates of lipids and carbohydrates ➢ Present in **white matter of brain** and **myelin sheath of nerve fiber**. ➢ Found in the **inner membrane of chloroplast**. ➢ Integral part of biological membrane.
Lipoproteins	➢ Conjugate of protein and lipids. ➢ Helps in **transport of lipids in plasma membrane, found in milk and blood**. ➢ Component of membrane of **mitochondria, ER, nucleus, egg yolk and chloroplast membrane, bacterial antigens and viruses**. ➢ Lipoproteins carry **triglycerides, cholesterol, and fat-soluble vitamins** through the bloodstream to various tissues for energy, storage, and hormone production.
Nucleohistone	➢ Formed by single basic protein and nucleic acid. ➢ Found in **chromosomes**. ➢ Involved in **regulation of gene expression**. ➢ During cell division, Nucleohistone help to condense chromosomes, ensuring accurate DNA segregation and proper distribution to daughter cells.

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1. **Nucleic acids were first isolated by:**
   (A) F. Sanger
   (B) F. Miescher
   (C) F. Griffith
   (D) Franklin and Wilkins
2. **Each nucleoside is made up of:**
   (A) One subunit (B) Three subunits
   (C) Two subunits (D) Four subunits
3. **Double ringed nitrogenous bases are:**
   (A) Cytosine (B) Purines
   (C) Thymine (D) Pyrimidines
4. **DNA differs from RNA in having:**
   (A) Uracil (B) Thymine
   (C) Pentose (D) Phosphate
5. **In a DNA duplex both polynucleotide chains are held together by:**
   (A) Phosphodiester
   (B) Disulphide bond
   (C) Hydrogen bonds
   (D) Hydrophobic interaction
6. **All information for the structure and functioning of a cell is stored in:**
   (A) RNA (B) Cell
   (C) DNA (D) Chromosome
7. **The agent responsible for transforming S-type bacteria to R- type bacteria was discovered by:**
   (A) Avery
   (B) Mc Carty
   (C) Macleod
   (D) Avery, Macleod, and Mc Carty
8. **Additional evidence supporting Avery's conclusion was provided by:**
   (A) Meselson and Stahl
   (B) Hershey and Chase
   (C) Lederberg and Tatum
   (D) Franklin and Wilkins
9. **The basic structure of nucleic acid was determined by the biochemist:**
   (A) P.A Levene (B) Rosalind Franklin
   (C) Frederick Griffith (D) Watson and Crick
10. **The overall stability of DNA molecule is contributed by:**
    (A) Hydrophobic interaction
    (B) Hyperphobic interactions
    (C) Hydrophilic interaction
    (D) Hyperphilic interaction
11. **It may be folded back in itself, to give double helical characteristics:**
    (A) DNA (B) Polynucleotide
    (C) RNA (D) Dinucleotide
12. **Pick up the base pair which enables us to identify RNA:**
    (A) C≡G (B) A=U
    (C) A=T (D) G≡C
13. **It carries the genetic information from DNA to ribosomes:**
    (A) mRNA (B) tRNA
    (C) rRNA (D) Ribosomal RNA
14. **Its length depends upon the size of gene as well as the protein for which it is taking the message:**
    (A) Ribosomal RNA (B) tRNA
    (C) Messenger RNA (D) Any type of RNA
15. **For a protein molecule of 1000 amino acids, mRNA will have the length of:**
    (A) 1000 nucleotides (B) 3000 nucleotides
    (C) 2000 nucleotides (D) 4000 nucleotides
16. **It is about 3 to 4% of the total RNA in the cell:**
    (A) rRNA (B) mRNA
    (C) snRNA (D) tRNA
17. **There is one specific _____ for each amino acid:**
    (A) mRNA (B) rRNA
    (C) tRNA (D) Ribosome
18. **At least how many kinds of tRNA molecules are found in a cell:**
    (A) Twenty (B) Forty
    (C) Thirty (D) Fifty
19. **According to Watson and Crick model of DNA the total length of a single turn of a DNA duplex is;**
    (A) 20A° (B) 34A°
    (C) 3.4A° (D) 0.2A°
20. **The backbone of a polynucleotide chain is provided by:**
    (A) Nitrogenous bases
    (B) Pentose sugar
    (C) Phosphoric acids
    (D) Pentose sugar and phosphoric acids
21. **Adenines have amino group at corner number:**
    (A) 2 (B) 4
    (C) 6 (D) 5
22. **Amount of _____ is fixed in each diploid cell of a species:**
    (A) DNA (B) Proteins
    (C) RNA (D) Lipids

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23. Miescher extracted a white substance from the nuclei of human pus and fish sperm cells and called it:
(A) Nucleic acid (B) Nuclein
(C) DNA (D) RNA

24. The sugar of ATP is:
(A) Pentose (B) Ribose
(C) Deoxyribose (D) Hexose

25. The amount of DNA is fixed for particular:
(A) Population (B) Genus
(C) Community (D) Species

26. It is a unit of biological inheritance:
(A) Nucleotide (B) Triplet code
(C) Genetic code (D) Gene

27. In Hershey and Chase experiments, which label was transferred to the interior of the bacteria:
(A) S^{35} (B) S^{32}
(C) P^{32} (D) P^{35}

28. It is strongly associated with ribosomal protein where 40 to 50% of it is present:
(A) mRNA (B) snRNA
(C) rRNA (D) tRNA

29. The RNA molecules mostly occur as a:
(A) Duplex
(B) Single standard structure
(C) Double standard structure
(D) Genetic material

30. All three types of _____ are synthesized from _____ in the _____:
(A) RNA, DNA, Nucleus
(B) DNA, RNA, Nucleus
(C) RNA, Nucleus, DNA
(D) Nucleus, RNA, DNA

31. This type of RNA consists of a single strand of variable length:
(A) Messenger RNA (B) Transfer RNA
(C) Ribosomal RNA (D) snRNA

32. It comprises about 10 to 20% of the cellular RNA:
(A) mRNA (B) rRNA
(C) tRNA (D) snRNA

33. Transfer RNA molecules are small, each with a chain length of:
(A) 70 to 80 nucleotides
(B) 75 to 85 nucleotides
(C) 75 to 80 nucleotides
(D) 75 to 90 nucleotides

34. It is the major form of RNA in the cell:
(A) rRNA (B) mRNA
(C) tRNA (D) snRNA

35. One the surface of ____ the mRNA and tRNA interact to translate the information form genes into a specific protein:
(A) rRNA (B) Ribosome
(C) Chromosome (D) Nucleosome

36. For most of the enzymes of human body, the optimum temperature is:
(A) 37C° (B) 37F°
(B) 35C° (D) 98.6C°

37. Starches are found in:
(A) Wood (B) Cotton
(C) Cereals (D) Paper

38. The example of polyhydroxy aldehyde is:
(A) Dihydroxyacetone (B) Ribulose
(C) Fructose (D) Glyceraldehyde

39. These are the primary products of photosynthesis:
(A) Proteins (B) Carbohydrates
(C) Nucleic acids (D) Lipids

40. They cannot be hydrolyzed into simple sugar:
(A) Carbohydrates (B) Oligosaccharides
(C) Polysaccharides (D) Monosaccharide

41. How many carbon atoms are kept outside the ring in fructose:
(A) 01 (B) 03
(C) 02 (D) 04

42. Amylose starches have branched chains of _____ and are _____ in hot water:
(A) Glucose, soluble (B) Ribose, Soluble
(C) Glucose, insoluble (D) Ribose, Insoluble

43. Maximum amount of energy is stored by:
(A) Lipids (B) Nucleic acids
(C) Proteins (D) Carbohydrates

44. Pick up the one which is not a lipid:
(A) Acyl glycerol (B) Chitin
(C) Waxes (D) Steroid

45. ____ _ are one of the most important components of triglyceride:
(A) Alcohols (B) Esters
(C) Glycerol's (D) Fatty acids

46. Lecithin minus choline is equal to:
(A) Phosphatidylcholine
(B) Phosphatidic acid
(C) Phospholipids
(D) Glycerol

47. The proteins which regulate metabolic activities are:
(A) Hormones (B) Antibodies

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(C) Enzymes (D) Carrier

48. The number of amino acids in different proteins varies from:
(A) A few to a few thousands
(B) A few to 3000
(C) A few to two thousand
(D) A few to 3000 or even more

49. Most of the proteins are made of:
(A) 25 Amino acids (B) 170 Amino acids
(C) 20 Amino acids (D) 3000 Amino acids

50. Glycylalanine is a/an:
(A) Amino acid (B) Dipeptide
(C) A pair of amino acids (D) Dinucleotide

51. The primary structure of proteins comprises the _____ and _____ of amino acids:
(A) Size, shape
(B) Number, size
(C) Number, shape
(D) Number, sequence

52. Number of peptide bonds involved in stabilization of a molecule of insulin is:
(A) 51 (B) 49
(C) 50 (D) 48

53. Triglycerides are esters of _____ fatty acids and ____glycerol/s:
(A) 3,1 (B) 3,3
(C) 1,3 (D) 1,1

54. Melting point of a fatty acid decreases by:
(A) Increasing number of carbon atoms
(B) Decreasing number of double bonds
(C) Decreasing number of carbon atoms
(D) Increasing number of double bonds and decreasing number of carbon atoms

55. The reason that many humans gains weight as they grow older is that the amount at energy, they need decrease with age while their intake of____ does not:
(A) Lipids (B) Proteins
(C) Carbohydrates (D) Fats

56. An unusual role of lipids is that they are metabolic source of:
(A) Water (B) Steroid hormones
(C) Potential energy (D) Cholesterol

57. To make a peptide bond one amino acid loses_____ and other loses ____:
(A) N, OH (B) H, H_2O
(C) H_2O, OH (D) OH, H

58. A polypeptide chain can be broken down into amino acids by:
(A) Dehydration (B) Hydrolysis
(C) Condensation (D) Polymerization

59. Fibrous proteins have following properties EXCEPT:
(A) Insoluble in water (B) Structural proteins
(C) Crystalline nature (D) Elastic nature

60. A globular protein is soluble in:
(A) Aqueous media (B) Solution of bases
(C) Solution of acids (D) Salt solutions

61. Spider's web is a:
(A) Globular protein (B) Fibrous protein
(C) Functional protein (D) Soluble protein

62. In glucopyranose, carbon atom number 1, joins to the oxygen on carbon atom number:
(A) 4 (B) 6
(C) 5 (D) 3

63. Monosaccharides perform following roles in living organisms EXCEPT:
(A) Source of energy in respiration
(B) Monomers of polysaccharides
(C) Building blocks for larger molecules
(D) Storage carbohydrates

64. Which one of the following is not a sugar:
(A) Glucose (B) Lignin
(C) Sucrose (D) Fructose

65. Amylose lacks which one the following:
(A) Glucose monomer
(B) 1,6 glycosidic bonds
(C) 1,4 glycosidic bonds
(D) Straight chain characteristics

66. The sugar that most humans eat as sweetener is:
(A) Amylose (B) Sucrose
(C) Starch (D) Glucose

67. About two third of any organism's body is composed of:
(A) Proteins (B) Water
(C) Lipids (D) Minerals

68. The attraction between water molecules is called:
(A) Cohesion (B) Polarity
(C) Adhesion (D) Surface tension

69. Small insects can walk on water because of:
(A) Adhesion (B) Surface tension
(C) Cohesion (D) Solubility

70. The number of calories required to raise the temperature of gram of water by one degree Celsius i.e. from 15°C to 16°C:
(A) 574 Kcal (B) 1 calorie

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(C) 1 Kcal (D) 574 calories

71. Evaporation of only two ml out of one liter of water, lowers the temperature of remaining 998 ml by:
(A) 1°C (B) 3°C
(C) 2°C (D) 4°C

72. Water forms a fluid cushion around organs to protect them from trauma, following are the examples of such protection EXCEPT:
(A) CSF (B) Tears
(C) Pleural fluid (D) Pericardial fluid

73. Water acts as a cooling agent for animals and example is:
(A) Transpiration (B) Perspiration
(C) Sublimation (D) Condensation

74. The capability of water to be ionized is important because enzymes are sensitive to changing it:
(A) Temperature (B) Substrate conc.
(C) pH (D) Enzyme conc.

75. Water provides protection to life in following ways EXCEPT:
(A) Protection against thermal shock
(B) Protection form abrasion
(C) Cushioning against physical trauma
(D) Protection against bone fracture

76. A dipeptide has:
(A) 2 amino acids and 1 peptide bond
(B) 2 amino acids and 2 peptide bonds
(C) 2 amino acids and 3 peptide bonds
(D) 2 amino acids and 4 peptide bonds

77. The insulin has two polypeptide chins α & β. The number of amino acids in each chain is:
(A) α=21, β=30 (B) α=30, β=21
(C) α=141, β=146 (D) α=146, β=141

78. Which of the following statements is incorrect regarding RNA:
(A) RNA is single stranded
(B) RNA is the only genetic material in viruses
(C) RNA is the genetic material in some viruses
(D) All of these

79. Ribozymes are actually:
(A) Catalytic RNA
(B) Enzymes
(C) Non-protein components of enzymes
(D) Glycoprotein molecules

Regarding the nature of enzymes, which one is correct?
(A) They are inorganic catalyst
(B) Large quantities and required to bring a change in large number of substrates.
(C) They are non-specific in their nature but specific in their action.
(D) They are specific both in their nature and action.

81. First microbe to have genome completely sequenced and published in 1995:
(A) *E. coli*
(B) *Hemophilus influenza*
(C) *Saccharomyces*
(D) *Homo sapiens*

82. In deoxyribose oxygen atom is removed from carbon number:
(A) 1 (B) 2
(C) 3 (D) 4

83. 1gm of glucose will yield how much energy:
(A) 3800 Cal (B) 5300 Cal
(C) 717.6 Kcal (D) 71.76 Kcal

84. Mono-unsaturated fatty acids having C 18, what is the formula:
(A) $C_{18}H_{35}COOH$ (B) $C_{17}H_{33}COOH$
(C) $C_{17}H_{35}COOH$ (D) $C_{18}H_{33}COOH$

85. The two chains of insulin are held together by:
(A) Peptide linkage (B) Sulfide linkage
(C) Disulphide bridge (D) Hydrogen bonding

86. It is present in Nails, hair, and horns:
(A) Fibrin (B) Keratin
(C) Myosin (D) Dextrin

87. Number of oxygen atoms in lipids are always ---------- as compared to number of hydrogen atoms:
(A) Less (B) Double
(C) Equal (D) More

88. Which is an Aldo form?
(A) Dihydroxyacetone (B) Glyceraldehyde
(C) Fructose (D) Ribulose

89. In nucleic acid, the bases are always attached to the _____ carbon of the sugar:
(A) 5' (B) 4'
(C) 3' (D) 1'

90. If 1ml of water is vaporized from 1000ml found at room temperature of 27°C what will be the temperature of the rest?
(A) 26°C (B) 25.5°C
(C) 26.5°C (D) 28°C

91. The structure of proteins found as crystalline form is different from fibrous by in having _____bond additionally?

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(A) Peptide (B) Disulphide bridges
(C) Hydrogen (D) Covalent linkage

92. **Select the formula of choline?**
(A) $CH_3.CH_2.N^+.(CH_3)_3$
(B) $2N.\ CH_3.CH_2.N^+.(CH_3)_3$
(C) $HO.\ CH_2.CH_2.N^+.(CH_3)_3$
(D) $O.CH_3.CH_2.N+.(CH_3)_3$

93. **During the formation of phosphatidic acid resultant product has ..... molecular weight change?**
(A) 2 water molecules will be added
(B) 3 water molecules will be added
(C) 2 water molecules will be removed
(D) 3 water molecules will be removed

94. **Waxes are different from acylglycerol in having?**
(A) Ketones and aldehydes
(B) Ketones and odd carbon alkane chains
(C) Aldehydes and even carbon alkane chains
(D) Ketones and alcohols

95. **Select the sequence of biological organic molecules which are found in abundance?**
(A) Water > Proteins > Lipids > Carbohydrates > DNA
(B) Proteins > Lipids > Carbohydrates > DNA
(C) Proteins > Carbohydrates > Lipids > DNA
(D) Proteins > Lipids > Carbohydrates > RNA

96. **Which one of the following combinations of biological molecules is the same both in bacterial cell and mammalian cells?**
(A) Water and DNA
(B) Enzymes and inorganic ions
(C) Inorganic ions and RNA
(D) Organic molecules (lipids and proteins) and inorganic ions

97. **Which of the following disaccharides is exclusively synthesized by animal body?**
(A) Sucrose
(B) Lactose
(C) Maltose
(D) Maltose and lactose

98. **Mannitol is?**
(A) Amino acid (B) Sugar alcohol
(C) Amino alcohol (D) Sugar acid

99. **At 25C the concentration of each H+ and OH- ions in pure water is about _____mole/liter?**
(A) 10^{-5} (B) 10^{-7}
(C) 10^{-6} (D) 10^{-8}

100. **How many carbon atoms are found in ribofuranose ring?**
(A) 4 (B) 6
(C) 5 (D) 7

101. **The general formula of carbohydrates is $C_x(H_2O)_y$ so in monosaccharide's what will be the correct one:**
(A) x=y (B) x<y
(C) x>y (D) x≠y

102. **Monomeric unit of cellulose is?**
(A) Glucose (B) Mannose
(C) Fructose (D) Ribose

103. **_____ of the total cell mass is formed by Carbohydrates in eukaryotes:**
(A) 1 % (B) 3 %
(C) 2 % (D) 4 %

104. **All are correct about lipids, except:**
(A) Compounds of carbon, hydrogen, and oxygen.
(B) Compounds of glycerol and fatty acid.
(C) Insoluble in water.
(D) Heavier than water.

105. **Match the column:**

Column I	Column II
1. Collagen	1. Hormone
2. Trypsin	2. Enzyme
3. Insulin	3. Fight Infectious agent.
4. Antibody	4. Intercellular ground substance.

(A) 1-1, 2-3, 3-4, 4-2 (B) 1-4, 2-2, 3-1, 4-3
(C) 1-1, 2-2, 3-3, 4-4 (D) 1-4, 2-3, 3-1, 4-2

106. **Sequence or positional information of amino acid is given by the:**
(A) Secondary structure
(B) Tertiary structure
(C) Primary structure
(D) Quaternary structure

107. **In primary structure of protein:**
(A) Left end represent → 1st amino acid (C-terminal amino acid)
(B) Right end represent → Last amino acid (N-terminal amino acid)
(C) Left end represent → 1st amino acid (N-terminal amino acid)
(D) Right end represent → 1st amino acid (C-terminal amino acid)

108. **Identify the nucleoside from the following:**
1-Adenosine 2-Uridine phosphate
3-Uridine 4-Cytidine phosphate
(A) 1 and 2 only (B) 3 and 4 only
(C) 1 and 3 only (D) 2 and 3 only

109. **How many double bonds are present in adenine?**
(A) 3 (B) 4
(C) 5 (D) 6

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110. How many "OH" found in Monosaccharides with 5 carbon atoms have?
(A) 5 (B) 6
(C) 4 (D) 7

111. Which of the following is true of both starch and cellulose?
(A) They are both polymers of glucose.
(B) They are geometric isomers of each other.
(C) They can both be digested by humans.
(D) They are both structural components of plant cell wall.

112. Cellulose forms a major portion of food of grazing cattle. It is:
(A) Digested by intestinal bacteria.
(B) Digested partly by the animal and partly by the bacteria.
(C) Digested by the animal itself.
(D) Passed out undigested.

113. The most abundant protein in the plant world is found in:
(A) Root hairs (B) Chloroplast
(C) Mitochondria (D) Vacuole

114. Nucleic acids are composed of following elements:
(A) C, H, O, N, S (B) C, H, O, P, N
(C) C, H, N, O, Fe (D) C, Fe, O, P, N

115. Which of the following sequence is correct on the basis of increasing molecular weight?
(A) DNA, ATP, NADP, AMP
(B) ATP, AMP, DNA, NADP
(C) AMP, ATP, NADP, DNA
(D) ATP, ADP, NADP, DNA

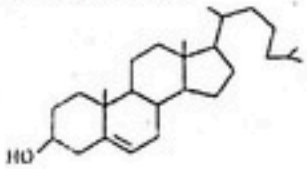
116. In a single strand from a DNA molecule, nucleotides are linked by covalent bonds between:
(A) Nitrogen bases
(B) Phosphate group and nitrogenous base
(C) Sugar and phosphate group
(D) Sugar and nitrogen base

117. Pyrimidine and purine are equal when we consider:
(A) Single strand of DNA
(B) Either single or Double strand
(C) Double strand of DNA
(D) DNA as monomer

118. Arrange the steps of catalytic action of an enzyme in order and choose the correct option:
I. The enzyme releases the products of the reaction, and the enzyme is free for another substrate.
II. The active site of enzyme is in proximity of the substrate and breaks of chemical bonds of the substrate.
III. The binding of substrate induces the enzyme to alter its shape fitting more tightly around the substrate.
IV. The substrate binds to the active site of the enzyme fitting into the active site.
(A) IV, III, II, I (B) III, II, I, IV
(C) IV, II, I, III (D) II, I, IV, III

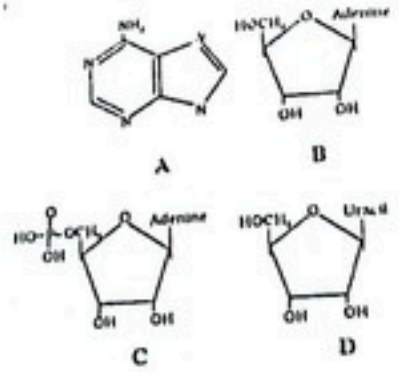
119. What will be the molecular formula of a polypeptide consisting of 10 glycine molecules when the formula of glycine is $C_2H_5O_2N$?
(A) $C_6H_{12}ON_5$ (B) $C_{20}H_{32}O_{11}N_{10}$
(C) $C_{30}H_{16}O_6N_{10}$ (D) $C_{25}H_{16}O_6N_5$

120. Given structural formula is correctly identified along with its related function by which of the following options?



(A) Cholesterol: A component of Animal cell membrane
(B) Adenosine: A component of nucleic acid
(C) Lecithin: A component of cell membrane
(D) Triglyceride: An energy source

121. The Four structural formulae A, B, C and D are given here. Identify them and select the correct option:



	A	B	C	D
(A)	Adenine	Adenosine	Adenylic acid	Uridylic acid
(B)	Adenine	Adenosine	Adenylic acid	Uridine
(C)	Adenosine	Adenylic acid	Adenine	Uridylic acid
(D)	Adenosine	Adenylic acid	Adenine	Uridylic acid

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122. Match Column-I with Column-II and select the correct option from the codes given below:

Column-I	Column-II
A. Galactose	(i) Protein
B. Anticoagulant	(ii) Phospholipid
C. Fructose	(iii) Brain sugar
D. Lecithin	(iv) Heparin
E. Insulin	(v) Fruit sugar

(A) A-(v), B-(iii), C-(ii), D-(i), E-(iv)
(B) A-(v), B-(iii), C-(i), D-(iv), E-(ii)
(C) A-(i), B-(ii), C-(iii), D-(v), E-(iv)
(D) A-(iii), B-(iv), C-(v), D-(ii), E-(i)

123. Read the given statement and select the option that correctly identifies X and Y:
In a glycogen molecule, successive glucose units are joined together by X and branches are linked together by Y:
(A) X-1,4-α-glycosidic bonds, Y- 1,4-α-glycosidic acids
(B) X-1,4-α-glycosidic bonds, Y- 1,6-α-glycosidic bonds
(C) X-1,6-α-glycosidic acids, Y- 1,4-α-glycosidic acids
(D) X-1,6-α-glycosidic acids, Y- 1,6-α-glycosidic acids

124. Select the option that correctly identifies the chemical bonds present in the given biomolecules. Polysaccharides-A, Proteins-B, Fats-C, Water-D:

	A	B	C	D
(A)	Ester	Peptide	Glycosidic	Hydrogen
(B)	Glycosidic	Peptide	Ester	Hydrogen
(C)	Glycosidic	Peptide	Hydrogen	Ester
(D)	Hydrogen	Ester	Peptide	Glycosidic

125. _____ of wood, cotton and paper is example of carbohydrates:
(A) Starches (B) Cellulose
(C) Chitin (D) Pectin

126. _____ are the main source of energy in the cell:
(A) Complex carbohydrates
(B) Structural carbohydrates
(C) Intermediate carbohydrates
(D) Simple carbohydrates

127. The general formula of carbohydrates is:
(A) $(CH_2O)_n$ (B) $C_n(H_2O)_n$
(C) $C_x(H_2O)_y$ (D) $(CHO)_n$

128. Green plants are sources of:
(A) Proteins (B) Nucleic acids
(C) Carbohydrates (D) Lipids

129. $C_3H_6O_3$ is the chemical formula of:
(A) Glyceraldehyde (B) Aldo-sugar
(C) Dihydroxyacetone (D) Triose

130. These are rare in nature and occur in some bacteria:
(A) Glucose (B) Erythrose
(C) Ribulose (D) Ribose

131. Our blood normally contains:
(A) 0.08% glucose (B) 0.008% glucose
(C) 0.8% glucose (D) 8.0% glucose

132. The covalent bond between two monosaccharaides is called:
(A) Peptide bond (B) Ester bond
(C) Glycosidic bond (D) Disulphide bond

133. One hydrolysis it yields glucose and fructose:
(A) Maltose (B) Sucrose
(C) Lactulose (D) Lactose

134. Both glucose and fructose are hexoses, glucose makes a _____ whereas fructose makes a _____ in a solution, respectively:
(A) Pyran, Pyran (B) Furan, Pyran
(C) Furan, Furan (D) Pyran, Furan

135. The main source of carbohydrates for animals is:
(A) Glycogen (B) Cellulose
(C) Starch (D) Dextrin

136. Amylopectin is insoluble in:
(A) Hot water
(B) Hot and cold water both
(C) Cold water
(D) Lukewarm water

137. It is most abundant carbohydrates in nature:
(A) Starch (B) Amylopectin
(C) Amylose (D) Cellulose

138. A heterogeneous group of compounds related to fatty acids is that of:
(A) Carbohydrates (B) Proteins
(C) Lipids (D) Nucleic acids

139. It also acts as waterproof material:
(A) Carbohydrates (B) Nucleic acids
(C) Lipids (D) Proteins

140. During the formation of triacylglycerol, we get:
(A) One water molecule
(B) Three water molecules
(C) Two water molecules
(D) Four water molecules

141. In animals the fatty acids are:
(A) Branched (B) Ringed
(C) Straight chain (D) Unsaturated

142. An unsaturated fatty acid with eighteen carbon atoms is:
(A) Acetic acid (B) Palmitic acid
(C) Butyric acid (D) Oleic acid

143. These are widespread as protective coatings on fruits and leaves:

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(A) Acylglycerols (B) Waxes
(C) Fats (D) Phospholipids

144. Waxes protect plants from:
(A) Water loss
(B) Abrasive damage
(C) Both water loss and abrasive damage
(D) Water absorption

145. Phospholipids are derivatives of:
(A) Phosphatides acid
(B) Lecithin
(C) Phosphatidylcholine
(D) Phosphatidylserine

146. Phospholipids are widespread in:
(A) Algae, Fungi and Protozoan cells
(B) Bacteria, Fungi and Animal cells
(C) Algae, Fungi and Protist cells
(D) Bacteria, Animal and Plant cells

147. Pick up the one which is a terpenoid:
(A) Wax (B) Rubber
(C) Cutin (D) Lecithin

148. Over 50% of the total dry weight of a cell consists of:
(A) Lipids (B) Carbohydrates
(C) Proteins (D) Nucleic acids

149. Movement of organs and organisms and movement of chromosomes during anaphase of cell division are caused by:
(A) Carbohydrates (B) Lipids
(C) Proteins (D) Nucleic acids

150. If 'R' is CH_3 the amino acid will be:
(A) Alanine (B) Valine
(C) Glycine (D) Glutamic acid

151. Number of peptide bonds involved in maintenance of primary structure of each beta chain of hemoglobin is:
(A) 146 (B) 144
(C) 145 (D) 143

152. We know that there are _____ proteins in the human body:
(A) Less than 10,000 (B) 10,000
(C) Over 10,000 (D) Many 10,000

153. The word carbohydrates literally mean:
(A) Dehydrated carbons (B) Hydrated carbons
(C) Hydrolyzed carbons (D) Reduced carbons

154. It is the chief form of carbohydrates stored in animal body:
(A) Starch (B) Pectin
(C) Cellulose (D) Glycogen

155. The most common type of lipids is that of:
(A) Waxes (B) Triglycerides
(C) Phospholipids (D) Terpenoids

156. Attaching a hydrocarbon tail to a – COOH group _____ is synthesized:
(A) Triglyceride (B) Fatty Acid
(C) Glycerol (D) Wax

157. Blubber, a lipid found in sea mammals like whales acts as:
(A) Hydrophobic barrier
(B) Protective barrier against infection
(C) Source of potential energy
(D) Insulator

158. A protein strengthening to our bones and the walls of arteries is called:
(A) Fibrin (B) Albumin
(C) Collagen (D) Keratin

159. The type of amino acids contained in a chain and the sequence in which they are joined, is called:
(A) Primary structure or protein
(B) Tertiary structure of protein
(C) Secondary structure of protein
(D) Quaternary structure of protein

160. The example of a tertiary structure of protein is:
(A) Hemoglobin molecules
(B) Myoglobin molecules
(C) Insulin molecules
(D) Silk protein

161. Which one of the following is a fibrous protein:
(A) Myoglobin (B) Myosin
(C) Hemoglobin (D) Albumin

162. The color of hemoglobin is due to:
(A) Haem group (B) Alpha chains
(C) Quaternary structure (D) Beta chains

163. Amino acids differ from each other on the bases of:
(A) $-NH_2$ (B) -COOH
(C) 'R' group (D) H

164. A glucopyranose having hydroxyl group –OH, on carbon atom 1, below the ring is called:
(A) α-glucose (B) D-glucose
(C) β-glucose (D) L-glucose

165. Synthesis of polysaccharides form monosaccharaides is called:
(A) Condensation synthesis
(B) Hydration synthesis
(C) Hydrolysis
(D) Condensation or dehydration synthesis

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166. Storage of surplus glucose in cell in free form without converting it into polysaccharides will disturb the cell's:
(A) Respiration (B) Energy synthesis
(C) Osmotic balance (D) Metabolism

167. The transport sugar of human being is:
(A) Sucrose (B) Glucose
(C) Fructose (D) Maltose

168. Many animals provide energy for their young ones in the form of:
(A) Sucrose (B) Maltose
(C) Lactose (D) Glycogen

169. Which one of the following combinations of carbon is never involved in protein synthesis:
(A) C – H, C – O, C – N, C – S
(B) C – H, C – O, C – S, C – P
(C) C – H, C – O, C – N, C – C
(D) Both A & B

170. Which statement about biomolecules is false?
(A) Monomers are the building blocks of polymers
(B) Both DNA and RNA are linear polymers of nucleotides
(C) A monosaccharide is a long chain of polymer formed of simple sugars
(D) Both cellulose and starch are polymers of glucose

171. For synthesis of 100 grams of glucose, the requirement of solar energy is:
(A) 717.6 KCal (B) 717000 KCal
(C) 7176 KCal (D) 71700 KCal

172. It is the most abundant compound in living organisms and makes up two-thirds of the weight of adults:
(A) Protein (B) Carbohydrate
(C) Water (D) Nucleic acid

173. Monosaccharides contain carbon atoms:
(A) 3-7 (B) 3-9
(C) 3-6 (D) 3-10

174. Which of these is an example of condensation?
(A) Amino acid + amino acid-----Dipeptide + H_2O
(B) Dipeptide + H_2O-----amino acid + amino acid
(C) Monomer + monomer -----polysaccharides+H_2O
(D) Both A & C

175. The source of carbohydrates is green plants. These are primary product of:
(A) Respiration (B) Photosynthesis
(C) Catabolism (D) Glucose

176. The sugar found in RNA is:
(A) Fructose (B) Deoxyribose
(C) Galactose (D) Ribose

177. Tetroses occurs in:
(A) All bacteria (B) Some bacteria
(C) All viruses (D) Some viruses

178. When in solution, most of the monosaccharide form a:
(A) Straight chain structure
(B) Ring structure
(C) Branched chain structure
(D) Chain & Ring

179. The molecular formula of maltose is:
(A) $C_{12}H_{22}O_{11}$ (B) $C_{12}H_{22}O_{12}$
(C) $C_{12}H_{24}O_{12}$ (D) $C_6H_{22}O_{11}$

180. Three carbon aldehyde form of sugar:
(A) Glyceraldehyde (B) Dihydroxyacetone
(C) Aldehyde (D) Formaldehyde

181. What kind of Glycosidic linkage is found in sucrose?
(A) 1,6 (B) 2, 6
(C) 1,4 (D) 1,2

182. RuBP is a phosphorylated:
(A) Aldo sugar (B) Hexose
(C) Keto sugar (D) Seduhetulose

183. Which possesses the beta Glycosidic linkage?
(A) Amylose starch (B) Amylopectin
(C) Cellulose (D) Glycogen

184. The most common carbohydrate monomer is:
(A) Maltose (B) Glucose
(C) Lactose (D) Galactose

185. All the following are Aldo sugars except:
(A) Ribose (B) Glyceraldehyde
(C) Glucose (D) Fructose

186. In Lactose, the glycosidic linkage found is:
(A) 1, 4 (B) 1, 6
(C) I, 3 (D) 1, 2

187. Maltose on hydrolysis yields:
(A) Two glucose molecules
(B) Glucose & fructose
(C) Glucose & galactose
(D) Two fructose molecules

188. It is not true for carbohydrates:
(A) Carbohydrates are used in synthesis of lipids
(B) Carbohydrates are less soluble than fats in water
(C) Carbohydrates form component of nucleic acids

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(D) Carbohydrates are utilized in the synthesis of amino acids

189. The main source of carbohydrates for animals is:
(A) Starch (B) Glycogen
(C) Chitin (D) Cellulose

190. If three molecules of a fatty acid, each having the formula $C_{18}H_{22}COOH$, were joined to a molecule of glycerol ($C_3H_8O_3$) the resulting molecule would have the formula:
(A) $C_{48}H_{68}O_6$ (B) $C_{48}H_{74}O_6$
(C) $C_{54}H_{72}O_6$ (D) $C_{54}H_{68}O_9$

191. Glycerol is the backbone molecule for:
(A) Disaccharides (B) Triglycerides
(C) DNA (D) ATP

192. Steroid are classified as:
(A) Carbohydrates (B) Proteins
(C) Lipids (D) Nucleic acids

193. Triglycerides that is solid at room temperature:
(A) Fats (B) Linoleic acid
(C) Oils (D) Waxes

194. Triglycerides that is liquid at room temperature:
(A) Fats (B) Stearin
(C) Oils (D) Terpenoids

195. Phosphatidic acid lacks:
(A) Fatty acids (B) Glycerol
(C) Phosphate group (D) Choline

196. Specific gravity of fats and oils is:
(A) 0.8 (B) 0.6
(C) 1.8 (D) 0.08

197. Heterogeneous group of compounds related to fatty acids:
(A) Protein (B) Lipid
(C) Carbohydrate (D) DNA

198. Phosphatidylcholine is one of the common:
(A) Phospholipids (B) Glycolipids
(C) Sphingolipids (D) Terpenoids

199. Lipids are soluble in:
(A) Alcohol (B) Benzene
(C) Chloroform (D) All of these

200. Long chain alkanes found in the waxes have no. of carbon atoms ranging from:
(A) 2-20 (B) 25-35
(C) 20-30 (D) 35-40

201. Which is not a lipid?
(A) Terpenes (B) Steroids
(C) Vitamin B (D) Vitamin D

202. Stearic acid $C_{17}H_{35}COOH$ is:
(A) Not a fatty acid
(B) Saturated fatty acid
(C) Unsaturated fatty acid
(D) Is also named as oleic acid

203. Which of following forms the head in phospholipids?
(A) Fatty acid
(B) Glycerol
(C) Phosphoric acid, glycerol & nitrogenous base
(D) Phosphoric acid and fatty acid

204. Testosterone is:
(A) Phospholipids (B) Terpenoids
(C) Sphingolipids (D) Acylglycerol

205. Number of oxygen atoms in lipid molecules is always _____ as compared to number of carbon atoms:
(A) Less (B) Equal
(C) More (D) Double

206. They are widespread in bacteria, animal and plant cell and associated with membranes:
(A) Phospholipid (B) Sphingolipids
(C) Terpenoids (D) Steroids

207. It is also called as neutral lipid:
(A) Cutin
(B) Carotenoid
(C) Triglyceride
(D) Phosphatidylcholine

208. In Phosphatidic acid phosphoric acid is attached with glycerol at:
(A) Carbon 1 (B) Carbon 3
(C) Carbon 2 (D) Carbon 4

209. The simplest amino acid is:
(A) Alanine (B) Glycine
(C) Proline (D) Valine

210. The identity and unique chemical properties of amino acid are determined by:
(A)The nature of the carboxyl group
(B) The nature of the 'R' group
(C) The nature of the 'H' group
(D) The nature of the amino group

211. Proteins are the polymers of:
(A) Amino acid (B) Nucleic acid
(C) Fatty acid (D) Acetic acid

212. Glycylalanine is:
(A) Tripeptide (B) Tetrapeptide
(C) Dipeptide (D) Polypeptide

213. Peptide bond lies between:

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(A) C-H Link (B) N-H Link
(C) C-O Link (D) C-N Link

214. The amino acid is called ---- if the "R" is replaced by CH_3:
(A) Glycine (B) Leucine
(C) Alanine (D) Valine

215. Each of the 20 naturally occurring amino acids has a different:
(A) NH_2 group (B) R group
(C) –COOH group (D) –OH group

216. A hormone is an example of which functional class of proteins:
(A) Contractile (B) Regulatory
(C) Structural (D) Cyclic

217. Hemoglobin is an example of which functional class of protein:
(A) Contractile (B) Regulatory
(C) Structural (D) Transportive

218. Which one is not a fibrous protein:
(A) Fibrinogen (C) Keratin
(B) Actin (D) Antibodies

219. Fibrous proteins are:
(A) In soluble in aqueous medium
(B) Soluble in salt solution
(C) Inelastic
(D) Crystalline

220. Glycylalanine has how many peptide linkages:
(A) One (B) Three
(C) Two (D) Four

221. How many types of amino acids are found in cells and tissues:
(A) 180 (B) 45
(C) 20 (D) 170

222. Which structure is most important in fibrous proteins?
(A) Primary (B) Tertiary
(C) Secondary (D) Quaternary

223. The secondary helical structure of protein is kept stable by the formation of:
(A) Disulfide bond
(B) Hydrogen bond
(C) Covalent bond
(D) Hydrophobic interaction

224. Amino acid which gets attached with tRNA, uses its _____ group:
(A) Amino group
(B) R- group
(C) Carboxylic group
(D) R- and Amino group

225. Polypeptide bends & folds upon itself forming a globular shape in which structure?
(A) Tertiary (B) Secondary
(C) Primary (D) Quaternary

226. Enzymes, antibodies, hormones, and hemoglobin are examples of:
(A) Ovular proteins (B) Fibrous proteins
(C) Globular proteins (D) Tough proteins

227. Which protein is involved in blood clotting?
(A) Silk fiber (B) Myosin
(C) Keratin (D) Fibrin

228. Type of chemical bond present in tertiary protein:
(A) Disulphide bond (B) Hydrogen bond
(C) Ionic bond (D) All of these

229. The elements that are found in proteins are:
(A) Carbon, hydrogen, nitrogen, oxygen, and sulphur
(B) Carbon, hydrogen, nitrogen, oxygen and phosphorous
(C) Carbon, hydrogen, nitrogen, oxygen, and magnesium
(D) Carbon, hydrogen, and nitrogen only

230. ATP releases energy when:
(A) It undergoes a condensation reaction
(B) A hydroxyl group is added to it
(C) A phosphate group is added to it
(D) A phosphate group is removed from it

231. Nucleic acids are polymers composed of monomer units known as:
(A) Amino acids (B) Nucleotides
(C) Nucleosides (D) Nitrogenous bases

232. There are _____ nitrogenous bases:
(A) Four (B) Six
(C) Five (D) Three

233. The length of one turn of DNA double helix is:
(A) 34 nm (B) 3.4 A
(C) 3.4 nm (D) 0.34 nm

234. How many nucleotides form tRNA:
(A) 60-75 (B) 70-80
(C) 75-90 (D) 60-80

235. DNA contents in mammalian cells:
(A) 1.1% (B) 0.25%
(C) 2% (D) 4%

236. Which has ability to form ester linkage with OH group of pentose sugar:
(A) Nucleoside (B) Nitrogenous bases
(C) Phosphoric acid (D) Adenine

237. E. coli genome codes for how many proteins?

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(A) 4288 (B) 4000
(C) 4200 (D) 4888

238. A cell must have at least 20 kinds of:
(A) tRNA (B) cRNA
(C) mRNA (D) rRNA

239. RNA is synthesized from DNA in a process:
(A) Transcription (B) Replication
(C) Translation (D) Regeneration

240. Electrolytes that release hydrogen ions in water are called:
(A) Acids (B) Amphoteric
(C) Bases (D) Neutral

241. A bond that forms between a positively charged hydrogen atom of one molecule and a negative charged region of another molecule is:
(A) Ionic bond (B) Covalent bond
(C) Hydrogen bond (D) Basic bond

242. Due to high specific heat capacity water acts as:
(A) Buffer
(B) Temperature stabilizer
(C) Lubricant
(D) Shock absorber

243. Which bond is potential source of chemical energy for cellular activities:
(A) C-C (B) C-N
(C) C-O (D) C-H

244. 10^{-7}moles per $dm^3$of water is concentration of which of the followings?
(A) Hydrogen ion
(B) Hydroxyl ion
(C) Collective concentration of both
(D) None

245. In different organisms, water varies from:
(A) 55 to 79% (B) 40 to 80%
(C) 65 to 89% (D) 65 to 66%

246. Lipids are organic molecules which are insoluble in:
(A) Alcohol (B) Chloroform
(C) Ether (D) Water

247. Which of following organic compound may belongs to lipids:
(A) $C_{18}H_{32}O_{16}$ (B) $C_{57}H_{110}O_6$
(C) $C_{300}H_{500}O_{250}$ (D) $C_{42}H_{85}O_{23}N_{17}S$

248. Which types of linkage from which an alcohol and acid reacts:
(A) Hydrogen bonds (B) Glycosidic bond
(C) Peptide bond (D) Ester bonds

249. Which of the following organic compounds is the main constituent of Lecithin:
(A) Arachidonic acid (B) Phospholipid
(C) Cholesterol (D) Phosphoprotein

250. Which of the following are not polymeric:
(A) Proteins (B) Polysaccharides
(C) Lipids (D) Nucleic acids

251. Maximum number of double bonds are found in:
(A) Linolic acid
(B) Linolenic acid
(C) Arachidonic acid
(D) Docosahexaenoic acid

252. It is an amino acid and also the part of phospholipids:
(A) Serine (B) Choline
(C) Ethanolamine (D) Aspartic acid

253. The head of phospholipid molecule is polar (hydrophilic) due to:
(A) Fatty acid (B) Phosphate
(C) Carboxylic acid (D) Tri glycerol

254. Myelin sheath of neuron is composed of:
(A) Sphingolipids (B) Choline
(C) Ethanolamine (D) Waxes

255. How many double bonds are present in the "R" group of oleic acid:
(A) 1 (B) 2
(C) 4 (D) 6

256. Which of following is unsaturated fatty acid:
(A) Linolic acid (B) Linolenic acid
(C) Arachidonic acid (D) All of the above

257. Which of the following are examples of terpenoids:
(A) Vitamin A (B) Coenzyme Q
(C) Carotenoids (D) All of the above

258. It is the precursor of bile acid:
(A) Waxes (B) Steroids
(C) Phospholipids (D) Acylglycerol

259. Which of following is most prominent part of the cell membrane in living organism:
(A) Waxes (B) Terpenoids
(C) Phospholipids (D) Acylglycerol

260. Lipase can hydrolyze them:
(A) Triglycerides (B) Terpenoids

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(C) Waxes (D) All of the above

261. Which of following statement is not correct for waxes:
(A) Provide protective coating in plants and animals
(B) High melting point and not digested by animals
(C) Non-polar due to non-polar nature
(D) Waxes in oil surface and helps in oil extraction

262. Milk protein is:
(A) Collagen (B) Mucin
(C) Casein (D) Pepsin

263. Histone is a basic protein due to:
(A) Alanine & glycine
(B) Methionine & serine
(C) Threonine & tyrosine
(D) Lysine & Arginine

264. Variations in proteins are due to:
(A) Sequence of amino acids
(B) Number of amino acids
(C) R – group
(D) α-carbon

265. Which one is the most abundant protein in the human body:
(A) Collagen (B) Insulin
(C) Trypsin (D) Haemoglobin

266. Which of the following is an amino acid derived hormone:
(A) Epinephrine (B) Ecdysone
(C) Estradiol (D) Progesterone

267. Which of the following is the least likely to be involved in stabilizing the three–dimensional folding of most proteins:
(A) Disulphide bridges (B) Ester bonds
(C) Hydrogen bonds (D) Ionic bond

268. Which of the following is aromatic amino acid:
(A) Tyrosine (B) Tryptophan
(C) Phenyl alanine (D) All the above

269. All of the following are example of fibrous protein except:
(A) Silk protein (B) Keratin
(C) Myoglobin (D) Fibrin

270. Which molecular structure of enzyme is essential for the activity:
(A) Primary Structure
(B) Secondary Structure
(C) Tertiary Structure
(D) Quaternary Structure

271. Which type of bond is required to maintain α-helix configuration of a protein:
(A) Disulphide bridges
(B) Hydrophobic interaction
(C) Hydrogen bonds
(D) Ionic bond

272. Which of the following is a complex of globular protein with non-proteinaceous materials:
(A) Collagen (B) Fibrinogen
(C) Albumin (D) Hemoglobin

273. Which of the following protein protect the body from the foreign pathogens:
(A) Antigens (B) Vaccines
(C) Antibodies (D) Fibrinogens

274. Proteins of hair, horns, feathers, and other skin parts are:
(A) Storage protein
(B) Enzymatic protein
(C) Structural protein
(D) Contractile protein

275. Identify the protein, which cannot be crystallized:
(A) Antibodies (B) Hemoglobin
(C) Fibrins (D) Enzymes

276. Usually, a polypeptide chain bends and fold upon itself to form a globular shape. This is protein's:
(A) Primary conformation
(B) Secondary conformation
(C) Tertiary conformation
(D) Quaternary conformation

277. Identify odd among the rest:
(A) Amylase (B) Cellulase
(C) Cellulose (D) Lipase

278. Identify the most complex amino acid with respect to "R" group:
(A) Glycine (B) Tryptophan
(C) Methionine (D) Cysteine

279. Identify Sulphur containing amino acids:
(A) Glycine and Alanine
(B) Methionine and Cysteine

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(C) Tyrosine and Proline
(D) Glutamic acid and Serine

280 Which amino acid give rise to adrenaline, nor-adrenaline, thyroxin, dopamine and melanin:
(A) Isoleucine (B) Tyrosine
(C) Glutamic acid (D) Valine

281. The first protein to have its complete amino acid sequence determined was:
(A) Hemoglobin (B) Insulin
(C) Fibrinogen (D) Keratin

282. Which protein provide resilience and elasticity to the tissues and organs:
(A) Elastin (B) Collagen
(C) Titin (D) Keratin

283. Which of the following is a protease:
(A) Oxidase (B) Catalase
(C) Rennin (D) Deaminase

284. Water is very good solvent for the substance due to its _____nature and act as _____ due to its high heat capacity:
(A) Dipole nature, thermostabilizer
(B) Polar, bipolar
(C) Organic, inorganic
(D) Ionic, covalent

285. Water molecules remains attached together and do not separate because of this bonding:
(A) Non-covalent (B) Ionic
(C) Hydrogen (D) Hydrophobic

286. Which property of water plays an important role in regulation of heat produced by oxidation:
(A) Heat capacity
(B) Heat of vaporization
(C) Dipole nature
(D) Ionization of water

287. Which property of water helps to maintain the integrity of lipid membrane:
(A) Specific heat capacity
(B) Cohesion and adhesion
(C) Hydrogen bonding
(D) Hydrophobic exclusion

288. Ice floating on the water due to which property of water:
(A) Ionization
(B) Heat of vaporization
(C) Low density
(D) Hydrophobic exclusion

289. Most abundant carbohydrates in nature:
(A) Cellulose (B) Starch
(C) Polysaccharides (D) Glycogen

290. Glucose combines to with _____ to form milk sugar:
(A) Glucose (B) Galactose
(C) Fructose (D) Mannose

291. Pick out the odd one:
(A) Cellulose (B) Agar
(C) Pectin (D) Lignin

292. Fehling's and Benedict tests gives positive results to detect:
(A) Reducing Sugars
(B) Non-Reducing sugars
(C) Only Polysaccharides
(D)Both Reducing and non-reducing sugars

293. Which of the following carbon present outside the ring of fructose:
(A) 1st and 2nd (B) Only 1st
(C) 1st and 5th (D) 1st and 6th

294. The two functional groups characteristic of sugars are:
(A) Hydroxyl and methyl
(B) Carbonyl and methyl
(C) Carbonyl and phosphate
(D) Carbonyl and hydroxyl

295. Which one of the following is a non - reducing carbohydrate:
(A) Maltose (B) Sucrose
(C) Lactose (D) Ribose

296. Which one is a disaccharide:
(A) Galactose (B) Fructose
(C) Maltose (D) Dextrin

297. Which of the following is trisaccharide:
(A) Mannose (B) Cellobiose
(C) Raffinose (D) Arabinose

298. The chitinous exoskeleton of arthropods is formed by the polymerization of:
(A) Lipoprotein
(B) keratin
(C) Mannitol
(D) N-acetyl glucosamine

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One of the major components of cell wall of most fungi is:
(A) Chitin (B) Peptidoglycan
(C) Cellulose (D) Hemicellulose

All the following statements about the structure of glycogen are true, except:
(A) Branched chains occur, after every ten residues
(B) It is a co-polymer of glucose and mannose
(C) It contains α–1, 4–glycosidic linkages
(D) It contains α –1, 6–glycosidic linkages

True statement for cellulose molecule:
(A) β- 1'- 4" linkage, Unbranched
(B) β - 1'- 4" linkage, Branched
(C) α - 1' - 4" linkage, branched
(D) β - 1' - 6" linkage, unbranched

Starving person will first use:
(A) Fats (B) Glycogen
(C) Blood protein (D) Muscle protein

Which is odd:
(A) Chitin - Carbohydrate (B) Pectin - Protein
(C) Steroid - Lipid (D) Wax - Lipid

All of following biomolecules are nutritious except:
(A) Carbohydrates (B) Proteins
(C) Lipids (D) Nucleic acids

DNA was first discovered by:
(A) Miescher (B) Robert Brown
(C) Flemming (D) Watson & Crick

Back bone in structure of DNA molecule is made up of:
(A) Pentose Sugar and phosphate
(B) Hexose sugar and phosphate
(C) Purine and pyrimidine
(D) Nitrogenous bases and phosphate

Substance common in DNA and RNA:
(A) Ribose Sugar (B) Uracil
(C) Thymine (D) Phosphate groups

Prokaryotic genetic system contains:
(A) DNA & histones
(B) RNA & histones
(C) Either DNA or histones
(D) DNA but no histones

309. The purine & pyrimidine pairs of complementary strands of DNA are held together by:
(A) H–bonds (B) O–bonds
(C) C–bonds (D) N–bonds

310. In RNA, Nucleotides are bonded by:
(A) H–bonds
(B) Phosphodiester bonds
(C) Ionic bonds
(D) Salt linkage

311. Wilkins X - ray diffraction showed the diameter of the DNA helix is:
(A) 10 Å (B) 20 Å
(C) 30 Å (D) 40 Å

312. In a double strand DNA amount of Guanine is 35% then what will be the amount of Thymine:
(A) 70% (B) 15%
(C) 30% (D) 35%

313. The short DNA segment has 80 thymine and 90 guanine bases. The total number of nucleotides are:
(A) 160 (B) 40
(C) 80 (D) 340

314. In a nucleotide H_3PO_4 binds to which carbon atom of pentose sugar:
(A) Only 1st carbon
(B) Only 3rd carbon
(C) Only 5th carbon
(D) Both 3rd and 5th carbon

315. The clear-cut proof that DNA is the genetic material came from the experiments of:
(A) Hershey and Chase (1952)
(B) Frederic Griffith (1928)
(C) Watson and Crick (1953)
(D) Meselson and Stahl (1958)

316. Phosphodiester Bond is:
(A) P-O-C-P-O-C (B) C-O-P-O-C
(C) C-O-P (D) C-C-O-P

317. Type of RNA that is used to start process of replication in prokaryotic cell:
(A) tRNA (B) mRNA.
(C) rRNA (D) Primer

318. Which of the following RNA is catalytic in nature:

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(A) tRNA (B) mRNA
(C) rRNA (D) Ribozyme

319. Double helix model of DNA which was proposed by Watson and crick was of:
(A) C-DNA (B) B-DNA
(C) D-DNA (D) Z-DNA

320. What is the nature of the two strands of a DNA duplex:
(A) Identical & Complementary
(B) Antiparallel & complementary
(C) Dissimilar & non-complementary
(D) Antiparallel & non-complementary

321. One turn of the helix in a B-form DNA is approximately:
(A) 20 nm (B) 0.34 nm
(C) 3.4 nm (D) 2 nm

322. In DNA, the complimentary bases are:
(A) Adenine and guanine, thymine and cytosine
(B) Uracil and adenine; cytosine and guanine
(C) Adenine and thymine; guanine and cytosine
(D) Adenine and thymine; guanine and uracil

323. If the base sequence of one strand of DNA is GAT, TAG, CAT, GAC, what shall be the sequence of its complementary strand:
(A)CAT, CTG, ATC, GTA
(B)GTA, ATC, CTG, GTA
(C)ATC, GTA, CTG, GTA
(D)CTA, ATC, GTA, CTG

324. A DNA molecule contains 10,000 base pairs, then the length of this DNA molecule is:
(A) 3.4×10^{-5} meter (B) 0.34×10^{-5} meter
(C) 34×10^{-5} meter (D) None of the above

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325. The covalent bond formed between two monosaccharides is called: (2011)
(A) Glycosidic bond (B) Peptide bond
(C) Hydrogen bond (D) Disulphide bond

326. The bond formed between glucose and fructose to form sucrose is: (2011)
(A) 1, 4 glycosidic linkages
(B) 1, 6 glycosidic linkage
(C) 1, 2 glycosidic linkage
(D) 1, 3 glycosidic linkage

327. In an amino acid in which R-group is hydrogen, the amino acid will be: (2011)
(A) Alanine (B) Leucine
(C) Glycine (D) Valine

328. The combination of a pentose sugar with a base result in a compound known as: (2011)
(A) Nucleotide (B) Nucleic acid
(C) Nucleoside (D) Polynucleotide

329. Fatty acids are organic compounds containing hydrogen, oxygen and one of the following groups: (2011)
(A) Carboxylic (B) Acyl
(C) Amino (D) Sucrose

330. Which of the following is an unsaturated fatty acid? (2012)
(A) Acetic acid (B) Oleic acid
(C) Butyric acid (D) Palmitic acid

If in lipid there is a higher proportion of

331. Which of the following is a peptide bond? (2012)
(A) – C – N (B) – C – P
(C) – C – O (D) – C – S

332. Amino acid in which the R-group is hydrogen is: (2013)
(A) Alanine (B) Valine
(C) Leucine (D) Glycine

333. Carbohydrates are organic molecules and contain three elements: (2012)
(A) Carbon, water and oxygen
(B) Carbon, calcium, and hydrogen
(C) Carbon, sulfur, and hydrogen
(D) Carbon, hydrogen and oxygen

334. Which one are intermediates in respiration and photosynthesis both? (2012)
(A) Ribose and heptolose
(B) Glucose and galactose
(C) Glyceraldehyde and dihydroxyacetone
(D) Fructose and ribulose

335. Which of the following combinations of base pair is absent in DNA? (2012)
(A) A – T (B) A – U
(C) C – G (D) T – A

336. Which of the following is a purine? (2013)
(A) Cytosine (B) Uracil
(C) Thymine (D) Guanine

337. It is the most abundant carbohydrate in nature: (2013)
(A) Cellulose (B) Glycerol
(C) Waxes (D) Starch

338. Which of the following is keto sugar? (2013)
(A) Glyceraldehyde (B) Dihydroxyacetone

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(C) Ribose (D) Glucose

339. **Acylglycerol like fats and oils are esters formed by condensation reaction between: (2013)**
(A) Fatty acids and water
(B) Fatty acids and alcohol
(C) Fatty acids and glucose
(D) Fatty acids and phosphates

340. **If the genetic code is made up of three nucleotides, the total possible genetic codes will be: (2014)**
(A) 4 (B) 64
(C) 20 (D) 61

341. **In translation, the terminating codon is: (2014)**
(A) GUA (B) UUG
(C) UAA (D) AGU

342. **Number of base pairs in one turn of DNA is: (2015)**
(A) 10 (B) 34
(C) 2 (D) 54

343. **Waterproof surface like cuticle of leaf and protective covering of an insect's body are: (2014)**
(A) Phospholipids (B) Terpenoids
(C) Waxes (D) Acylglycerols

344. **Which one of the following is an example of unsaturated fatty acid? (2015)**
(A) Butyric acid (B) Palmitic acid
(C) Oleic acid (D) Acetic acid

345. **The most common respiratory substrate as a source of energy is: (2014)**
(A) Glucose (B) Fructose
(C) Sucrose (D) Insulin

346. **The simplest monosaccharide containing keto group is: (2014)**
(A) Glyceraldehyde (B) Glucose
(C) Dihydroxyacetone (D) Ribose

347. **Monosaccharides are major components of: (2015)**
(A) DNA, ATP, Ribulose bisphosphate and cysteine
(B) DNA, NAD and Insulin
(C) DNA, NADP, ATP and ribulose bisphosphate
(D) DNA, RNA and myosin

348. **Blood group antigen contains: (2015)**
(A) Glycoprotein (B) Glycolipid
(C) Phospholipids (D) Sphingomyelin

349. **Myosin is a_____type of protein:(2015)**
(A) Intermediate (B) Globular
(C) Simple (D) Fibrous

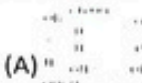
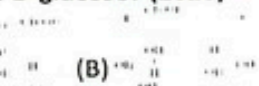
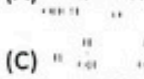
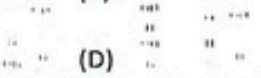
350. **Waxes are formed by combination of fatty acids with: (2016)**
(A) Alcohol (B) Serine
(C) Glycerol (D) Cysteine

351. **Secondary structure of protein is found in: (2016)**
(A) Trypsin (B) Insulin
(C) Keratin (D) Glucagon

352. **The compound which on hydrolysis yield polyhydroxy aldehyde and ketones subunits: (2016)**
(A) Lipids (B) Polynucleotides
(C) Proteins (D) Carbohydrates

353. **Phosphodiester bond is: (2016)**
(A) P – O – C – P – O – C
(B) C – O – P – O – C
(C) C – O – P
(D) C – C – O – P

354. **When X-rays are passed through crystalline DNA, it shows helix making onecomplete twist every: (2016)**
(A) 2 nm (B) 34nm
(C) 3.4 nm (D) 4 nm

355. **Which one of the following is the formula structure of D-glucose? (2016)**
(A)  (B) 
(C)  (D) 

356. **____are the specific structures related to monosaccharides: (2017)**
(A) Glycosidic bond (B) Maltose
(C) Keto group (D) Fructose

357. **are the major sites for the storage of glycogen in animal's body: (2017)**
(A) Muscles and liver:
(B) Around belly and hips
(C) Around thighs and belly
(D) Liver and kidneys

358. **What is general formula of Monosaccharides: (2017-Retake)**
(A) $C_x(H_2O)_y$ (B) $C_n(H_2O)_n$
(C) $(CH_2O)_n$ (D) $C_n(H_2O)_{n-1}$

359. **Which of the following is light molecular weight and sparingly soluble in water: (2017-Retake)**
(A) Monosaccharide (B) Oligosaccharides
(C) Disaccharides (D) Polysaccharides

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(D) It is a semiconservative process

397. The DNA that has been altered and which now contains length of nucleotides from two different organisms is called as: (2021)
(A) Plasmid (B) Combined DNA
(C) Vector (D) Recombinant DNA

398. It is a method for rapid production of very large number of copies of particular fragment of DNA: (2021)
(A) Gel electrophoresis (B) DNA Extraction
(C) PCR (D) Recombination

399. Unique three-dimensional shape of fully folded polypeptide, constitute: (2022)
(A) Primary structure of protein
(B) Secondary structure of protein
(C) Tertiary structure of protein
(D) Quaternary structure of protein

400. Butyric acid is a _____ carbon fatty acid: (2022)
(A) 2 (B) 4
(C) 6 (D) 8

401. Which of the following is a conjugated molecule? (2022)
(A) Protein (B) Lipid
(C) Glycoprotein (D) Vitamin

402. Hydrolysis process is the reverse of ____process: (2022)
(A) Photolysis (B) Deduction
(C) Condensation (D) Convection

403. Proteins are the main _____ of cell: (2022)
(A) Physiological components
(B) Functional components
(C) Biological components
(D) Structural components

404. Most of the monosaccharides form a ring structure within a solution. For example, ribose will form a five-cornered ring known as: (2023)
(A) Glucopyranose (B) Glyceraldehyde
(C) Ribfuranose (D) Acetaldehyde

405. Which statement is true regarding both starch and cellulose? (2023)
(A) They are both polymer of glucose
(B) They are geometric isomer of each other
(C) They can both be digested by humans
(D) They are both used for energy storage in plants

406. Which type of bond must be broken for water to vaporize? (2023)
(A) Non-polar covalent bond
(B) Polar covalent bond
(C) Hydrogen bond
(D) Covalent bond

407. The specific heat of vaporization of water plays an important role in regulation of heat produced by: (2023)
(A) Reduction (B) Redox
(C) Oxidation (D) None

408. Basically, _____ plays a key role in maintaining the integrity of lipid bilayer membranes: (2023)
(A) Hydrophilic exclusion
(B) Heat of vaporization
(C) Hydrophobic exclusion
(D) Heat capacity of water

409. Energy is _____ by breakdown of complex molecules into simple one, such reactions are called catabolic reactions: (2023)
(A) Released (B) Produced
(C) Consumed (D) Destroyed

410. _____ forms almost three-fourth of body by weight: (2023)
(A) Water (B) Carbohydrates
(C) Protein (D) Lipids

411. Monosaccharides have a general formula represented by: (UHS 2024)
(A) $Cn(H_2O)n$ (B) $Cn(H_2O)n\text{-}1$
(C) $C(H_2O)n$ (D) $Cx(H_2O)y$

412. What is the percentage of water in bone cells: (UHS 2024)
(A) 70 % (B) 99 %
(C) 20 % (D) 60 %

413. When glycerol reacts with fatty acid, which type of chemical bond will form: (UHS 2024)
(A) Ester bond (B) Ether linkage
(C) Hydrogen bond (D) Ionic bond

414. Polysaccharides in plants are synthesized by the process of: (UHS 2024)
(A) Hydrolysis (B) Oxidation
(C) Condensation (D) Glycolysis

415. Which of the following process involved in breakdown of protein into amino acids: (UHS 2024)
(A) Oxidation (B) Hydrolysis
(C) Condensation (D) Glycolysis

416. The hydrophilic end of phospholipid molecule is polar because of the presence of: (UHS 2024)
(A) Glycerol (B) Fatty acid

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(C) Phosphate group (D) Amino group

417. **Which monosaccharide will form a glucopyranose ring in solution: (UHS 2024)**
(A) Fructose (B) Ribose
(C) Glucose (D) Deoxyribose

418. **Chromosome is typically made up from a combination of: (ETEA 2024)**
(A) DNA and protein (B) DNA and RNA
(C) RNA and lipids (D) RNA and proteins

419. **Sugarcane contains _____: (ETEA 2024)**
(A) Fructose (B) Glucose
(C) Ribose (D) Sucrose

420. **Sickle cell anaemia results from: (ETEA 2024)**
(A) Reduction in oxygen carrying capacity of haemoglobin
(B) Linkage between the polypeptide chains
(C) Single amino acid substitution in the haemoglobin molecule
(D) Viral infections of RNA viruses

421. **Which is INCORRECT about the globular Proteins: (ETEA 2024)**
(A) Abundantly found in hair
(B) Are spherical in shape
(C) Have polypeptide chains
(D) Soluble in water

422. **What is the ester of fatty acids and long chain alcohol called: (ETEA 2024)**
(A) Acylglycerol (B) Glycerol
(C) Phospholipid (D) Wax

423. **Lipids, which do not contain fatty acid are: (ETEA 2024)**
(A) Neutral lipids (B) Phosphatidic acid
(C) Steroids (D) Waxes

424. **Loss reactivity of sucrose is due to its: (NUMS 2024)**
(A) High solubility in water
(B) Polar nature enzymes
(C) Unavailability of functional group
(D) Alpha 1-2 Glycosidic linkage

425. **Sucrose is used as transport carbohydrates instead of glucose because: (NUMS 2024)**
(A) It is not disaccharide
(B) It is non-reducing sugar
(C) It is soluble in water
(D) It does not change osmotic potential of water

426. **Proteins with tertiary structure are helpful in: (NUMS 2024)**
(A) Carrying messages from glands to target organs
(B) Maintaining epithelial lining of skin
(C) Making the matrix of connective tissue
(D) Helping muscle contraction

427. **Rebounding is process of straightening the curly hairs, which bond is targeted by oxidizing agents used during this process: (NUMS 2024)**
(A) Peptide bond (B) Ionic bond
(C) Disulphide bridge (D) Hydrogen bond

428. **Histone proteins are rich in: (DUHS 2024)**
(A) Basic amino acid (B) Basic fatty acid
(C) Acidic amino acid (D) Basic citric acid

429. **In gel electrophoresis, how do molecules migrate through gel: (DUHS 2024)**
(A) Under the influence of agar
(B) Under the influence of an electric field
(C) By osmosis
(D) By Active transport

430. **Which one of the following carbohydrates show red color with iodine solution: (SZABMU 2024)**
(A) Cellulose (B) Glucose
(C) Glycogen (D) Sucrose

431. **Which of the following proteins do NOT exhibit quaternary structure: (SZABMU 2024)**
(A) Actin (B) Haemoglobin
(C) Insulin (D) Myoglobin

432. **Which of the following conjugate molecules are deficient as surfactants in respiratory distress syndrome: (SZABMU 2024)**
(A) Glycolipids (B) Glycoproteins
(C) lipopolysaccharides (D) Lipoproteins

433. **Which of the following part of phospholipids constitutes hydrophobic zone in plasma membrane: (DUHS 2024)**
(A) Cholesterol (B) Fatty acid tail
(C) Phosphate Head (D) Glycolipids

434. **Which one of the following monosaccharides is a hexose-aldehyde form of sugar: (BUMHS 2024)**
(A) Fructose (B) Glucose
(C) Ribose (D) Sucrose

435. **Which one of the following is the main component of lipid bilayer of plasma membrane: (BUMHS 2024)**
(A) Acylglycerol (B) Lecithin
(C) Triglyceride (D) Waxes

436. **Ribose is an example of ____ sugar: (BUMHS 2024)**
(A) Pentose (B) Heptose
(C) Hexose (D) Tetrose

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CELL STRUCTURE & FUNCTION: KEY CONCEPTS

Introduction to Cell

- Cell is the structural and functional unit of living organisms.
- **Robert Hooke (1665)**: Observed "cells" in a cork slice (dead plant material) using a primitive microscope. He coined the term "cell," although he was viewing **dead cell walls**. He published his work about cell discovery in **Micrographia.**
- **Anton van Leeuwenhoek (1673)**: Improved microscopy and observed living cells, including bacteria and sperm cells, which he called **"animalcules."**
- **Lorenz Oken (1805)**: Believed that "all living things originates from vesicles or cells".
- **J.B.de-Lamarck (1809):** Expressed the idea that "no body can have life if constituent parts are not cells"
- **Robert Brown (1831):** Reported the presence of Nucleus.
- **T. Schwan (1839):** Formulated cell theory.
- **M.J. Schleiden (1839):** Formulated cell theory.
- **Rudolph Virchow (1855):** *Omnis cellula e cellula*, hypothesized that new cells have arisen from preexisting cell by cell division.
- **Louis Pasteur (1862):** Provide experimental proof for Virchow's hypothesis by demonstrating that bacteria could be formed only from existing bacteria.
- **August Weismann (1880):** All living organism shared common ancestors because of basic similarities in structure and molecules.

Postulates of Cell theory

- Cell is the structural and functional unit of living organisms.
- All living things are made up of one or more cells.
- Cells arise from other cells through cell division.

Microscopy

- **Magnification:** The degree to which an image is enlarged. It's the product of the magnifications of ocular and objective lenses.
- **Resolution:** The ability of a microscope to distinguish two points as separate. Higher resolution allows clearer detail of closely spaced objects.

Compound Microscope	Electron Microscope
The magnifying power of light microscope is about 500X-4000 X than the naked eye.	The magnifying power of electron microscope is about 2,000,000 X than naked eye & 500 X greater than compound microscope.
Resolution of human naked eye is 1.0 mm. Resolution of typical compound microscope is 250 nm (0.2 um).	Resolution of electron microscope is 0.2 nm (2-4 Å).
Uses visible light to illuminate the specimen.	Uses beams of electrons as the illumination source.
Ideal for observing live cells and tissues.	Ideal for observing dead samples.
Open (atmosphere) medium is used for working	Vacuum medium is used for working.
Commonly used in educational settings, clinical laboratories, and basic research for observing cell structure, tissues, and larger microorganisms.	Used in advanced research settings, such as biology, nanotechnology, and material sciences, for studying detailed structures of cells, viruses, proteins, and inorganic materials.

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Types of Electron Microscope

Transmission EM	Scanning EM
Electrons pass through a very thin specimen to create an image.	Uses reflected electrons to create a 3D image of the specimen's surface.
Resolution Power 0.1 - 0.5 nm	Resolution Power 1 - 20 nm
Internal cell structure, viruses, proteins, and nanomaterials.	Surface topography of cells, tissues, and material surfaces.

Differences B/W Animals and Plant Cell

Feature	Animals Cell	Plant Cell
Shape	Usually round or irregular	Usually rectangular or fixed shape
Size	10-30 um	10-100 um
Vacuole	Small or absent	Large central vacuole
Lysosomes	Commonly present	Rare or absent
Centriole	Present	Absent
Mitotic apparatus	Amphiastral (Asters at both sides) + Spindle fibers	Anastral (No asters) only Spindle fibers
Glyoxysomes	Absent	Present
Nucleus Location	Centered	Often pushed to the side by vacuole
Plastid	Absent	Present (e.g., chloroplasts, chromoplasts)
Mode of nutrition	Heterotrophic	Autotrophic
Storage of Carbs	Glycogen	Starch
Cell Division	Cleavage furrow during cytokinesis	Cell plate (Phragmoplast) formation during cytokinesis
Amino acids	10 essential and 10 non-essentials	All non-essentials
Cell adhesions	Desmosomes (Tight Junctions)	Plasmodesmata
Ability to Differentiate	Highly differentiated with specialized cells, tissues, and organs	Less specialized, with many cells remaining totipotent
Flagella and Cilia	Often present (e.g., in sperm cells) ✓	Rarely present
Growth	Limited by animal's size and typically stops with age	Continuous cell division for growth throughout life
Coordination	Both Nervous and Chemical coordination	Only chemical coordination (Growth Hormones)
Response to Environment	Rapid response to stimuli (e.g., nervous system)	Slower response, mostly through growth and chemical changes
Phagocytosis	Present	Absent

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Feature	Passive transport	Active Transport
Definition	Movement of substances down their concentration gradient without energy.	Movement of substances against their concentration gradient, requiring energy.
Types	➢ Simple Diffusion ➢ Facilitated Diffusion ➢ Osmosis	➢ Primary Active Transport ➢ Secondary Active Transport
Examples of Substances	➢ Oxygen (O_2), carbon dioxide (CO_2) (simple diffusion) ➢ Glucose, amino acids (facilitated diffusion) ➢ Water (osmosis)	➢ Sodium (Na^+), potassium (K^+) ions (sodium-potassium pump) ➢ Calcium ions (Ca^{2+} pump) ➢ Glucose absorption (secondary active transport)
Examples of Processes	➢ Gas exchange in lungs (O_2/CO_2 diffusion) ➢ Nutrient absorption in small intestine (facilitated diffusion) ➢ Water absorption in roots (osmosis)	➢ Maintenance of Na^+/K^+ balance in nerve cells (Na^+/K^+ pump) ➢ Calcium storage in sarcoplasmic reticulum (Ca^{2+} pump) ➢ Sodium-glucose cotransport in intestinal cells

Types of Active Transport

Feature	Primary Active transport	Secondary Active Transport
Energy Source	Use direct energy from ATP hydrolysis to transport molecules against their concentration gradient.	Use indirect energy by coupling the transport of one molecule with another molecule's movement down its concentration gradient.
Mechanism	ATP is directly used to power the movement of substances across the membrane.	One molecule moves down its gradient, providing the energy to transport another molecule against its gradient.
Proteins Involved	Involves ATP-driven pumps or ATPases (e.g., sodium-potassium pump).	Involves symporters or antiporters that use the gradient of one substance to move another.
Examples	➢ **Sodium-Potassium Pump (Na^+/K^+-ATPase):** Pumps Na^+ out and K^+ into the cell. ➢ **Calcium Pump (Ca^{2+}-ATPase):** Moves Ca^{2+} ions out of the cytoplasm into the endoplasmic reticulum.	➢ **Sodium-Glucose Symporter:** Glucose is transported into the cell by using the energy of Na^+ moving into the cell. ➢ **Sodium-Calcium Exchanger:** Na^+ moving into the cell drives Ca^{2+} out of the cell.

Bulk Transport

Feature	Endocytosis	Exocytosis
Definition	Process of taking in substances into the cell.	Process of releasing substances from the cell.
Energy Requirement	Requires energy (ATP).	Requires energy (ATP).
Types & Examples	➢ **Phagocytosis (Cell eating):** Phagocytosis by white blood cells. ➢ **Pinocytosis (Cell drinking):** Nutrient absorption. ➢ **Receptor-Mediated Endocytosis:** Cholesterol uptake by cells.	➢ **Constitutive Exocytosis:** Continuous release of substances (e.g., secretion of proteins like collagen). ➢ **Regulated Exocytosis:** Triggered by signals (e.g., release of neurotransmitters or insulin).

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CYTOPLASM

- Jelly-like, semi-fluid substance inside the cell between cell membrane and nuclear membrane.
- Common component of prokaryotic and eukaryotic cell but in prokaryotes cytoskeleton is absent in cytoplasm.
- Protoplasm is the living content of eukaryotic cell consists of cytoplasm and nucleus.
- **Cytosol:** The liquid portion, composed of water (90%), ions, proteins, and small molecules.
- **Organelles:** Specialized structures like mitochondria, endoplasmic reticulum, and ribosomes suspended in the cytosol.
- **Inclusions:** Stored substances like glycogen granules, lipid droplets, and pigments.
- **True Solution:** Small molecules such as salts, sugars, amino acids, fatty acids, nucleotides and dissolved gases form true solution.
- Some large molecules such as proteins form **colloidal solution** which may be sol (non-viscous) or Gel (viscous).

Functions of Cytoplasm

- Acts as storehouse of vital chemicals.
- Site for various metabolic reactions such as **Translation** (Protein synthesis), **Glycolysis** (Breakdown of glucose), **Glycogenolysis** (Breakdown of glycogen to produce glucose) and **Gluconeogenesis** (Formation of glucose from non-carbohydrates sources).
- **Cyclosis** (Amoeboid movement) is the active mass movement of cytoplasm which helps in distribution of cell contents in cytoplasm.

Cell Organelles: Sub-Cellular Structures

Organelles	Membrane	Discover by
Endoplasmic reticulum	Single Membranous	Keith R. Porter, Albert Claude, and Ernest Fullam
Golgi apparatus	Single Membranous	Camillo Golgi
Lysosomes	Single Membranous	Christian de Duve
Glyoxysomes	Single Membranous	Harry Beevers
Peroxisomes	Single Membranous	Christian de Duve
Vacuole	Single Membranous	Antonie van Leeuwenhoek
Mitochondria	Double Membranous	Albert Von Kolliker
Plastids	Double Membranous	Ernst Haeckel
Nucleus	Double Membranous	Robert Brown
Ribosomes	Non-Membranous	George E. Palade
Centrioles	Non-Membranous	Edouard van Beneden
Cytoskeleton	Non-Membranous	Nikolai Koltsov

RIBOSOMES

- **Tiny, dense granular, non-membranous bodies** found in both prokaryotic and eukaryotic cell.
- **Ribonucleoprotein particles** (almost an equal amount of RNA and proteins)
- **Assembled in nucleolus** and transported to cytoplasm through nuclear pores
- **They exist in two forms,** either dispersed in cytoplasm or attached with endoplasmic reticulum (RER) and outer membrane of nuclear envelope.
- **It consists of two subunits**: large subunit and smaller subunit.
- **Prokaryotic Ribosomes (70S):** Large subunit (50S) and Small Subunit (30S)
- **Eukaryotic Ribosomes (80S):** Large subunit (60S) and Small Subunit (40S)
- **Svedberg Subunit (S):** Non-SI unit of sedimentation rate (Not mass) so they are not additive

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- The attachment of subunits is controlled by the presence of Mg^{2+} concentration or forming salt bond between phosphate group of RNA and an amino group of amino acid or both by Mg^{2+} and salt bonds.
- Ribosomes are factories of protein synthesis (Translation)
- Polysomes (Polyribosomes) are group of ribosomes attached to mRNA.

ENDOPLASMIC RETICULUM (ER)

- Interconnected network of channels or tubules extended between cell membrane and nuclear membrane.
- Vary in appearance from cell to cell.
- The membrane of endoplasmic reticulum is called **Cisternae.**
- ER provides mechanical support to cell.
- Most of cell organelles are formed by ER (except Mitochondria and Chloroplast).
- ER also help to form nuclear membrane during cell division.

Type of ER

Rough ER	Smooth ER
Studded with ribosomes, giving it a rough appearance.	Lacks ribosomes, resulting in a smooth appearance.
Directly connected to outer nuclear membrane.	Not connected to outer nuclear membrane.
More stable structure	Less stable structure
Flattened, sheet-like sacs (cisternae) covered with ribosomes, which make it **less tubular.**	Consists of a network of interconnected tubules, giving it a **tubular and smooth appearance.**
Abundant in those cells which are actively involved in **protein synthesis or secretions.**	Abundant in those cells which are actively involved in **lipid and glycogen metabolism.**
Found in Pancreatic cells, Liver cells (Hepatocytes), Goblet cells and neurons.	Found in Muscles, Adipose tissues, Liver cells, Adrenal cortex cells and Tests and Ovarian cells.
Functions: - Protein synthesis (Translation) - Transport of Proteins - **Ergastoplasm** refers to regions of the cytoplasm that are rich in Rough Endoplasmic Reticulum (RER). In nerve cell ergastoplam is known as **Nissls granules.**	**Functions:** ➢ Metabolism of various compounds, particularly lipids. ➢ Assists in transporting lipids and proteins to other parts of the cell, particularly the Golgi apparatus. ➢ Detoxifies harmful substances like drugs, alcohol, and metabolic by-products, especially in liver cells. ➢ Regulates intracellular calcium levels, especially in muscle cells, where it is called the **sarcoplasmic reticulum.** ➢ Transmission of nerve impulse.

GOLGI COMPLEX

- **Golgi Body** is the single cisternal sac.
- **Golgi apparatus** is the stacks of cisternal sacs.
- **Golgi complex** is the stacks of cisternae with associated vesicles.
- **Dictyosome** is the Golgi apparatus in plants which are used in formation of cell wall.

Structure

- Consists of stacked, flattened, membrane-bound sacs called **cisternae.** Typically, **4-8 cisternae** are present in a stack.

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- **Cis-Face (Forming Face):** Located near the ER and receives vesicles called containing proteins and lipids. These are also called **Transport vesicles** which bring raw materials from the ER to the cis-face.
- **Trans-Face (Maturing Face):** Located toward the plasma membrane, responsible for sorting and exporting vesicles. These are called **Secretory vesicles** which deliver processed materials to the plasma membrane or other locations.

Functions

- **Cell secretions** are concerned with Golgi bodies.
- Sorting, packing and export of materials.
- **Modification of materials** by adding carbohydrates to protein and lipids to form glycoproteins and glycolipids **(Glycosylation).**
- Formation of **Phragmoplast** during cytokinesis in plants.
- Formation of **primary lysosomes.**
- Synthesis of components of **plant cell wall.**
- Formation of **acrosomal vesicles** during spermatogenesis.
- Formation of **synaptic vesicles.**

LYSOSOMES

- Cytoplasmic organelle is found in most eukaryotic cells **except RBCs.**
- Rich in **acid phosphatase** and several other **hydrolytic enzymes** (about 40) with acidic **pH (4.5-5.0).**
- **Most abundant** in those cells show phagocytic activities **(such as WBCs).**

Structure

- Rough special in shape and single membranous.
- The budded off Golgi vesicles are called **Primary Lysosomes** which contain processed enzymes.
- **Secondary Lysosomes** are formed by the fusion of primary lysosomes with the food vacuoles known as **Phagosomes.**
- **Tertiary lysosomes (residual bodies)** contain undigested material which removed as **exocytosis** in unicellular organism and in multicellular organism they retain in cell in the form of **lipofuscin granules** (yellowish-brown, irregular granules that accumulate in cells during aging and are also known as **"wear and tear" pigment).**

Functions

- Involves in **intracellular digestion and** digest the phagocytosed material (Food, virus, bacteria etc.).
- **Autophagy (Self eating)** is the regulated process where the cell degrades and recycles its own components (old mitochondria) with the help of lysosomal enzymes.
- **Autolysis (Self destruction)** is uncontrolled self-digestion of a cell due to bursting of lysosome **(Suicidal bags).**
- Involves in process of **apoptosis (Programmed cell death)** during developmental phase.
- Lysosomes (via the acrosome) are **vital in fertilization** by enabling sperm to penetrate the egg.
- In certain specialized cells like **osteoclasts** (cells that break down bone), lysosomes contain enzymes that degrade the bone matrix during the process of **bone resorption.**

Lysosomal Storage Diseases

Glycogenosis type II	Tay Sach's disease
Glycogen accumulates liver and muscle cell.	Accumulation of lipids in brain cells.
Absence of lysosomal enzyme (acid alpha-glucosidase) that converts glycogen to glucose.	Absence of lysosomal enzyme (hexosaminidase A) which involves catabolism of lipids.
Primarily affects muscles (skeletal and cardiac).	Affects the central nervous system (neurons in brain and spinal cord), leads to mental retardation and even death.

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Microbodies	
Peroxisomes	**Glyoxysomes**
Membrane-bound organelles that perform **oxidative metabolism and detoxification.**	Specialized peroxisomes found in plants and some fungi that function in lipid metabolism.
Found in **all eukaryotic cells**, including animals and plants.	Found **only in plants** (particularly **lipid rich germinating seeds** such as Sunflower, Sesame, Soybean, Flaxseeds, Castor Beans , Canola etc.)
Enzymes: Peroxides, catalase, glycolic acid oxidase	**Enzymes:** Catalase, glycolic acid oxidase, other enzymes.
Functions: - Detoxification of alcohol. - Formation and **decomposition of H_2O_2.** - Involved in **photorespiration.**	**Functions:** - Lipid metabolism - Conversion of stored fatty acid to carbohydrates (succinate) by **glyoxylate cycle.**

VACUOLES

- Large vesicles **originated from endoplasmic reticulum, Golgi complex and cell membrane.**
- Present in both animal and plant cell.
- **Tonoplast** is the membrane of vacuole and **Cell sap** is the matrix of vacuole.
- In **plant cells** single large central vacuole is present while in animals many small vacuoles are present.

Functions

- In **animal cell and protozoans**, food vacuole is involved in **phagocytosis** and contractile vacuoles help in **osmoregulation and excretion.**
- In **Young plants**, many small vacuoles **hold reserve of important organic molecules.** These vacuoles also help in **protection** of plant against herbivores.
- In **mature plant cells**, central vacuole serves as reservoir of inorganic ions and metabolic intermediate.
- Vacuole in plant also serve as **dumping site** of wastes and toxic chemicals.
- They also maintain cells **turgor , rigidity** of leaves and young part of plants.

CYTOSKELETON

- Dynamic network of protein filaments and tubules present in the cytoplasm of eukaryotic cells.
- It provides structural support, maintains cell shape, and enables intracellular transport, cell motility, and division.

Types of Cytoskeletons		
Microtubules	**Microfilaments**	**Intermediate filaments**
Long, unbranched slender structures.	More slender and cylindrical	Rope-like filaments
Diameter: 25nm	**Diameter:** 7nm	**Diameter:** 10-12 nm
Made up of **Tubulin protein**	Made up of **Actin and myosin** protein	Made up of **Vimentin, Desmin and Lamin** protein
Functions: - Movement of chromosomes during cell division. - Formation of **Cilia (9+2 arrangement of microtubules)**, Flagella (9+2), Centriole (9+0) and Basal bodies (9+0). - Assembling and dissembling of spindles	**Functions:** - Change in cell shape - Division of cytoplasm in daughter cells - **Cyclosis / Cytoplasmic streaming** - Movement of pseudopodia	**Functions:** - **Maintaining cell shape** - **Support of nerve cells processes axon** - **Help in anchoring organelles** - **Contribute to structural integrity in tissues (e.g., skin, muscles)**

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MITOCHONDRIA

- **Powerhouse / battery / furnace of the cell.**
- Believed to have originated from **endosymbiosis** of a prokaryotic cell (bacterial ancestor)
- Size and number vary in cells and depend upon their physiological activities.
- **Number of mitochondria** increased by self replication and **decreased by lysosomal activity.**
- **Maternal Inheritance:** It refers to the transmission of genetic material from the **mother to offspring** through non-nuclear DNA, typically **mitochondrial DNA (mtDNA).**
- Replicates independently of the cell cycle **via binary fission.**
- **Red Blood Cells** Lack mitochondria entirely, relying on anaerobic glycolysis for energy.

Structure

- The diameter of mitochondria is **0.2-1.0 um** while length is **1-4 um.**
- Under compound microscope appears as vesicle, rod or filament.
- Under electron microscope, it shows that they are bounded by two membranes.
- **Outer membrane**: Smooth and permeable to small molecules due to presence of **Porins.**
- **Inner membrane**: highly selective, Folded into **cristae**, which has granular structures called **F_0-F_1 Particles** actually an enzyme **(ATP Synthase)** for ATP production.
- The space between two membrane is called **intermembranous space** (Outer compartment) Contains a mixture of small molecules (e.g., protons, ions) and proteins imported from the cytoplasm.
- **Matrix (Inner compartment)**: Gel-like substance with mitochondrial DNA, ribosomes (70S), enzymes, co-enzymes and organic and inorganic salts.

Functions

- Site for aerobic cellular respiration.
- **ATP production** through oxidative phosphorylation in **ETC** in Cristae.
- **Pyruvic acid oxidation** and **Krebs cycle** (citric acid cycle) occur in the matrix.
- **Beta-oxidation** of fatty acids.
- Plays a role in **apoptosis** (programmed cell death).
- Stores and regulates **calcium ions.**
- **Mitochondrial antiviral signaling protein (MAVS)** helps the body respond to viral infections by inducing antiviral and anti-inflammatory pathways.

PLASTIDS / CHLOROPLAST

- Found in plants and algal cells, and they are important for photosynthetic process, food storage and pollination.

Proplastids

- **Young, immature,** self-replicating and **developing** and **undifferentiated plastids.**
- Divide and redivide in meristematic cells.
- May develop into leucoplast and chloroplast on exposure of light.

Chromoplast

- Impart **other than green color** to plants, found in the **petals of flowers and ripened fruits.**
- Help in **pollination** and **seed dispersal.**

Leucoplast

- Colorless, found in parenchyma cells and roots, stem and seeds.
- Triangular, tubular or of some other shape.
- **Amyloplast** store **starch** plays a role in gravity sensing **(gravitropism).**
- **Elaioplast** store **lipids** in the form of oil droplets.
- **Proteinoplast** store **protein.**
- **Etioplast** Found in tissues exposed to darkness **(e.g., underground shoots or seedlings germinated** without light). When **exposed to light,** they can **quickly transform into chloroplasts.**

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Nucleolus

- Not bound by a membrane (non-membranous), darkly stained body.
- **Nucleolar Organizing region (NOR)** is a specific region of a chromosome that contains genes encoding **ribosomal RNA (rRNA)**. These regions are crucial for the formation and function of the **nucleolus.**
- Nucleolus appear during interphase and disappear during cell division.
- Nucleolus is composed of **two regions: Peripheral granular area** is precursor for ribosomal subunits and **Central Fibril area** contains rRNA and rDNA.
- It is factory of **ribosome synthesis.**

Chromatin and Chromosomes

- Chromatin is the uncondensed form of genetic material and exists in **interphase** of cell cycle.
- **Histones** are proteins that help organize and condense the DNA into a compact structure. 200 nucleotides of DNA wraps around 8 histones to form **nucleosomes.**
- **Euchromatin:** Loosely packed chromatin and transcriptionally active.
- **Heterochromatin:** Densely packed chromatin, transcriptionally inactive **centromeres** and **telomeres.**
- **Chromosomes** are highly condensed, visible forms of chromatin during **cell division** (mitosis and meiosis).
- **Centromere (Primary constriction)** is a specialized region of a chromosome that acts as the attachment point for the **kinetochore** (interacts with **spindle fibers**) and plays a key role in **chromosome movement** during **cell division.**
- Based on the position of centromere chromosomes are divided into four categories.
- **Metacentric:** Equal arms, centromere is at the middle and V shaped appearance.
- **Submetacentric:** Unequal arms, centromere slightly off-center and J shaped appearance.
- **Acrocentric:** Very short arm and long arm, centromere close to one end and I shaped appearance.
- **Telocentric:** One arm (only a single arm), centromere at the end of the chromosome, rod shaped appearance.
- **Diploid** (2n) refers to a cell or organism that contains **two complete sets** of chromosomes, one inherited from each parent. E.g. Somatic cells
- **Haploid** (n) refers to a cell or organism that contains only **one complete set** of chromosomes. E.g. Germ cells (Sperm and egg).

Number of Chromosomes in some common Species

Species	NO. of chromosomes	Species	NO. of Chromosomes
Man	46	Cats	38
Chimpanzee	48	Dogs	78
Onion	16	Mice	40
Garden pea	14	Wheat	42
Frog	26	Housefly	12
Drosophila	08	Horses	64
Potato	48	Cows	60
Pigeon	80	Rice	24

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Differences Between Prokaryotic & Eukaryotic Cell

Feature	Prokaryotic Cell	Eukaryotic Cell
Size	Small (1–10 µm)	Larger (10–100 µm)
Cell Structure	Simple structure	Complex structure
Nucleus	No true nucleus, DNA is in the cytoplasm (nucleoid region)	True nucleus enclosed by a nuclear membrane
Organelles	No membrane-bound organelles	Membrane-bound organelles (e.g., mitochondria, Golgi apparatus)
DNA	Circular, double-stranded, and located in the nucleoid	Linear, double-stranded, and located in the nucleus
Chromosomes	Single, **circular chromosome**	Multiple, linear chromosomes
Histones	Absent	Present; DNA is associated with histone proteins
Cell Division	Binary fission (Amitosis)	Mitosis and meiosis
Ribosomes	Smaller (70S)	Larger (80S in cytoplasm, 70S in organelles)
Cytoskeleton	Absent or very simple	Complex cytoskeleton with microtubules, microfilaments, and intermediate filaments
Cell Wall	Present, made of peptidoglycan/murein **(Sacculus)**	Present in plants (cellulose) and fungi (chitin); absent in animal cells
Flagella	Simple, made of **flagellin** protein	Complex, made of microtubules **(9+2 arrangement)**
Plasma Membrane	No Sterols; some exceptions	Contains sterols (e.g., cholesterol in animal cells)
Respiration	Occurs in the cell membrane	Occurs in mitochondria
Photosynthesis	Occurs in infoldings of the plasma membrane (thylakoids in cyanobacteria) **Non-Oxygenic photosynthesis** in bacteria	Occurs in chloroplasts (plants and algae) **Oxygenic photosynthesis**
Replication Enzyme	DNA polymerase I, II, III	DNA polymerase α, δ, and ε
Okazaki fragments	1000–2000 nucleotides	100–200 nucleotides
Origin of Replication	**Single origin** (e.g., in E. coli)	**Multiple origins** of replication per chromosome
Transcription Enzyme	Single RNA polymerase	**Multiple RNA polymerases** (I, II, III)
Enzyme Speed	Faster enzyme activity (e.g., DNA replication)	Slower due to complex structure
Binding sites in Promotor	TTGACA **(-35 Sequence)** TATAAT **(-10 Sequence)**	**-75 and -25 sequence** respectively
Splicing	Rare or absent, no introns in mRNA	Requires spliceosome for intron removal
Post-transcriptional Modifications	Limited or absent	Extensive modifications **(7-methyl GTP cap and Poly-A tail added to save mRNA from variety of nucleases and phosphatases)**
Examples	Archaea, Bacteria, Cyanobacteria	Animals, Plants, Fungi, Protists

CELL DIVISION

- Cell division is the process by which a parent cell divides into two or more daughter cells. It is essenti for growth, repair, and reproduction in living organisms.
- Cell cycle is divided into two phases, **Interphase** and **Mitotic Phase**.

Phase of Interphase

Phase	Key Features
G_1 Phase (Gap 1)	• **Cell growth** and normal metabolic activity • **Synthesis of proteins** and organelles • **Preparation** for DNA replication begins (**accumulation of nucleotides**).
S Phase (Synthesis)	• **DNA replication** occurs (Each chromosome duplicates to form two identical chromatids.) • Centrosomes also replicate.
G_2 Phase (Gap 2)	• Synthesis of proteins (e.g., spindle fibers). • Cell checks for **DNA replication errors.** • Energy stored for chromosomal movement
G_0 Phase	• A phase where **cells exit** the cell cycle and stop dividing temporarily or permanently. • Cells that do not need to divide frequently (e.g., **neurons, muscle cells**) • Cells under unfavorable conditions (e.g., lack of nutrients or growth su

Differences Between Mitosis and Meiosis

Feature	Mitosis	Meiosis
Purpose	Growth, repair, and asexual reproduction	Production of gametes for sexual
Divisions	One	Two
Daughter Cells	Two identical daughter cells	Four non-identical daughter cel
Chromosome	Maintains the same chromosome number as the parent cell (diploid, 2n)	Reduces chromosome numbe
Genetic Variation	No genetic variation (daughter cells are clones)	Introducing **genetic variatio** over and independent assor
Crossing Over	Does not occur	Occurs during **Prophase I** (P Meiosis
Cell Type	Occurs in somatic (body) cells	Occurs in germ (reproduct
Phases	Prophase, Metaphase, Anaphase, Telophase (single round)	**Meiosis I: Reductional di** Meiosis II: Equational div
Duration	Shorter process	Longer process due to t

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Differences Between Mitosis and Meiosis

Feature	Mitosis	Meiosis
Purpose	Growth, repair, and asexual reproduction	Production of gametes for sexual reproduction
Divisions	One	Two
Daughter Cells	Two identical daughter cells	Four non-identical daughter cells
Chromosome	Maintains the same chromosome number as the parent cell (diploid, 2n)	Reduces chromosome number to half (haploid)
Genetic Variation	No genetic variation (daughter cells are clones)	Introducing genetic variation through crossing over and independent assortment
Crossing Over	Does not occur	Occurs during Prophase I (Pachytene) of Meiosis
Cell Type	Occurs in somatic (body) cells	Occurs in germ (reproductive) cells
Phases	Prophase, Metaphase, Anaphase, Telophase (single round)	Meiosis I: Reductional division Meiosis II: Equational division
Duration	Shorter process	Longer process due to two rounds of division

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Phases of Mitosis

Phase	Key Features	Details
Prophase	Chromosomes condense and become visible as sister chromatids.	Nuclear envelope begins to break down. Spindle fibers start forming from centrioles.
Metaphase	Chromosomes align at the cell's equatorial plate (metaphase plate).	Spindle fibers attach to the centromeres of each chromosome via kinetochores.
Anaphase	Sister chromatids separate and move to opposite poles of the cell.	Spindle fibers shorten, pulling chromatids toward the poles.
Telophase	Chromatids reach the opposite poles and decondense into chromatin.	Nuclear envelope re-forms around each set of chromosomes and Spindle fibers disappear.
Cytokinesis	Division of the cytoplasm to form two separate daughter cells.	Animal cells: Cleavage furrow forms. Plant cells: Cell plate forms.

Phases of Meiosis

Phase	Key Features	Details
Meiosis I (Reductional Division)	Reduces chromosome number by half.	Homologous chromosomes separate.
Prophase I	Homologous chromosomes pair up (synapsis) and crossing over occurs. Lengthy phase.	Exchange of genetic material creates genetic diversity. Nuclear envelope breaks, spindle fibers form.
Metaphase I	Homologous pairs align at the metaphase plate.	Spindle fibers attach to centromeres of homologous chromosomes.
Anaphase I	Homologous chromosomes are pulled to opposite poles.	Sister chromatids remain attached at their centromeres.
Telophase I	Nuclear membranes may reform, and the cell divides into two haploid daughter cells.	Each daughter cell contains half the number of chromosomes.
Meiosis II (Equational Division)	Separates sister chromatids (similar to mitosis).	Produces four haploid daughter cells.

Phases of Prophase-I

Phase	Key Features
Leptotene	Chromosomes begin to condense and become visible as thin threads.
Zygotene	Homologous chromosomes pair up through a process called synapsis to form bivalents (tetrads).
Pachytene	Crossing over occurs between homologous chromosomes, exchanging genetic material
Diplotene	Homologous chromosomes start to separate but remain connected at points of crossover (chiasmata).
Diakinesis	Chromosomes fully condense, nuclear envelope breaks down, and spindle fibers start forming.

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1. **Most of the plant cells differ from those of the animals in lacking:**
(A) SER (B) Cell Wall
(C) Centriole (D) Plastids

2. **Prokaryotic cells represent:**
(A) A less primitive stage of evolution
(B) A more primitive stage of evolution
(C) A more advanced stage of evolution
(D) A moderate stage of evolution

3. **Prokaryotic cell differs from eukaryotic one in lacking:**
(A) Chromosomes (B) 80s ribosomes
(C) Nucleoids (D) Plasmid

4. **Most of the plant cells differ from those of the animals in lacking:**
(A) Central larger vacuole
(B) Flagellum
(C) Definite shape
(D) Ribosomes

5. **It is absent in plant cells:**
(A) Microtubules
(B) Microfilaments
(C) Microbodies
(D) Phagocytic vacuoles

6. **Plant cells never suffer from:**
(A) Lysosomal disorders
(B) Viral disorders
(C) Fungal disorders
(D) Bacterial disorders

7. **A plant cell differs from animal cell in having:**
(A) Vacuoles (B) Microfilaments
(C) Microtubules (D) Plastids

8. **Contrary to the animal cells, plant cells lack:**
(A) Thylakoids (B) Asters
(C) Cell Wall (D) Central vacuole

9. **Nuclear material is directly submerged in cytoplasm in:**
(A) Plant cell (B) Prokaryotic cell
(C) Animal cell (D) Viral cell

10. **For DNA replication energy comes from:**
(A) System or cell
(B) Breaking of phosphate group of nucleotides
(C) Enzymes provide energy
(D) Only ATP can provide energy

11. **Most of the eukaryotic cells are:**
(A) Macroscopic (B) Microscopic
(C) Huge (D) Moderate in size

12. **Part of eukaryotic cell where formation and action of primase takes place respectively:**
(A) Nucleoplasm and cytoplasm
(B) Cytoplasm only
(C) Cytoplasm and nucleoplasm
(D) Nucleoplasm only

13. **The entire cell wall of prokaryotes is often regarded as a single huge molecule or molecular complex called:**
(A) Murein (B) Capsule
(C) Peptidoglycan (D) Sacculus

14. **Prokaryotic cell differs from eukaryotic one in having:**
(A) Ribosomes
(B) Flagella
(C) Extra chromosomal DNA
(D) Pili

15. **In plasma membrane, carbohydrates are conjugated with:**
(A) Proteins
(B) Lipids
(C) Proteins and lipids both
(D) Glycoproteins & glycolipids both

16. **The outer surface of plasma membrane contains:**
(A) Intermediate filaments
(B) Microtubules
(C) Microfilaments
(D) Fibers of the extracellular matrix

17. **Ions, being charged particles _____ in crossing the plasma membrane:**
(A) Have some difficulty
(B) Have no difficulty
(C) Have some ease
(D) Have no possibility

18. **The function of channel proteins in membrane is to:**
(A) Transport phospholipids across membrane
(B) Act as a receptor molecule which can bind to ligand
(C) Permit the diffusion of specific substance through the membrane
(D) Bind to a substance on one side and release it on the other side of the membrane

19. **The movement of substance from area of low concentration to area of high conc. across plasma membrane is called:**
(A) Uphill movement
(B) Facilitated transport
(C) Passive transport
(D) Bulk transport

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20. In many animal cells, the cell membrane helps to take in materials by infoldings in the form of:
(A) Mesosome (B) Crista
(C) Vacuole (D) Lysosome

21. Following are the functions of cell membrane EXCEPT:
(A) Endocytosis
(B) Transmission of never input
(C) Maintenance of definite gradient
(D) Maintenance of definite cell shape

22. Which of the following components of plasma membrane involved in enhancement of cell surface area?
(A) Cilia (B) Microvilli
(C) Desmosomes (D) Gap junctions

23. RNA binds with _____ ribosomal subunit during translation in mitochondrial matrix:
(A) 30S (B) 60S
(C) 50S (D) 40S

24. Metabolic pathways generally occur in cytosol:
(A) Glycolysis (B) Gluconeogenesis
(C) Glycogenolysis (D) All of above

25. Which of the following is odd among rest regarding structure of Golgi bodies:
(A) Outer face (B) Maturing face
(C) Forming face (D) Cis face

26. Which function is not related to Golgi complex:
(A) Sorting of material
(B) Phragmoplast formation
(C) Modification of materials
(D) Synthesis of protein

27. The organelle which is absent in all animal cells and in majority of plant cells is:
(A) Vacuole (B) Glyoxysomes
(C) Microtubules (D) Peroxisome

28. Both animal and plant cells have:
(A) Lysosome
(B) Chloroplast
(C) Centriole
(D)Eukaryotic organization

29. The storage carbohydrate of animal cell is:
(A) Cellulose (B) Starch
(C) Glycogen (D) Amylase

30. In plant cell cytokinesis occur in:
(A) Centrifugal way (B) Acropetal way
(C) Centripetal way (D) Basipetal way

31. Animal cells do not have:
(A) Centriole (B) Plasmodesmata
(C) Lysosome (D) Microtubules

32. A cell membrane that carries a wave electrochemical change from one end to next is that of:
(A) Muscle cell (B) Skin cell
(C) Nerve cell (D) Bone cell

33. Which one of the following is absent prokaryotes:
(A) Binary fission (B) Mitosis
(C) Cell division (D) DNA replication

34. Prokaryotic cell lacks which one of following:
(A) DNA
(B) mRNA
(C) Transcription
(D) Cap and tail on mRNA

35. According to fluid mosaic model of membrane, the protein layers are:
(A) Not continuous
(B) Inner to phospholipid bilayer
(C) Outer to phospholipid bilayer
(D) Continuous with phospholipid bilayer

36. The contents of lysosomes are:
(A) Alkaline (B) Neutral
(C) Acidic (D) Neutral to alkali

37. Filaments of the cytoskeleton are attached the ___ on the ____ surface of cell membra
(A) Protein, outer
(B) Phospholipids, outer
(C) Protein, inner
(D) Phospholipids, inner

38. Active transport differs from diffusion a requires:
(A) Expenditure of energy
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(A) Contractile vacuole
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(C) Autophagosomes
(D) Primary lysosomes

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(A) Slices around omelet

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(B) Sugar in cup of tea
(C) Icebergs in a lipid sea
(D) Meat in sausage

41. "Suicidal bags" term used for which organelle?
(A) Cell wall (B) Lysosomes
(C) Golgi bodies (D) Nucleus

42. This is a programmed cell death in which lysosomes burst and release their enzyme contents in cytoplasm:
(A) Autophagy
(B) Tay Sach disease
(C) Autolysis
(D) Glycogenosis disease

43. An understanding of the structure of cellular membranes depends on an understanding of the structure of:
(A) Glycoproteins (B) Sphingolipids
(C) Phospholipids (D) Lipoproteins

44. The word "fluid" in the fluid mosaic model of cell membrane refers to the:
(A) Movement of individual phospholipid molecules
(B) Pattern produced by protein molecules
(C) Movement of protein molecules
(D) Movement of individual phospholipids and protein molecules

45. The aqueous medium that surrounds the cell membrane is faced by _____ of phospholipids:
(A) Tails
(B) Both tails and heads
(C) Heads
(D) Non-polar ends

46. The outer membrane of mitochondria has special stalkless proteins:
(A) F_1 Particles (B) ATP synthase
(C) F_0 Particles (D) Porins

47. Most of the transport across cell membrane is regulated by?
(A) Phospholipids bilayers
(B) Glycoprotein
(C) Protein
(D) Glycolipids

48. Mitochondrial matrix contains all of following components except:
(A) All types of RNAs (B) Small circular DNA
(C) Ribosomes (80s) (D) Enzymes

49. An example of active transport across cell membrane is:
(A) Transport O_2 into alveolar space
(B) Transport CO_2 out of alveolar space
(C) Transport water into the lumen of descending limb of Loop of Henle
(D) Transport of sodium from lumen of ascending limb of loop of Henle

50. The outermost boundary of the protoplast of a plant cell is:
(A) Cell wall (B) Tonoplast
(C) Cell membrane (D) Capsule

51. Perhaps the most distinctive feature of the prokaryotic cell is/are:
(A) Its nuclear membrane
(B) Its cell walls
(C) Its organelles
(D) Cell division

52. A process that is present in eukaryotes but missing in prokaryotes is:
(A) Binary fission (B) Meiosis
(C) Conjugation (D) Cell division

53. An organelle containing _____ occupies the central area of a plant cell:
(A) Cytoplasm (B) Cell sap
(C) Nucleoplasm (D) Matrix

54. The Primitive type of cells lacks definite:
(A) Nucleus
(B) Cell division
(C) Nuclear body
(D) Cremation material

55. In a prokaryotic cell the position near the center of the cell is occupied:
(A) Nuclear material (B) Plasmid
(C) Nucleus (D) Ribosomes

56. Which cell component form pinocytic vesicles?
(A) Endoplasmic reticulum
(B) Cell surface membrane
(C) Lysosome
(D) Ribosome

57. Which of the following cell structures contains the highest concentration of RNA?
(A) Lysosome (B) Nucleolus
(C) Chromosome (D) Centriole

58. Which of the following is present in all eukaryotic cells?
(A) Cell wall
(B) Flagellum

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(C) Diploid nucleus
(D) Membrane bound organelles

59. **Which process does glucose move into red blood cells from the plasma membrane?**
(A) Active transport (B) Endocytosis
(C) Facilitated diffusion (D) Osmosis

60. **The source of illumination in a typical laboratory microscope is:**
(A) Visible light
(B) Beam electron
(C) Beam of photons
(D) Blue& red light

61. **_____ is non-membranous organelle of cell:**
(A) Lysosomes (B) Glyoxysomes
(C) Microtubules (D) Peroxisome

62. **Which of the following is an example of primary active transport?**
(A) Cl^--HCO_3^- exchange
(B) Na^+ - H^+ exchange
(C) Na^+-Ca^{2+} exchange
(D) Na^+-K^+ ATPase

63. **The name of a process expelling particles from a cell is:**
(A) Exocytosis (B) Phagocytosis
(C) Endocytosis (D) Osmosis

64. **Which one is the cell and tissue respectively?**
(A) Muscle fiber & heart
(B) Muscle fiber and Muscle
(C) Heart& muscle
(D) Muscle & lysosomes

65. **In which of the following ways does a bacterial cell differ from an animal cell?**
(A) A bacteria cell is much larger than an animal cell.
(B) A bacterial cell has more mitochondria than an animal cell.
(C) A bacterial cell has RNA for its genetic material, whereas an animal cell does not.
(D) A bacterial cell does not have membrane bound organelles, whereas an animal cell does.

66. **Which one has metabolically active plasma membrane?**
(A) Plant cell (B) Bacteria
(C) Animal cell (D) Virus

67. **Which one of the following eukaryotic cell structures does not contain DNA?**
(A) A Nucleus
(B) Endoplasmic reticulum
(C) A Mitochondrion
(D) A Chloroplast

68. **A substance only can be accumulated against its electrochemical gradient by:**
(A) Facilitated diffusion
(B) Passage through ion channels
(C) Diffusion through a uniport
(D) Active transport

69. **Which of the following represents active transport?**
(A) Simple diffusion
(B) Concentration gradient
(C) Filtration
(D) Solute pumps

70. **Precursors of ribosomal subunits are found in:**
(A) Nucleolus (B) Central fibril
(C) Peripheral area (D) Nucleoplasm

71. **Polyribosomes are aggregates of:**
(A) Ribosomes and rRNA
(B) Many ribosomes and many mRNA
(C) Only rRNA
(D) Several ribosomes and a mRNA.

72. **Which of the following gives rise to both lysosomes and vesicles?**
(A) Rough E. R (B) Golgi apparatus
(C) Mitochondria (D) Ribosomes

73. **Which of the following correctly matches an organelle with its function?**
(A) Mitochondrion: Photosynthesis
(B) Nucleus: Cellular respiration
(C) Central vacuole: Storage
(D) Ribosome: Manufacture of lipids

74. **Phragmoplasts are formed by:**
(A) ER (B) Golgi bodies
(C) Mitochondria (D) Nucleus

75. **The fluid mosaic model describes membranes as having:**
(A) A set of protein channels separated by phospholipids.
(B) A bilayer of phospholipids in which specialized proteins are embedded.
(C) A sugar-phosphate backbone that interconnects specific transport molecules.
(D)Two sheets of protein with a layer of phospholipids sandwiched between them.

76. **Enveloped nuclear material is absent in?**
(A) Parenchyma cells (B) Clostridium
(C) Epithelial cells (D) Megakaryocyte

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77. In the replication of bacterial genome, Okazaki fragments in the leading strand are of:
(A) 100-200
(B) 1000-2000
(C) 500-1000
(D) No Okazaki fragments are formed

78. Bacterial cell membrane is differing from eukaryotic cell by lacking member of____ family of lipids:
(A) Terpenoids (B) Acylglycerol
(C) Phospholipids (D) Waxes

79. Anterior of chloroplast is divided into heterogenous structure, embedded in the matrix known as:
(A) Grana (B) Thylakoids
(C) Stroma (D) Cisternae

80. Mesosomes structure is:
(A) Mimics the action of nucleus in bacterial cells.
(B) Mimics the action of chloroplast in bacterial cells.
(C) Mimics the action of mitochondria in bacterial cells.
(D) Mimics the action of cell wall in bacterial cells.

81. Choose the correct one:
(A) Mitochondria and chloroplast = same ribosome size
(B) Mitochondria and chloroplast = same DNA size
(C) Mitochondria and chloroplast = same protein size
(D) Mitochondria and chloroplast = same inner membrane structure

82. Exchange of gases at alveoli is by the movement of:
(A) Facilitated diffusion (B) Diffusion
(C) Active transport (D) Osmosis

83. The position of the two centrioles with respect to each other?
(A) 0° (B) 45°
(C) 90° (D) 180°

84. The size of mitochondria depends upon which factor of the cell?
(A) Biochemical (B) Physiological
(C) Evolutionary (D) Genetics

85. Chromatin material which remains condensed during interphase is called?
(A) Heterochromatin (B) Polysome
(C) Euchromatin (D) Nucleosome

86. The ratio of RNA between animal and bacterial cells:
(A) 1.1 : 6 (B) 4 : 7
(C) 6 : 1.1 (D) 3 : 1

87. Which organelle of cell helps to detoxify the harmful drugs?
(A) RER (B) Golgi apparatus
(C) SER (D) Ribosomes

88. According to the fluid mosaic model, extrinsic proteins are attached with which part of lipid bilayer:
(A) Hydrophobic head
(B) Hydrophobic tail
(C) Hydrophilic head
(D) Hydrophilic tail

89. Blebs from tips of smooth endoplasmic reticulum fuse with Golgi apparatus cisternae at:
(A) Concave face (B) Maturing face
(C) Forming face (D) Trans face

90. E.R is absent in:
(A) Animal cells (B) Plant cells
(C) Prokaryotes (D) Protists and fungi

91. Which plays an important role in transport of materials from one part of cell?
(A) Golgi apparatus (B) Ribosomes
(C) R.E. R (D) S.E.R

92. Which of the following correctly shows structures that are found in a eukaryotic cell? (✓ = Present; × = Absent)

	Nuclear Membranes	Mesosomes	Ribosomes
(A)	×	✓	×
(B)	✓	×	×
(C)	✓	×	✓
(D)	✓	✓	✓

93. It is true about Golgi apparatus:
(A) Its convex face is present far from cell membrane
(B) Its forming face is located towards cell membrane
(C) Its maturing face is present close to nucleus
(D) Its concave face is present far from cell membrane

94. Golgi apparatus consist of:
(A) Golgi Body + SER

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(A) Structurally and functionally similar
(B) Structurally and functionally dissimilar
(C) Structurally similar but functionally different
(D) Structurally different but functionally similar

130. The size and number of mitochondria depend upon which factor of the cell:
(A) Biochemical (B) Genetic
(C) Physiological (D) Evolutionary

131. Which substances form contractile ring during cytokinesis in animal cells?
(A) Troponin and tropomyosin
(B) Actin and troponin
(C) Myosin and tropomyosin
(D) Myosin and actin

132. Which of the following properties are incorrect for both mitochondria and chloroplast?
(A) Both have an electron transport system
(B) ATP synthesis
(C) Both are present in all cells
(D) Both are double membrane structures

133. Which of the following sets of organelles is present in plants and not in animals?
(A) Plastids, Centrioles, Cell wall
(B) Cell wall, plastids, Glyoxysomes
(C) Mitochondria, Ribosomes, Nucleus
(D) Centrioles, vacuoles, Plasma membrane

134. Eukaryotic cells are more efficient than prokaryotes because their internal compartmentalization:
(A) Makes each compartment nutritionally independent of all other
(B) Allows for specialization through the subdivision of tasks
(C) Allows for specialization through merging of different tasks
(D) Reduces overall cell size

135. What is the most important difference between active and passive transport?
(A) Active transport requires energy input, passive transport does not
(B) Active transport occurs in animals, passive transport occurs only in plants
(C) Active transport does not use membranes, passive transport always uses membranes
(D) Active transport occurs whenever an organism moves, passive transport does not involve movement of the organism

136. The main function plasma membrane is to:
(A) Synthesize ribosomes
(B) Control what goes into and out of the cell
(C) Allows all kinds of substances to enter the cell
(D) Move the cell from place to place

137. Carbohydrates present in the plasmalemma are in the form of.
(A) Cellulose
(B) Hemicellulose
(C) Starch
(D) Glycolipids and glycoproteins

138. RNA is absent in:
(A) Plasmalemma (B) Chromosome
(C) Ribosomes (D) Cytoplasm

139. The complex of sugar polymers and proteins which are patchily distributed on the plasma membranes of animal cells is called.
(A) Cellulose (B) Chitin
(C) Glycocalyx (D) Cytoskeleton

140. Which of the following organelles is directly connected to the outer membrane of the nucleus in a eukaryotic cell?
(A) Mitochondrion
(B) Lysosome
(C) Golgi apparatus
(D) Endoplasmic reticulum

141. What is the sequence of organelles that a secreted protein would have passed through on its journey out of a cell?
(A) Mitochondria, Golgi apparatus, cell membrane
(B) Cell membrane, mitochondria, Golgi apparatus
(C) Rough endoplasmic reticulum, Golgi apparatus, cell membrane
(D) Golgi apparatus, rough endoplasmic reticulum, cell membrane

142. De Duve and coworkers discovered peroxisomes from:
(A) Liver cells (B) Kidney cells
(C) Neurons (D) Lymphocytes

143. Chromosome movement during cell division is regulated by:
(A) Microtubules
(B) Microfilaments

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(C) Intermediate filaments
(D) All of these

144. **Which of the following statement is wrong?**
(A) Fungi have mitochondria
(B) Mitochondria have DNA and ribosomes
(C) Mitochondrial ribosomes resemble more to eukaryotic ribosomes
(D) Mitochondria are self-replicating organelles

145. **The mitochondria DNA is:**
(A) Paternally inherited
(B) Maternally inherited
(C) Formed by the nucleus of the zygote
(D) Formed by the mitochondria of the zygote

146. **Oxidative metabolism is carried out ____ of mitochondria:**
(A) In the intermembrane space
(B) On the surface of the inner membrane
(C) In the inside of the outer membrane
(D) In the matrix

147. **It is related with mitochondria:**
(A) Replication of ATP synthase gene
(B) Glycosylation of albumin
(C) Conversion of hexose to triose
(D) Porphyrin synthesis

148. **Generally, the cells with more than two nuclei are called:**
(A) Anucleate (B) Multinucleate
(C) Binucleate (D) Mononucleate

149. **Which of the following molecule/structure does not move from the nucleus to the cytoplasm?**
(A) mRNA (B) Ribosomes
(C) DNA polymerase (D) tRNA

150. **Identify the labeling "X":**

(A) Nucleus
(B) Chromatin material
(C) Nucleolus
(D) Nuclear

151. **Cell with multiple nuclei:**
(A) Nucleus (B) Leukocyte
(C) Myocyte (D) Paramecium

152. **Cell theory is not applicable to:**
(A) Algae (B) Viruses
(C) Bacteria (D) RBCs

153. **The resolving power of microscope means the capacity to:**
(A) Magnify the object
(B) Distinguish between two objects
(C) Distinguish between organelles
(D) Distinguish between two close points

154. **Microscopy technique in which a beam of electrons is transmitted through a specimen to form an image:**
(A) Transmission electron microscopy
(B) Scanning electron microscopy
(C) Ultraviolet microscopy
(D) Florescent microscopy

155. **Cell organelles are separated by:**
(A) X-ray diffraction
(B) Autoradiography
(C) Thin section microtomy
(D) Differential centrifugation

156. **Which of following can be seen only under electron microscope:**
(A) Chloroplast (B) Ribosomes
(C) Chromoplast (D) Chromosomes

157. **The Singer and Nicolson's Model of Plasma membrane differs from the Robertson's model in the:**
(A) Number of lipid layers
(B) Arrangement of proteins
(C) Arrangement of lipid layers
(D) Absence of proteins

158. **In fluid mosaic model of plasma membrane:**
(A) Upper layer is non-polar and hydrophilic
(B) Polar layer is hydrophobic
(C) Phospholipids form a bimolecular layer in middle part
(D) Proteins form a middle layer

159. **The plasma membrane consists mainly of:**
(A) Proteins embedded in a carbohydrate bilayer
(B) Phospholipids embedded in a protein bilayer
(C) Proteins embedded in a phospholipid bilayer
(D) Proteins embedded in a polymer of glucose molecules

160. **The main lipid components of the cell membrane are:**
(A) Phospholipid (B) Glycocalyx
(C) Peptidoglycan (D) Sterol

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(A) Fe (B) Cu
(C) Ni (D) Mg

199. The organelle which plays an important role in intracellular digestion is:
(A) Mitochondria
(B) Lysosomes
(C) Endoplasmic reticulum
(D) Golgi apparatus

200. Of the following organelles, which group is involved in manufacturing substances needed by cell:
(A) Lysosomes, vacuole, ribosomes
(B) Ribosomes, RER, SER
(C) RER, microtubules, lysosomes
(D) SER, Lysosomes, vacuole

201. Spindle apparatus is made up of:
(A) ER (B) Polysomes
(C) Microtubules (D) Spherosomes

202. The arrangement of outer and central microtubules in a cilium is called:
(A) 9+2 pattern (B) 8+2 pattern
(C) 9+1 pattern (D) 9+0 pattern

203. Cellular structure which always disappeared during mitosis or meiosis is:
(A) Plastids
(B) Plasma membrane
(C) Nuclear membrane and nucleolus
(D) Mitochondria

204. Which of the following molecules move regularly from nucleus to cytoplasm:
(A) DNA (B) RNA
(C) Protein (D) DNA Polymerase

205. Nuclear envelope is a derivative of:
(A) Membrane of Golgi complex
(B) Microtubules
(C) Rough endoplasmic reticulum
(D) Smooth endoplasmic reticulum

206. Which of the following will not be channelized through RER:
(A) Immunoglobulin (B) TSH
(C) Interferon (D) Arginase

207. Mechanical support, enzymes circulation, protein synthesis and detoxification of drugs are the function of:
(A) ER (B) Chloroplast
(C) Ribosomes (D) Dictyosomes

208. If living cells, similar to those found on earth, were found on another planet, where there was no oxygen, then which cell organ would most probably be absent:
(A) Ribosomes
(B) Golgi apparatus
(C) Mitochondria
(D) Endoplasmic Reticulum

209. Which of the following statement about endoplasmic reticulum is correct?
(A) It is involved in glycogenolysis
(B) It consists of collection of unconnected vesicles
(C) It is continuous with outer mitochondrial membrane
(D) It contains enzymes for the breakdown of cellular organelles

210. Which type of membrane is most abundant within the cell?
(A) ER membrane
(B) Golgi membrane
(C) Plasma membrane
(D) Nuclear membrane

211. Golgi apparatus involved in the processing of:
(A) Salivary amylase
(B) Glucokinase
(C) Phenylalanine hydroxylase
(D) EcoR1

212. During G_2 - phase a diploid cell contains the amount of DNA equal to a:
(A) Diploid cell (B) Tetraploid cell
(C) Haploid cell (D) Hexaploid cell

213. At which stage of the cell cycle are histone proteins synthesized in a eukaryotic cell:
(A) During telophase
(B) During S–phase
(C) During G_2–phase
(D) During entire prophase

214. Which of the following does not occur in Anaphase–I but occurs in Anaphase–II:
(A) Condensation of chromosomes
(B) Poleward movement of chromosomes
(C) Shortening of spindle fibers
(D) Splitting of centromere

215. In which order, cytokinesis occurs in plants:
(A) Centripetal (B) Centrifugal
(C) Oblique (D) Equatorial

216. Which does not occur in prophase:
(A) Decondensation of chromatin
(B) Condensation of chromatin
(C) Appearance of chromosome

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(D) Disappearance of nuclear membrane and nucleolus

217. **In which stage of cell division, number of chromosomes best counted:**
(A) Prophase (B) Metaphase
(C) Telophase (D) Interphase

218. **In which stage of mitosis, the chromosomes are composed of two chromatids:**
(A) Prophase & metaphase
(B) Anaphase and telophase
(C) Prophase and telophase
(D) Metaphase and anaphase

219. **During cell division, spindle fibers attach to which part of chromosome:**
(A) Primary constriction
(B) Secondary constriction
(C) Telomere
(D) Satellite

220. **Identify the meiotic stage in which the homologous chromosomes separate while the sister chromatids remain associated at their centromeres:**
(A) Anaphase I (B) Anaphase II
(C) Metaphase I (D) Metaphase II

221. **At anaphase-II, sister chromatids move towards opposite poles of the cell by:**
(A) Elongation in spindle fiber attached to kinetochores
(B) Shortening of microtubules attached to kinetochores
(C) Lengthening of microtubules attached to kinetochores
(D) Relaxation in spindle fiber attached to kinetochores

222. **In meiosis:**
(A) Division of nucleus twice but replication of DNA only once
(B) Division of nucleus twice and replication of DNA twice
(C) Division of nucleus once and replication of DNA is also once
(D) Division of nucleus once and DNA - replication is twice

223. **Reappearance of nuclear membrane & nucleolus along with thinning & elongation in chromosomes are diagnostic characters for the:**
(A) Anaphase (B) Metaphase
(C) Interphase (D) Telophase

224. **The correct sequence of prophase–I of meiosis is:**
(A) Leptotene, pachytene, zygotene, diplotene, diakinesis
(B) Leptotene, diplotene, pachytene, zygotene, diakinesis
(C) Leptotene, zygotene, pachytene, diplotene, diakinesis
(D) Leptotene, zygotene, diakinesis, diplotene, pachytene

225. **Crossing over those results in genetic recombination in higher organisms occurs between:**
(A) Non-sister chromatids of a bivalent
(B) Two daughter nuclei
(C) Two different bivalents
(D) Sister chromatids of a bivalents

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226. **Which of the following organelles is concerned with cell secretion? (2011)**
(A) Ribosomes (B) Lysosomes
(C) Golgi apparatus (D) Mitochondria

227. **Which of the following contains peptidoglycan cell wall? (2011)**
(A) Penicillium (B) Adiantum
(C) Bacterium (D) Polytrichum

228. **The inner membrane of mitochondria folded to form finger like structure called: (2011)**
(A) Cristae (B) Matrix
(C) Vesicles (D) Cisternae

229. **The interior of the chloroplasts is divided into heterogeneous structures embedded in the matrix known as: (2011)**
(A) Grana (B) Thylakoids
(C) Stroma (D) Cisternae

230. **Plastids are only found in the: (2012)**
(A) Animals and plants (B) Plants
(C) Animals (D) Viruses

231. **Plasma membrane is chemically composed of: (2012)**
(A) Phospholipids only
(B) Lipids and carbohydrates
(C) Lipids and proteins
(D) Glycoproteins

232. **Endoplasmic reticulum contains a system of flattened membrane-bounded sacs, which are named as: (2012)**
(A) Cristae (B) Cisternae

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(C) Marks (D) Tubules

233. The ribosomal RNA is synthesized and stored in: (2012)
(A) Endoplasmic reticulum
(B) Golgi complex
(C) Nucleolus
(D) Chromosomes

234. Lipids synthesis/metabolism takes place in which of the following organelle? (2012)
(A) Mitochondria
(B) Rough endoplasmic reticulum
(C) Vacuoles
(D) Smooth endoplasmic reticulum

235. Ribosomes exist in two forms, either attached with RER or freely dispersed in the: (2012)
(A) Tonoplast (B) Cytoplasm
(C) Golgi bodies (D) SER

236. The model of plasma membrane suggests that proteins are embedded in lipid bilayer: (2013)
(A) Unit membrane (B) Ultracentrifuge
(C) Permeable (D) Fluid mosaic

237. The function of nucleolus is to make: (2013)
(A) rDNA (B) Ribosomes
(C) RNA (D) Chromosomes

238. Lipid metabolism is the function of: (2013)
(A) Sarcoplasmic reticulum
(B) Mitochondria
(C) Rough endoplasmic reticulum
(D) Smooth endoplasmic reticulum

239. The enzymes of lysosomes are synthesized on: (2013)
(A) Smooth endoplasmic reticulum
(B) Chloroplast
(C) Rough endoplasmic reticulum
(D) Golgi apparatus

240. Centrioles are made up of_____microtubules triplet: (2013)
(A) 9 (B) 12
(C) 3 (D) 27

241. Which of the following structures is absent in higher plants and found in animal cells? (2013)
(A) Cytoskeleton (B) Centriole
(C) Mitochondria (D) Cytoplasm

242. The soluble part of the cytoplasm or fluid that remains when all organelles are removed is known as: (2013)
(A) Cytosol (B) Gelatin material
(C) Solution (D) Cytoplasm

243. The outer membrane of the nuclear envelope is at places continuous with the: (2013)
(A) Golgi apparatus
(B) Endoplasmic reticulum
(C) Lysozymes
(D) Peroxisomes

244. The process by which unwanted structures within the cell are engulfed and digested with lysosome is known as: (2014)
(A) Endocytosis (B) Exocytosis
(C) Autophagy (D) Hydrolysis

245. During animal cell division, the spindle fibers are formed from: (2014)
(A) Mitochondria (B) Ribosomes
(C) Centrioles (D) Lysosomes

246. Which component of the cell is concerned with cell secretions? (2014)
(A) Plasma membrane (B) Cytoskeleton
(C) Golgi complex (D) Mitochondria

247. In mitochondria, small knob like structures called F_1 particles are found in: (2014)
(A) Outer membrane
(B) Inner membrane
(C) Outer compartment
(D) Inner compartment

248. The intake of liquid material across the cell membrane: (2014)
(A) Phagocytosis (B) Pinocytosis
(C) Endocytosis (D) Exocytosis

249. Which one of the following is the site of oxidative phosphorylation in mitochondria? (2014)
(A) Cristae (B) Outer membrane
(C) Matrix (D) Ribosomes

250. Organelle involved in the synthesis of ATP is: (2014)
(A) Ribosome (B) Nucleus
(C) Mitochondria (D) Centriole

251. Peptidoglycan or murein is a special or distinctive of cell wall for: (2014)
(A) Algae (B) Bacteria
(C) Fungi (D) Plants

252. Fluid mosaic model of plasma membrane states that protein molecules float in a fluid of _____bilayer: (2015)
(A) Galactose (B) Glucose
(C) Phospholipids (D) Carbohydrate

253. How many triplets of microtubules are present in centrioles? (2015)

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(A) Ten (B) Nine
(C) Eight (D) Seven

254. Which one of the following cell structure is involved in the synthesis of lipids? (2015)
(A) Endoplasmic reticulum
(B) Centriole
(C) Golgi complex
(D) Mitochondrion

255. Ribosomes are tiny organelles, which are involved in the synthesis of: (2015)
(A) Protein (B) Nucleus
(C) RNA (D) Nucleosome

256. Which organelle is bounded by two membranes? (2015)
(A) Ribosome (B) Lysosome
(C) Mitochondrion (D) Nucleolus

257. At the beginning of nuclear division, the number of microtubule triplets in two pairsof centrioles that migrate to opposite poles are: (2015)
(A) 9 (B) 108
(C) 18 (D) 36

258. The rapid exchange of materials through carrier proteins across the plasma membrane is called: (2016)
(A) Passive diffusion
(B) Endocytosis
(C) Active transport
(D) Facilitated diffusion

259. The inner membrane of mitochondria forms extensive infoldings called: (2016)
(A) Cristae (B) Lamella
(B) Cisternae (D) Bifidae

260. Which of the following organelle is found in both prokaryotic and eukaryotic cells? (2016)
(A) Centriole
(C) Nucleus
(B) Endoplasmic reticulum
(D) Ribosome

261. Out of the given option, choose the one which shows the structures found only in plants: (2016)
(A) Vacuole, chloroplast, ribosomes
(B) Chloroplast, cell wall, mitochondria
(C) Chloroplast, microtubules, peroxisomes
(D) Chloroplast, cell wall, vacuole

262. Presence of large central vacuole is the characteristic of: (2016)
(A) Prokaryotes (B) Plants
(C) Protists (D) Fungi

263. The basic structure of plasma membrane is provided by: (2016)
(A) Proteins (B) Phospholipids
(C) Cholesterols (D) Cytoskeleton

264. The organelle involved in detoxification of drugs and poisons in the liver cells is: (2016)
(A) S.E.R (B) Lysosome
(C) Golgi Body (D) Peroxisome

265. Select the organelle which is only present in animal cells: (2017)
(A) Centriole
(B) Microtubule
(C) Rough Endoplasmic Reticulum
(D) Ribosome

266. Which one of the following structures is present in both animal and plant cells but absent in prokaryotic cells? (2017)
(A) Centrioles (B) Plastids
(C) Microtubules (D) Sieve tubes

267. Cilia and flagella are absent in: (2017)
(A) Viruses (B) Higher plants
(C) Bacteria (D) Lower animals

268. Nuclear membrane is continuing with: (2017-Retake)
(A) E.R (B) Lysosome
(C) Golgi Body (D) Peroxisome

269. Group of ribosomes attached to mRNA is called: (2017-Retake)
(A) Polyploid (B) Polysome
(C) Polynucleotide (D) Polysaccharide

270. Which of the following organelle consist of two subunits: (2017-Retake)
(A) Golgi body (B) Ribosome
(C) Mitochondria (D) Plastids

271. Ribosome present in prokaryotes: (2017-Retake)
(A) 70S (B) 60S
(C) 80S (D) 40S

272. Which of the following is common organelle in plant and animal: (2017-Retake)
(A) Peroxisome (B) Centrioles
(C) Flagella (D) Plastids

273. Organelle involved in aerobic respiration: (2017-Retake)
(A) Mitochondria (B) Plastids
(C) Lysosome (D) Ribosome

274. Self-eating of lysosomes is called: (2017-Retake)

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(A) Phagocytosis (B) Autophagy
(C) Pinocytosis (D) Exocytosis

275. **Select the organelle which is only present in animal cells: (2017)**
(A) Centriole
(B) Microtubule
(C) Rough Endoplasmic Reticulum
(D) Ribosome

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(C) Lysosome (D) Ribosome

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(A) Phagocytosis (B) Autophagy
(C) Pinocytosis (D) Exocytosis

284. **Taking in of solid particle by cell is called: (2017-Retake)**
(A) Phagocytosis (B) Exocytosis
(C)Pinocytosis (D) Endocytosis

285. **Ribosomal RNA is synthesized in: (2017-Retake)**
(A) Nucleolus (B) Golgi body
(C) Peroxisome (D) Nucleoplasm

286. **Inner membrane of mitochondria is called: (2017-Retake)**
(A) Cisternae (B) Lemma
(C) Cristae (D) Tonoplast

287. **Crossing overtake place during _____ of meiosis: (2018)**
(A) Prophase-I (B) Anaphase-I
(C) Metaphase-I (D) Telophase-I

288. **The ability to distinguish between two separate points/objects is: (2018)**
(A) Magnification (B) Centrifugation
(C) Fractionation (D) Resolution

289. **Lipid synthesis or lipid metabolism is the function of: (2018)**
(A) SER (B) Golgi Complex
(C) Mitochondria (D) RER

290. **Synthesis of microtubules increases in: (2018)**
(A) M-phase (B) G_1-phase
(C) S-phase (D) G_2-phase

291. **In cross section each centriole consists of nine (each in triplets) of: (2018)**
(A) Microtubules
(B) Microfilament
(C) Microvilli
(D) Intermediate filament

292. **Ribosomes are made up of _____ & _____: (2018)**
(A) Protein & carbohydrates
(B) RNA & lipids
(C) RNA & protein
(D) RNA & carbohydrates

293. **Which statement is correct for mitochondria and Chloroplast: (2018)**
(A) Number of chloroplast and mitochondria are same in all cells
(B) Chloroplast and mitochondria are single membranous organelle
(C) Chloroplast and mitochondria cannot live independently
(D) 70S ribosomes are found in mitochondria and chloroplast

294. **Site of protein synthesis in cell: (2018)**
(A) Ribosomes (B) Nucleolus
(C) ER (D) SER

295. **Which of the following cell do not have nucleus: (2018)**
(A) Eosinophil (B) Basophil
(C) Neutrophil (D) Platelets

296. **The structure that involved in breakdown of old organelles: (2018)**

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(A) Leucoplast (B) Glyoxysomes
(C) Peroxisomes (D) Lysosomes

297. **Tonoplast bound which organelle: (2018)**
(A) Golgi complex (B) Vacuole
(C) Nucleus (D) ER

298. **The cisternae break up into vesicles from _____, _____ of Golgi complex: (2018)**
(A) Convex, maturing face
(B) Concave, maturing face
(C) Convex, forming face
(D) Concave, forming face

299. **Microtubule subunits (for spindle fibers) are synthesized in _____ phase: (2019)**
(A) G_2 (B) G_1
(C) S (D) M

300. **Among the following which cellular organelle contain circular DNA similar to those found in bacteria: (2018)**
(A) Ribosomes (B) Chloroplast
(C) Lysosomes (D) Nucleus

301. **The phase of mitosis in which sister chromatids moves towards opposite poles: (2019)**
(A) Prophase (B) Metaphase
(C) Anaphase (D) Telophase

302. **The prokaryotes possess small ribosomes of size: (2019)**
(A) 40S (B) 65S
(C) 70S (D) 60S

303. **If 15µm size object is observed under light microscope using 5X eyepiece and 10X objective lens, its magnified image size will be: (2019)**
(A) 250 µm (B) 750 µm
(C) 50 µm (D) 500 µm

304. **Smooth Endoplasmic reticulum is responsible for the metabolism of: (2019)**
(A) Carbohydrate (B) Nucleic acid
(C) Lipid (D) Protein

305. **During the G_2 Phase: (2019)**
(A) Specific enzymes are synthesized, and DNA base units are accumulated
(B) The chromosomes are left with only one chromosome
(C) Chromosome number is duplicated
(D) Energy is stored for chromosomes movement and mitotic specific protein (tubulin) are produced

306. **Which cell organelle is responsible for cell secretion: (2019)**
(A) Mitochondrion (B) Ribosomes
(C) Golgi Bodies (D) Chloroplast

307. **Passive Process for movement of molecules across cell surface membrane are: (2019)**
(A) Facilitated diffusion and osmosis
(B) Pinocytosis and facilitated diffusion
(C) Diffusion and exocytosis
(D) Osmosis and phagocytosis

308. **The cells in our body are all genetically identical, apart from the: (2020)**
(A) Somatic cells (B) Muscle cells
(C) Reproductive cells (D) W.B.Cs

309. **In which type of cells, cell wall is not present: (2020)**
(A) Plant cells (B) Bacterial cells
(C) Liver cells (D) Fungal cells

310. **According to fluid mosaic model of cell membrane, which zone is embedded inside? (2020)**
(A) Hydrophobic (B) Globular
(C) Hydrophilic (D) Filamentous

311. **The membrane separating the vacuole from the cytoplasm: (2020)**
(A) Cristae (B) Tonoplast
(C) Cisternae (D) Plasmalemma

312. **Select the one which is not the function of smooth endoplasmic reticulum: (2020)**
(A) Metabolism of lipids
(B) Transmission of impulse
(C) Processing of glycoprotein
(D) Transport of materials

313. **Which of following organelles involves in the synthesis of plant cell wall: (2020)**
(A) ER (B) Golgi Bodies
(C) Lysosomes (D) Peroxisomes

314. **During meiosis, the homologous chromosomes come together and from pairs. This process is called: (2020)**
(A) Linkage (B) Pairing
(C) Synapsis (D) Crossing over

315. **At what phase the DNA content of cell is doubled: (2020)**
(A) Prophase (B) Interphase
(C) Anaphase (D) Telophase

316. **Which of the following is involved in the conversion of fats to carbohydrates by oxidation of fats: (2021)**
(A) Peroxisomes (B) Microsomes

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Answer Key

1. C	2. B	3. B	4. B	5. D	6. A	7. D	8. B	9. B	10. B
11. B	12. C	13. D	14. D	15. C	16. D	17. A	18. C	19. A	20. C
21. D	22. B	23. A	24. D	25. B	26. D	27. B	28. D	29. C	30. A
31. B	32. C	33. B	34. D	35. A	36. C	37. C	38. A	39. B	40. C
41. B	42. C	43. C	44. D	45. C	46. D	47. C	48. C	49. D	50. C
51. B	52. B	53. B	54. A	55. A	56. B	57. B	58. D	59. C	60. A
61. C	62. D	63. A	64. B	65. D	66. B	67. B	68. D	69. D	70. C
71. D	72. B	73. C	74. B	75. B	76. B	77. D	78. A	79. A	80. C
81. A	82. B	83. C	84. B	85. A	86. A	87. C	88. C	89. C	90. C
91. D	92. C	93. A	94. C	95. D	96. D	97. D	98. D	99. B	100. B
101. D	102. C	103. A	104. D	105. A	106. A	107. C	108. B	109. C	110. C
111. B	112. A	113. B	114. B	115. A	116. B	117. C	118. D	119. C	120. D
121. D	122. D	123. A	124. A	125. C	126. A	127. A	128. B	129. C	130. C
131. D	132. C	133. B	134. B	135. A	136. B	137. D	138. A	139. C	140. D
141. C	142. A	143. A	144. C	145. B	146. B	147. D	148. B	149. C	150. C
151. C	152. B	153. D	154. A	155. D	156. B	157. B	158. C	159. C	160. A
161. B	162. B	163. D	164. D	165. D	166. A	167. A	168. D	169. C	170. C
171. A	172. B	173. D	174. C	175. B	176. B	177. C	178. C	179. C	180. D
181. C	182. A	183. C	184. C	185. B	186. B	187. C	188. D	189. A	190. B
191. C	192. A	193. B	194. B	195. C	196. C	197. B	198. D	199. B	200. B
201. C	202. A	203. C	204. B	205. C	206. D	207. A	208. C	209. A	210. A
211. A	212. B	213. B	214. D	215. B	216. A	217. B	218. A	219. A	220. A
221. B	222. A	223. D	224. C	225. A	226. C	227. C	228. A	229. A	230. B
231. C	232. B	233. C	234. D	235. B	236. D	237. B	238. D	239. C	240. A
241. B	242. A	243. B	244. C	245. C	246. C	247. B	248. B	249. A	250. C
251. B	252. C	253. B	254. A	255. A	256. C	257. D	258. D	259. A	260. D
261. D	262. B	263. B	264. A	265. A	266. C	267. A	268. A	269. B	270. B
271. A	272. A	273. A	274. B	275. A	276. C	277. A	278. B	279. B	280. A
281. A	282. A	283. B	284. A	285. A	286. C	287. A	288. D	289. A	290. D
291. A	292. C	293. C	294. A	295. D	296. D	297. B	298. B	299. A	300. B
301. C	302. C	303. C	304. C	305. D	306. C	307. A	308. C	309. C	310. A
311. B	312. C	313. B	314. C	315. B	316. C	317. A	318. D	319. D	320. C
321. C	322. C	323. C	324. B	325. C	326. C	327. C	328. A	329. C	330. C
331. C	332. D	333. A	334. C	335. A	336. A	337. A	338. B	339. C	340. A
341. C	342. C	343. C	344. B	345. B	346. C	347. D	348. A	349. D	350. C
351. C	352. C	353. A							

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UNIT # 05

COORDINATION AND CONTROL

(NERVOUS & CHEMICAL COORDINATION)

High Yield Content:

- Function of Brain and spinal cord
- Nerve impulse
- Synapse
- Nervous disorder
- Chemical Nature of Hormones (Peptides & Steroids)
- Pituitary gland, Thyroid gland, Adrenal gland, Gonad.
- Positive and Negative feedback

SCAN QR CODE To Watch MDCAT Lectures, Test Discussions, and Past Papers Discussion on

"Coordination & Control"

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Structural Parts of a Generalized Neuron

Structure	Functions
Cell Body (Soma)	**Main Nutritional part**, Contains the **nucleus** and **organelles** such as prominent nucleolus, ER, ribosomes, Golgi apparatus and mitochondria. **Nissls granules** consist of rough endoplasmic reticulum (RER) and ribosomes and are involved in protein synthesis.
Dendrites	**Branched extensions** from the cell body that receive signals from other neurons. They are **devoid of Schwann cells and thus non-myelinated.** **Dendron:** Single long dendrite which is structurally and functionally similar to axon.
Axon	**Long, thin projection** that transmits electrical impulses away from the cell body to other neurons or target cells. Size varies from **few millimeters to a meter long.** **Cell organelles** like mitochondria, microtubules, neurofibrils, RER and Golgi apparatus are present throughout the **axoplasm** of the neurons.
Axon Hillock	The **conical region** at the junction of the cell body and axon, where **action potentials are initiated.**
Myelin Sheath	**Fatty insulating layer** around axons (formed by Schwann cells in PNS and oligodendrocytes in CNS) that speeds up electrical signal transmission.
Nodes of Ranvier	**Gaps in the myelin sheath** where action potentials are regenerated, facilitating rapid signal transmission.
Axon Terminals (Synaptic Terminals)	The **end of the axon** where **neurotransmitters are released** to communicate with other neurons or muscles.

Types of Neurons

Sensory Neuron (Afferent)	Motor Neuron (Efferent)	Inter Neuron (Associative/Relay)
Transmit sensory information from receptors to the CNS	Carry signals from the CNS to effectors (Muscles or Glands)	Connect sensory neurons to motor neurons and involve in processing and interpretation of information.
Long dendron and short axon	Short dendrites and long axon	Dendrites and axon (comparatively thin and non-myelinated) both short
Dendron and cell body outside CNS while axon moving into CNS.	Dendrites and cell body inside CNS while axon moving out.	Found entirely within the CNS (brain and spinal cord).
Unipolar	Multipolar	Multipolar

REFLEXES & REFLEX ARC

- A reflex is an **automatic, rapid, and involuntary response** to a specific stimulus (internal environmental change or injurious stimulus)
- Reflexes protect the body from harm and help maintain homeostasis (e.g., pulling away from a hot surface, regulating blood pressure).
- The reflex arc is the neural pathway that mediates a reflex. It consists of **five main components:**

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COORDINATION & CONTROL: KEY CONCEPTS

- Stimulus is any change in the internal or external environment that elicits a response in an organism.
- **External Stimuli:** Changes in the external environment, e.g., light, temperature, sound.
- **Internal Stimuli:** Changes within the body, e.g., blood sugar levels, oxygen concentration.
- **Threshold stimulus:** Minimum intensity required to elicit a response.
- **Suprathreshold Stimulus:** Above threshold potential, Triggers a strong response (increased action potential frequency).
- **Subthreshold Stimulus:** Below threshold potential, a stimulus that is too weak to depolarize a cell to its threshold potential.
- There are two types of coordination: **Nervous (By neurons), Chemical (By hormones).**

NERVOUS COORDINATION

- Three basic components of neurons: **Receptors, Neurons and Effectors**

RECEPTORS / TRANSDUCERS

- May be a **cell, organ or nerve ending** and detect change in external of internal environment.
- Act as transducers because convert signal from one form to another.

Types of Receptors

Receptor Type	Functions	Location	Examples
Mechanoreceptors	Detect touch, pressure **(Baroreceptors)**, stretch, hearing, equilibrium and sound **(Phonoreceptors).**	Skin, ears, muscles, Blood vessels	Meissner's corpuscles, Pacinian corpuscles, Ruffini Endings, Merkel Cells, Hair Follicle Receptors
Thermoreceptors	Sense heat or cold.	Skin, hypothalamus	**Cold and warm receptors**
Chemoreceptors	Detect smell, taste, blood pressure, ions or molecules.	Tongue, nose, blood vessels, Hypothalamus	Olfactory receptors (smell), gustatory receptors (taste buds), **Osmoreceptors** (osmotic pressure)
Photoreceptors	Detect light and color for vision.	Retina of the eye	Rods, cones
Nociceptors	Detect tissue damage and painful stimuli.	Skin, muscles, joints, viscera	Free nerve endings

Distribution of Receptors in Skin

- Receptors are **not evenly distributed**. Pain receptors are **27 times** more abundant than Cold receptors and Cold receptors are **10 times** more abundant than Heat receptors.

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Sensory Skin Receptors

- About 5 different sensations are perceived by skin, i.e., touch, pressure, heat, cold and pain

Receptor Type	Location	Structure	Sensation
Free nerve ending	Skin, mucosa, at the base of hairs	Unspecialized nerve endings with no encapsulating structure.	Crude touch, pain, temperature
Meissner's Corpuscles	Dermis of hairless skin, in papillae which extend into ridges of fingertips.	Specialized cellular encapsulated corpuscles, spiral and twisted endings, each ending terminates in a knob.	Light touch, texture, and low-frequency vibrations
Pacinian Corpuscles	Found in the deep dermis (hypodermis), Joints, tendons, Limbs	encapsulated neuron endings.	Deep pressure, vibration sensations.
Ruffini Endings	Dermis, ligaments, tendons	Elongated, spindle-shaped structures.	Stretch, sustained pressure
Merkel disks	Basal epidermis, fingertips	Comprised of Merkel cells (epidermal cells).	Sustained pressure, texture

NEURONS

- Basic structural and functional unit of nervous system.
- Once mature, they cannot divide but can regenerate if cell body is intact.
- **Neuroglia cell / Neuroglia:** also known as **glial cells**, Non-neuronal part of **not involved in conduction** but play an important role in nutrition of neuron and protection by myelin sheath. They constitute about half of nervous system.

Glial Cells

In CNS	In PNS
Oligodendrocytes: Produce myelin sheath in CNS and provide insulation to speed up electrical transmission.	**Schwann Cells:** Produce myelin sheath in PNS and provide insulation to speed up electrical transmission.
Astrocytes: Provide structural support for neurons.	**Satellite Cells:** Provide structural support and regulate the microenvironment of neurons.

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- The reflex arc is the neural pathway that mediates a reflex. It consists of **five main components:**

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Components	Role
1. Receptor	Detects the stimulus (e.g., pain receptor in skin).
2. Sensory Neuron	Transmits the sensory signal from the receptor to the CNS.
3. Integration Center	Processes the signal in the CNS (spinal cord or brain); may involve one or more interneurons.
4. Motor Neuron	Transmits the response signal from the CNS to the effector.
5. Effector	Executes the response (e.g., muscle contraction or gland secretion).

Types of Reflex Arc

Feature	Monosynaptic Reflex Arc	Polysynaptic Reflex Arc
Number of Neurons	Two (1 sensory + 1 motor neuron).	Three or more (sensory, motor, and interneurons).
Synapses	Single synapse.	Multiple synapses.
Response Speed	Faster (less processing).	Slower (more processing).
Example	Stretch reflex (e.g., knee-jerk reflex)	Withdrawal / Protective Reflexes

Classification of Reflexes

Type	Working	Example
Innate Reflexes	Reflexes that are present from birth and are genetically programmed.	Sucking reflex in infants
Acquired Reflexes	Reflexes that are learned through experience and repetition.	Salivary reflex to the sound of a bell (conditioning, as in Pavlov's experiment)
Somatic Reflexes	Involve skeletal muscles as effectors. These reflexes control voluntary body movements.	Stretch reflex (knee-jerk)
Autonomic Reflexes	Involve smooth muscles, cardiac muscles, or glands as effectors. These reflexes regulate involuntary functions.	Pupillary light reflex (pupil constriction in bright light)
Protective Reflexes	Reflexes designed to protect the body from harm.	Withdrawal reflex
Regulatory Reflexes	Reflexes that help maintain homeostasis.	Baroreceptor reflex (blood pressure regulation)
Spinal Reflexes	Reflexes integrated and processed in the spinal cord.	Withdrawal reflex
Cranial Reflexes	Reflexes integrated and processed in the brain.	Pupillary light reflex

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NERVE IMPULSE

- Wave of **electrochemical changes** which travel along the length of neurons.
- Electrochemical refers to **electrical potential** (Capacity to do electrical work).
- **Membrane potential** is the electrical work that exists across neuron cell membrane.

Types of Membrane Potential

Feature	Resting Membrane Potential	Action Membrane Potential
Definition	The stable electrical potential of a neuron when not transmitting signals.	The rapid, temporary change in membrane potential during a nerve impulse.
State	Polarized State	Depolarized State
Polarity	The inside of the neuron is **negatively charged** compared to the outside.	The inside becomes briefly **positively charged.**
Value	Typically, around **-70 mV (-0.07 volts)**	Peaks at around **+50 mV (+0.05 volts)**
Ion Distribution	K^+ is **30X greater** inside & Na^+ is **10X greater** outside. Maintained by the sodium-potassium pump (**two K^+ pumped** inward & **Three Na^+ pumped out**). Cell membrane is permeable to K^+ so some of K^+ leak out. Presence of **Negatively charged organic compounds** (Amino acids, Proteins, RNA)	Involves rapid influx of Na^+ due to opening of **sodium gates (Passive transport).**
State of Neuron	No conduction of nerve impulse	The neuron is actively transmitting an electrical signal.
Energy Use	Sodium-potassium pump continuously uses ATP to maintain ion gradients.	Minimal ATP use; relies on ion channel activity.
Duration	Persistent until a stimulus is applied.	Short-lived; **lasts a few milliseconds (2-3)**

Ion Channels Involved

Type	Role
Voltage-Gated Na^+ Channels	Open during depolarization to allow Na^+ into the cell.
Voltage-Gated K^+ Channels	Open during repolarization to allow K^+ out of the cell.
Sodium-Potassium Pump	Maintains resting potential by pumping Na^+ out and K^+ in against their gradient

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Stages of Nerve Impulse Transmission

Stage	Role
1. Resting Potential	➢ At rest, the inside of the neuron is negatively charged (-70 mV). ➢ Sodium-potassium pump actively maintains ion gradients: 3 Na^+ out, 2 K^+ in. ➢ Membrane is polarized (more negative inside).
2. Stimulus Arrival	➢ A stimulus causes a small depolarization, bringing the membrane potential closer to threshold.
3. Depolarization	➢ If the threshold is reached (-55 mV), voltage-gated Na^+ channels open. ➢ Na^+ ions rush into the cell, causing the membrane potential to become positive (+50 mV).
4. Repolarization	➢ Voltage-gated K^+ channels open, and K^+ ions flow out of the cell. ➢ The membrane potential returns to negative values.
5. Hyperpolarization	➢ K^+ channels close slowly (so lousy), causing the membrane potential to dip below the resting potential. ➢ The sodium-potassium pump restores resting potential.
6. Refractory Period	➢ During this time, the neuron cannot fire another action potential.

Velocities of Nerve Impulse

Feature	Continuous Conduction	Saltatory Conduction
Axon Type	Unmyelinated	Myelinated
Speed	Slower (1-3 m/sec.)	Faster (120 m/sec.)
Energy Efficiency	Less efficient (requires more ATP)	More efficient (less ATP used)
Mechanism	Impulse travels along the entire axon.	Impulse jumps between Nodes of Ranvier.

SYNAPSE

- A synapse is the junction between two neurons or between a neuron and an effector cell (muscle or gland), where information is transmitted through electrical or chemical signals.

Structure of Synapse

Structure	Role
Presynaptic Neuron	The neuron that sends the signal which contains synaptic vesicles filled with neurotransmitters.
Postsynaptic Neuron/Cell	The neuron or cell that receives the signal which contains receptors for neurotransmitters on its membrane.
Synaptic Cleft	The small gap between the presynaptic and postsynaptic membranes, so neurons are not in direct contact at a synapse.

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Types of Synapses

Feature	Electrical Synapse	Chemical synapse
Transmission Speed	Very fast; nearly instantaneous signal transmission.	Slower due to multiple steps (neurotransmitter release, diffusion, and binding).
Directionality	Bidirectional (signal can travel both ways). Both Membranes are physically connected by channel proteins (Connexin).	Unidirectional (signal moves from presynaptic to postsynaptic neuron).
Synaptic Cleft	0.2 nm	20 nm
Signal Type	Always electrical.	Electrical → Chemical → Electrical.
Synaptic Delay	No synaptic delay, signal transmission is instantaneous.	Significant delay (0.3–5 milliseconds) due to neurotransmitter release and receptor activation.
Occurrence	Found in specific systems, such as cardiac and smooth muscles, and in some invertebrates.	Found widely in the central nervous system (CNS) and peripheral nervous system (PNS).

Mechanism of Synaptic Transmission (Chemical)

Steps in Sequence	Action
1- Action Potential Arrival	The nerve impulse reaches the axon terminal of the presynaptic neuron.
2- Calcium Influx	Voltage-gated Ca^{2+} channels open, allowing Ca^{2+} ions to enter the presynaptic terminal.
3- Neurotransmitter Release	Synaptic vesicles fuse with the presynaptic membrane and release neurotransmitters into the synaptic cleft (exocytosis).
4- Neurotransmitter Binding	Neurotransmitters bind to specific receptors on the postsynaptic membrane.
5- Response in Postsynaptic Cell	Binding opens ion channels, leading to either depolarization called **Excitatory Post-Synaptic Potential (EPSP)** or hyperpolarization called **Inhibitory Post-Synaptic Potential (IPSP)**.
6- Termination of Signal	Neurotransmitters are removed from the synaptic cleft by: - **Enzymatic degradation** (e.g., **acetylcholinesterase** breaks down acetylcholine). - **Reuptake** into the presynaptic neuron. - **Diffusion** away from the synaptic cleft.

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Classification of Neurotransmitters

Feature	Excitatory Neurotransmitters	Inhibitory Neurotransmitters
Definition	Neurotransmitters that trigger nerve impulse by increasing the permeability of Na^+.	Neurotransmitters that decrease the likelihood of the postsynaptic neuron by decreasing membrane permeability to Na^+.
Effect on Membrane Potential	Cause **depolarization** by making the inside of the postsynaptic membrane less negative.	Cause **hyperpolarization** by making the inside of the postsynaptic membrane more negative.
Action	Moves the membrane potential closer to the threshold, making an action potential more likely.	Moves the membrane potential farther from the threshold, making an action potential less likely.
Examples	**Glutamate**: Major excitatory neurotransmitter in the CNS. **Acetylcholine**: Major excitatory at neuromuscular junctions (PNS). **Biogenic amines:** Dopamine, Epinephrine, Nor-epinephrine and serotonin are important **neurotransmitters in CNS and also serve as hormones.**	**GABA (Gamma-Aminobutyric Acid)**: Major inhibitory neurotransmitter in the CNS. **Glycine**: Inhibitory in the spinal cord. **Endorphin**: are peptides that function as both neurotransmitters and decrease the perception of pain **(Pain killer).**

- **Epinephrine and Nor-epinephrine** increase the heartbeat during stress while serotonin and dopamine affect sleep
- **Serotonin and Dopamine** affect sleep, mood, attention and learning.

HUMAN NERVOUS SYSTEM

- Consists of Central nervous system **(CNS)** and Peripheral nervous system **(PNS).**

Differences Between CNS and PNS

Feature	Central nervous system (CNS)	Peripheral nervous system (PNS)
Components	Brain and Spinal cord	Cranial nerves, Spinal nerves, and Ganglia
Location	Enclosed within the skull and vertebral column	Located outside the skull and vertebral column
Function	Processes, integrates, and interprets information	Transmits signals between CNS and the rest of the body
Protection	Protected by skull, vertebrae, meninges, and cerebrospinal fluid (CSF). **Three layers of meninges:** **Dura matter:** Next to cranium **Arachnoid matter:** Middle membrane **Pia matter:** Next to nervous tissues. **CSF** is present between arachnid and pia matter, in ventricles of brain and central canal of spinal cord.	No bony protection; some protection by connective tissue coverings (sheaths)

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BRAIN

- Bain is hollow structure as it has cavities called ventricles. There are four ventricles.
- 1st and 2nd are called lateral ventricles and found between limbic system and cerebrum.
- 3rd ventricle is found between limbic system and thalamus.
- 4th ventricle is present in brain stem (Includes the midbrain, pons, and medulla oblongata).

Structural Parts of Brain

Region	Key Structures	Functions
Forebrain (Prosencephalon) - Largest part - Divided into two regions. 1. Telencephalon 2. Diencephalon	Cerebrum ➢ Largest part of brain, divide into two hemispheres ➢ Corpus Callosum is the band of axons that communicates two hemispheres of brain. ➢ Each hemisphere has four lobes (Frontal, Parietal, Temporal, Occipital). ➢ Each lobe further contains different functional areas. ➢ Each functional areas consists of 3 subareas. 1. Sensory Areas: Process sensory information (e.g., visual, auditory, tactile). 2. Motor Areas: Control voluntary muscle movements. 3. Association Areas: Integration and higher-level functions like learning and memory.	➢ Decision-making, problem-solving, and reasoning. ➢ Voluntary motor control (via the motor cortex). ➢ Speech production (Broca's area in the left hemisphere). ➢ Sight, smell, tastes and hearing. ➢ Conscious sensation and voluntary movements. ➢ Processing sensory information (touch, pressure, pain, and temperature). ➢ Memory and dreams
	Thalamus ➢ Situated below the cerebrum	➢ Receive all sensory impulses (except sense of smell) and channel them to limbic system and to appropriate region of cortex for interpretation.
	Limbic System ➢ Complex set of structures that lie on both sides of thalamus. ➢ Divided into three further parts	
	1- Hypothalamus ➢ Located on the ventral side of thalamus	➢ Controls homeostasis, hunger, thirst, temperature, menstrual cycle, sleep-wake cycle, sexual response, fight and flight response, rhythms & endocrine functions.
	2- Amygdala ➢ Two almond shaped masses of neurons on either side of thalamus.	➢ Control feeling and emotions of pleasure, punishment, love, hate, anger, fear, rage and sexual arousal.
	3- Hippocampus ➢ Two horns shaped like masses that are back from amygdala.	➢ Formation of long-term memory and thus required for learning.

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Midbrain (Mesencephalon)	➢ **Reduced in humans** ➢ Contain **reticular formation** which is network of neurons running through medulla in the hindbrain, through the midbrain and up into the thalamus of the forebrain.	➢ Relay auditory and visual information. ➢ Controls **reflex movements of the head, neck, and eyes.** ➢ Filter sensory information and send it to higher brain center.
Hindbrain (Rhombencephalon)	**Pons** ➢ Small and lies above the medulla oblongata.	➢ Acts as a communication bridge between the cerebellum and cerebrum and medulla. ➢ Control the rate and pattern of breathing. transitions between sleep and wakefulness.
	Cerebellum ➢ **Second largest part** of brain. ➢ It consists of central lobe and two lateral lobes. ➢ Best developed in birds.	➢ Maintain Balance and posture ➢ Coordinate **muscles activities.** ➢ Coordinate complex activities such as walking, running, riding bicycles, doing delicate work with the hands. ➢ **Learning & memory storage** in **behaviors.**
	Medulla Oblongata ➢ Part of brain coordinates with the spinal cord through **foramen magnum.**	➢ Controls vital functions like heart rate, respiration, salivary secretions, swallowing, vomiting, coughing, sneezing and blood pressure **(Involuntary Actions).**

SPINAL CORD

- Part of CNS, critical **communication link** between brain and the rest of the body.
- **Foramen Magnum** a hole in the bottom of skull from where spinal cord continues with medulla to the level of **1st and 2nd lumber vertebrae.**
- Transmits sensory signals from the body to the brain **(ascending tracts).**
- Transmits motor commands from the brain to muscles and glands **(descending tracts).**
- Acts as the **center for reflex arcs,** enabling quick, automatic responses to stimuli **(e.g., withdrawal reflex).**
- Protected by vertebrae, meninges, and **cerebrospinal fluid (CSF).**

Structure of Spinal Cord

Feature	White matter	Grey matter
Location	Outer region of the spinal cord	Inner region of the spinal cord (H-shaped structure/ **Butterfly Shape**)
Composition	Made up of myelinated axons (nerve fibers). **Anterior median sulcus:** A deep, wide groove extending along the midline at anterior (ventral) surface. **Posterior median sulcus:** A shallow, narrow groove extending along the midline at posterior (dorsal) surface.	Composed of cell bodies, dendrites, unmyelinated axons, and interneurons. **Dorsal Horns:** Posterior (back) section of the grey matter in the spinal cord which receives sensory input from the body through sensory neurons. **Ventral Horns:** Anterior (front) section of the grey matter in the spinal cord Contains motor neurons that send signals to skeletal muscles.
Color	Appears white due to the presence of myelin	Appears grey due to the lack of myelin
Functions	➢ Conducts nerve impulses ➢ Ascending tracts: Carry sensory signals to the brain ➢ Descending tracts: Carry motor signals from the brain to the body	➢ Acts as a reflex center ➢ Coordinates incoming sensory and outgoing motor signals

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Segments of Spinal cord

- Spinal cord is divided into four different regions: the cervical, thoracic, lumber and sacral region.
- Two enlargements of the spinal cord can be visualized.
- **Cervical enlargement:** extends between **C3 to T1.**
- **Lumber enlargement:** extends between **L1 to S2.**
- There are **31 segments** of spinal cord associated with **31 pairs of Spinal nerves.**
- The nerves are divided into **8 cervical, 12 thoracic, 5 lumber, 5 sacral and 1 coccygeal nerve.**

PERIPHERAL NERVOUS SYSTEM (PNS)

- It connects the Central Nervous System (CNS) to the rest of the body.
- Comprises **sensory and motor neurons** that are distributed through the body in the form of ganglia and nerves.
- **Ganglia:** Collection of neuronal cell bodies.
- **Plexus:** Network of interconnected ganglia.
- **Nerves:** Bundles of axon fibers (dendrites or axons) covered by connective tissues.

Classification of Nerves

Feature	Cranial Nerves	Spinal Nerves
Origin	Arise from the brain or brainstem.	Arise from the spinal cord.
Number	12 pairs	31 pairs
Type of Fibers	Can be **sensory** (I, II, VIII), **motor** (III, IV, VI, XI, XII), or **mixed** (V, VII, IX, X).	All are mixed nerves (carry both sensory and motor fibers).
Location	Found in the head and neck region (except the vagus nerve).	Found throughout the body, distributed to the limbs and trunk

Divisions of the PNS

Feature	Somatic Nervous System (SNS)	Autonomic Nervous System (ANS)
Control	Under conscious control (Voluntary).	Operates subconsciously (involuntary).
Target Tissues	Skeletal muscles.	Smooth muscles, cardiac muscles, and glands.
Function	Controls voluntary movements of skeletal muscles.	Regulates involuntary functions like heart rate, digestion, and respiration.
Pathway	Single neuron from CNS to target muscle.	Two-neuron pathway (preganglionic and postganglionic neurons).
Subdivisions	None	Sympathetic and parasympathetic divisions.

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Divisions of the Autonomic Nervous System		
Feature	**Sympathetic**	**Parasympathetic**
Primary Function	Prepares the body for "fight or flight" response during stress.	Promotes "rest and digest" functions for relaxation and recovery.
Origin of nerves	Middle portion of spinal cord/ thoracic region.	Bottom portion of spinal cord + cranial nerves (vagus nerve) / Lumber region.
Position of ganglia	Near spinal cord	Near effector
Length of preganglionic fibers.	Short	Long
Length of postganglionic fibers.	Long	Short
Neurotransmitters	Norepinephrine (NE) and epinephrine (adrenaline) are primary.	Acetylcholine (ACh) is the primary neurotransmitter.
Effect on Blood Vessels	Constricts blood vessels in non-essential areas; dilates vessels to muscles.	Promotes blood flow to digestive organs.
Effect on Heart Rate	Increase heart rate.	Decreases heart rate.
Effect on Pupils	Dilates pupils (to enhance vision).	Constricts pupils.
Effect on Digestion	Inhibits digestion (reduces salivation and gastrointestinal activity i.e. peristalsis). Inhibit secretion of pancreatic juice and bile.	Stimulates digestion (increases salivation and gastrointestinal activity). Stimulate secretion of pancreatic juice and bile.
Effect on Lungs	Relaxes bronchial muscles (dilates airways for more oxygen).	Constricts bronchial muscles (reduces airflow to normal levels).
Effect on Urination	Inhibits urination (relaxes bladder).	Stimulates urination (contracts bladder).
Effect on Genitalia	Promote ejaculation and vaginal contraction	Promote erection of genitalia

NERVOUS DISORDERS

Parkinson's disease

- A degenerative disorder of the central nervous system caused by the **loss of dopamine-producing neurons.**
- Characterized by involuntary tremors, diminished motor power and rigidity.
- Onset in late ages **(50s and 60s) and progressive.**
- Due to cell death in brain area that produce dopamine.
- **L-Dopa** and use of GDNF are effective treatments.

Epilepsy

- A **chronic condition** characterized by recurrent **seizures** due to abnormal electrical activity in the **brain.**
- Symptoms are Seizures, loss of consciousness, confusion, and convulsions.
- If **onset** before 30s it is called epilepsy and after 30s it is then called **organic disease.**
- **EEG** (Electroencephalography) is the test for diagnosis.

Alzheimer's disease

- A **progressive neurodegenerative** disorder causing memory loss and cognitive decline.
- Late age disease and **progressive.**
- Caused by high level of **aluminum** and there is genetic predisposition (inherited risk).

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Meningitis

- Inflammation of the **meninges**, caused by bacterial, viral, or fungal infections.
- Symptoms are severe headache, fever, stiff neck, and sensitivity to light.
- Bacterial meningitis must be treated with intravenous antibiotics.

Encephalitis

- Inflammation of the brain, usually caused by viral infections.
- Symptoms are fever, headache, seizures, and confusion.

CHEMICAL COORDINATION

- Chemical coordination is achieved by Hormones (Greek word "to excite" or "to set in motion")
- Hormones regulate the enzymatic reaction hence called **Regulators.**
- They may either **stimulate or inhibit** the reaction.
- They **cannot initiate** new biochemical reaction (similar to enzymes).
- Hormones may also control some long-term changes such as **rate of growth, rate of metabolic activities** and **sexual maturity.**
- About **20 ductless glands** lying in different parts of the body.
- **Pheromones** are chemicals capable of acting like hormones outside the body of the secreting individual, to affect the behavior of the receiving individuals

Most Important Hormones

Hormone	Chemical Nature	Gland of origin	Primary Role
Insulin	Protein	Pancreas (Beta cells)	Lower blood glucose levels.
Glucagon	Protein	Pancreas (Alpha cells)	Raises blood glucose levels
Somatotrophic Growth Hormone (GH)	Protein	Pituitary (anterior)	Stimulates growth and regeneration.
Prolactin (PRL)	Protein	Pituitary (anterior)	Stimulates milk production in females.
Parathyroid Hormone (PTH)	Protein	Parathyroid gland	Increase calcium and phosphate levels.
Erythropoietin (EPO)	Protein	Kidneys	Stimulates red blood cell production.
Oxytocin	Polypeptide	Hypothalamus (Posterior Pituitary)	Induces labor contractions and bonding and milk ejection.
Antidiuretic Hormone (ADH)	Polypeptide	Hypothalamus (Posterior Pituitary)	Maintains water balance in the kidneys.
Melanocyte-stimulating hormone (MSH)	Polypeptide	Pituitary (median)	Skin pigmentation, Anti-inflammatory effects
Calcitonin	Polypeptide	Thyroid	Reduces blood calcium levels.
Thyroxine (T4)	Amino Acid Derivative	Thyroid	Regulates metabolism and energy levels.
Triiodothyronine (T3)	Amino Acid Derivative	Thyroid	Controls growth, development, and metabolism.
Adrenaline (Catecholamine)	Amino Acid Derivative	Adrenal Medulla	Triggers "fight or flight" response
Noradrenaline (Catecholamine)	Amino Acid Derivative	Adrenal Medulla	Enhances adrenaline effects on the body.

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Melatonin	Amino Acid Derivative	Pineal Gland (Epiphyses Cerebri) found in brain	Regulates sleep-wake cycles (circadian rhythm).
Testosterone	Steroid	Testes	Develops male secondary sexual traits.
Estrogen / Estradiol	Steroid	Ovaries	Develops female secondary sexual traits.
Progesterone	Steroid	Ovaries	Supports pregnancy and menstrual cycle.
Cortisol	Steroid	Adrenal Cortex	Manages stress, metabolism, and inflammation.
Aldosterone	Steroid	Adrenal Cortex	Maintains blood pressure and salt balance.
Follicle-Stimulating Hormone (FSH)	Glycoprotein	Pituitary (anterior)	Promotes development of eggs in ovaries and sperm in testes.
Luteinizing Hormone (LH)	Glycoprotein	Pituitary (anterior)	Triggers ovulation and testosterone production.
Secretin	Polypeptide	Small intestine	Stimulates pancreatic bicarbonate secretion.
Cholecystokinin (CCK)	Polypeptide	Small intestine	Stimulates digestion of fats and proteins.
Gastrin	Polypeptide	Stomach	Gastric juice Production
Human Chorionic Gonadotropin (HCG)	Glycoprotein	Placenta	Maintains pregnancy by supporting corpus luteum.
Leptin	Protein	Adipose (fat) tissue	Regulates energy balance by inhibiting hunger.
Renin angiotensin-aldosterone system (RAAS)	Protein	Kidney	Helps regulate blood pressure and maintain sodium and potassium level.
Prostaglandin (Local Hormone)	Lipids	Kidney	Inflammation, pain and uterine contractions.
Thymosin	Polypeptide	Thymus	Role in the immune system and other physiological processes.
Atrial natriuretic peptide (ANP)	Polypeptide	Heart	Regulates blood pressure, fluid volume, and electrolyte balance.
Brain natriuretic peptide (BNP)	Polypeptide	Heart	Help to regulate blood circulation throughout your body
C-type natriuretic peptide (CNP)	Polypeptide	Heart	Acts as Vasodilator, Relaxing Blood Vessels and role in Bone Growth and Development.
Inhibin	Protein	Testes / Ovary	Inhibits the synthesis and release of the follicle-stimulating.

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Endocrine functions of Hypothalamus

Hypothalamic Hormones	Target in anterior Pituitary	Effect
TRH (Thyrotropin-releasing hormone/Factor)	TSH (Thyroid-stimulating hormone)	Stimulates thyroid hormone release.
CRH (Corticotropin-releasing hormone/Factor)	ACTH (Adrenocorticotropic hormone)	Stimulates adrenal cortex (cortisol).
GnRH (Gonadotropin-releasing hormone/Factor)	FSH and LH	Regulates gonads (ovaries/testes).
GHRH (Growth hormone-releasing hormone)	GH (Growth hormone)	Promotes growth and metabolism.
Somatostatin (GHIH)	GH and TSH	Inhibits growth and thyroid hormones.
Prolactin-inhibiting hormone	Prolactin	Inhibits milk production.

PITUITARY GLAND (Hypophysis Cerebri)

- Connected to the hypothalamus by **infundibulum.**
- Ovoid structure and **0.5 gm** weigh in adults.
- There are three lobes: Anterior (**Adenohypophysis**), Median (**Pars intermedia**) and Posterior lobe (**Neurohypophysis**).
- **Master gland:** Anterior lobe producing **tropic hormones** so referred as master lobe.

Hormones of Anterior Pituitary

Hormones	Target	Major actions	Regulation
Growth Hormone (GH) Somatotrophin Hormone	Bones, muscles, liver	Stimulates growth, cell reproduction, and repair; increases protein synthesis and fat breakdown.	Regulated by SRF and Somatostatin from the hypothalamus.
Thyroid-Stimulating Hormone (TSH)	Thyroid gland	Stimulates thyroid gland to release thyroxine (T4) and triiodothyronine (T3).	Regulated by Thyrotropin-Releasing Hormone (TRH) from the hypothalamus.
Adrenocorticotropic Hormone (ACTH)	Adrenal cortex	Stimulates the adrenal glands to secrete cortisol and other glucocorticoids.	Controlled by Corticotropin-Releasing Hormone (CRH) from the hypothalamus.
Follicle-Stimulating Hormone (FSH)	Gonads (ovaries/testes)	Stimulates follicle development and estrogen secretion in ovaries. Stimulates spermatogenesis in testes.	Regulated by Gonadotropin-Releasing Hormone (GnRH) from the hypothalamus.
Luteinizing Hormone (LH)	Gonads (ovaries/testes)	Triggers ovulation and progesterone secretion in ovaries. Stimulates testosterone production in testes.	Controlled by Gonadotropin-Releasing Hormone (GnRH) from the hypothalamus.
Prolactin (PRL)	Mammary glands	Promotes milk production after childbirth.	Controlled by Prolactin-Inhibiting Hormone (PIH, dopamine).

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Mode of Action of Hormones

Hormone Type	Examples	Mode of Action	Receptors	Mechanism
Protein / Peptide Hormones	Insulin, Glucagon, ADH, FSH	Cannot cross the lipid bilayer; bind to receptors on the cell membrane. They are **water Soluble.**	Cell-surface receptors	**Fixed Receptors mechanism.** Activate secondary messengers (cAMP).
Steroid Hormones	Cortisol, Aldosterone, Estradiol	**Lipid-soluble,** diffuse through the cell membrane and bind to intracellular receptors.	Intracellular receptors	**Mobile Receptors mechanism.** Hormone-receptor complex binds directly to DNA. Regulates transcription of specific genes.
Amino Acid Derivatives	Epinephrine, Thyroxine (T4), Melatonin	**Mode varies:** **Lipophilic (e.g., Thyroxine)** acts intracellularly. Hydrophilic (e.g., Epinephrine) acts extracellularly.	Cell-surface or intracellular	Epinephrine: Activates G-protein coupled receptors (GPCR) and cAMP. Thyroxine: Alters gene transcription.
Glycoproteins	TSH, FSH, LH, hCG	Bind to cell-surface receptors; regulate target organ functions.	Cell-surface receptors	Stimulate secondary messengers (cAMP) to trigger specific physiological effects.

Types of Hormonal Action

Type	Definition	Action range	Example
Endocrine	Hormones released into the bloodstream.	Distant target organs.	Insulin, Thyroxine, Adrenaline.
Exocrine	Secretions through ducts to body surfaces or cavities.	Local effects.	Sweat, Saliva, Digestive enzymes.
Autocrine	Substances act on the same cell.	Self-targeted.	T-cell interleukins, Cancer growth factors.
Paracrine	Substances act on neighboring cells.	Short distance.	Neurotransmitters, Prostaglandins.

• ROLE OF HYPOTHALAMUS

- A link between the nervous system and the endocrine system.
- Part of forebrain and **master control center** of endocrine system.
- It contains special types of **neurosecretory cells** and directly control the pituitary gland.
- The hormones produced by hypothalamus are either **releasing factors** or **inhibiting factors.**
- The hypothalamus produces two hormones **(Oxytocin and ADH)** stored and released by the **posterior pituitary**
- **Hypothalamus → Releasing Hormone → Pituitary → Target Organ → Hormonal Response Example:** TRF → TSH → Thyroid Gland → Thyroxine (T4).

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Hormone of Median Pituitary			
Melanophore Stimulating Hormone (MSH)	Skin (melanocytes)	Stimulates melanin production in melanocytes, affecting skin and hair pigmentation.	External light governs the production while inhibited by hypothalamus through MIH.
Hormones of Posterior Pituitary			
Posterior Pituitary is not glandular by itself, but it is largely made up of axons of neurosecretory cells of **hypothalamus** which secrete **ADH and Oxytocin.**			
Antidiuretic Hormone (ADH) / Vasopressin	Kidneys (collecting ducts)	Promotes water reabsorption in kidneys, reducing urine volume. Helps maintain blood pressure and hydration levels.	Low blood pressure, decreased blood volume and dehydration **(Hyperosmotic Conditions).**
Oxytocin	Uterus, mammary glands	Stimulates uterine contractions during labor. Triggers milk ejection (let-down reflex) during breastfeeding.	Regulated by a **positive feedback mechanism** during childbirth and breastfeeding.

THYROID GLAND

- Located below the larynx (voice box).
- Composed of two lobes which are located on either side of trachea.

Hormones

- Thyroxin (Tetra-iodothyronine/T_4)
- Tri-iodothyronine (T_3)
- Calcitonin

Control

- T3 and T4: Negative physiological control by anterior pituitary via TSH.
- Calcitonin: Circulating calcium level in blood.

Functions of T3 and T4

- Iodine containing hormones and act synergistically in the same way.
- Increase basal metabolic rate **(BMR)** and heat production **(non-shivering thermogenesis)**
- Stimulate the breakdown of glucose, release energy (ATP).
- Enhance synthesis of cholesterol in the liver.
- Act in **conjunction with somatotrophin** in bringing growth.
- Promote development of nervous system in fetus and infants.
- Act of muscles for their development and functioning.
- Promote growth and maturation of skeleton.
- Promote normal motility of GIT.

Calcitonin

- Acts on **small intestine, kidney tubules and bone cells.**
- High level of calcium stimulates its secretion.

Functions of Calcitonin

- Control/ Decrease calcium level in blood by variety of ways.
- Inhibiting **calcium (Ca^{2+}) absorption** by intestine.
- Decrease reabsorption of Ca^{2+} from the kidney tubules allowing its secretion in urine.
- **Inhibits osteoclasts activity**, reducing calcium release; indirectly promotes bone formation.
- **Over secretion** leads to nervous and muscular disorders **(Tetany).**
- **Under secretion** disturbs the function of muscle and nervous system and may lead to **kidney stones.**

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Disorders of the Thyroid Gland

Disorder	Cause	Symptoms
Hyperthyroidism	Excess T3/T4 (e.g., in Graves' disease)	Increased BMR leads to cardiac failure if prolonged, heat intolerance, production of abnormal body protein, **bulging eyes (exophthalmic goiter).**
Hypothyroidism	Deficient T3/T4 (e.g., iodine deficiency)	**Myxedema** is full blown hypothyroid syndrome, which is characterized by low metabolic rate, felling chilled (cold intolerance), thick and dry skin with hair lost from scalp and eyebrows, edema, tongue swelling.
Cretinism	Congenital hypothyroidism (in infants)	Mental and growth retardation, disproportionate body size, delayed puberty and infertility are common.
Goiter	Iodine deficiency	Enlargement of the thyroid (Visible neck swelling).

PARATHYROID GLAND

- In humans, there are **four parathyroid glands.**
- Small, pea-shaped glands located on the posterior surface of the thyroid gland in the neck.
- Parathyroid glands secrete **Parathyroid Hormone (PTH)**, which is essential for calcium and phosphate homeostasis.

Parathyroid Hormone (PTH)

- PTH secretion is regulated by the blood calcium levels
- Targeted cells are small intestine, kidney tubules and Bone cells.
- **Low calcium levels** stimulate PTH release.
- **High calcium levels** inhibit PTH release (negative feedback mechanism).

Functions of Parathyroid Hormone (PTH)

- Work antagonistic to calcitonin.
- Increases calcium absorption in the **intestines (via activation of Vitamin D).**
- Stimulates calcium release from **bones** into the bloodstream (bone resorption).
- Promotes calcium reabsorption in the **kidneys**, reducing calcium excretion in urine.
- Decreases phosphate reabsorption in the kidneys, increasing phosphate excretion.
- **Hyperparathyroidism:** Leads to high calcium levels **(hypercalcemia)**, bone weakening, kidney stones, and fatigue.
- **Hypoparathyroidism:** Causes low calcium levels **(hypocalcemia)**, increases excitability of neurons and tetany.

PANCREAS (Double Gland)

- It is composed of two types of tissues e.g. exocrine and endocrine.
- **Exocrine Pancreas:** Produces digestive enzymes (amylase, lipase, protease).
- **Endocrine Pancreas (Islets of Langerhans):** Produces hormones that regulate blood sugar.
- They are under the control of **pituitary trophic hormones**, STH and ACTH and respond directly to the level of blood glucose.

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Endocrine Functioning of Pancreas

Feature	Insulin	Glucagon
Secreted By	Larger No. of **β-cells** of the pancreas	Small No. of **α-cells** of the pancreas
Stimulus for Secretion	High blood glucose levels (after a meal)	Low blood glucose levels (fasting state)
Target Organs	Liver, muscles, fat cells	Liver
Primary Function	Lowers blood glucose levels	Raises blood glucose levels
Mechanism of Action	➢ Promotes glucose uptake by cells. **Stimulates glycogenesis** (glucose → glycogen). ➢ Promote conversion of glucose into lipid and protein. ➢ **Inhibit** the hydrolysis of glycogen **(Glycogenolysis).** ➢ **Inhibit Gluconeogenesis**	➢ **Stimulates glycogenolysis** (glycogen → glucose). ➢ Promotes **gluconeogenesis** (formation of glucose from non-carbohydrate sources). ➢ Increase rate of breakdown of fats.
Disorders	**Type 1 Diabetes Mellitus (IDDM):** Insulin deficiency due to autoimmune destruction of beta cells. **Type 2 Diabetes Mellitus (NIDDM):** Insulin resistance in body cells. **Hypoglycemia:** Excessive insulin causing very low blood sugar. **Ketoacidosis:** Insulin deficiency causing fat breakdown and ketone production. **Symptoms of Diabetes** ➢ Glucose in the urine **(glucosuria)** ➢ Disturbance of body osmotic equilibrium ➢ Degeneration of nervous system ➢ Increased hunger **(Polyphagia)** ➢ Excessive thirst **(Polydipsia)**	**Glucagonoma:** A rare tumor of alpha cells causing excessive glucagon, leading to hyperglycemia. **Hypoglycemia:** Can occur if glucagon levels are too low to counteract low blood sugar.

ADRENAL GLANDS (Supra-Renal Glands)

- A pair of renal glands is present on top of each kidney.
- Crucial for producing hormones that regulate metabolism, immune response, blood pressure, and the body's stress response.
- Inner portion is called **adrenal medulla** while outer portion is called **adrenal cortex.**

Adrenal Medulla

- Adrenal medulla produces the hormones **adrenaline/epinephrine** and **noradrenaline/norepinephrine** secreted in stress conditions.
- Both hormones are **catecholamines** and act through the **sympathetic nervous system.**
- Both works synergistically to prepare the body for the **fight-or-flight** response during stress.

Functions

- Enhance metabolic activities and dilation of bronchioles.
- Adrenaline dilates blood vessels in certain areas such as skeletal muscles & increases the heart output.
- Nor-adrenaline constricts the blood vessels **(Vasoconstriction)** in certain body parts such as gut and skin.
- By the action of both hormones, it results in **raising blood pressure.**

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- They also promote the release of glucose from the liver glycogen.
- **Overproduction** of catecholamines due to a tumor in the adrenal medulla, causing severe hypertension, rapid heartbeat, excessive sweating, and anxiety.
- **Under-secretion** cause failure to combat with emergency situations.

Adrenal Cortex

- Hormones of adrenal cortex are secreted under the influence of **ACTH** from **anterior pituitary.**

Hormone	Function
Cortisol (Glucocorticoid)	➢ Regulates metabolism by stimulating gluconeogenesis (glucose production from fats and proteins). Antagonistic to insulin. ➢ Helps the body respond to stress.
Aldosterone (Mineralocorticoid)	➢ Regulates sodium and potassium balance. ➢ Increases sodium reabsorption and potassium excretion in kidneys. ➢ Maintains blood pressure by increasing blood volume.
Corticosterone	➢ Act as both glucocorticoid and mineralocorticoid
Androgens	➢ A group of male sex hormones responsible for male traits. ➢ Development of male secondary sexual characteristics. ➢ Small amount also produced in female, excess androgen in females develop certain male characteristics. ➢ Testosterone is a specific androgen.

Abnormalities of Adrenal Cortex

Feature	Addison's Disease	Cushing's Disease
Cause	A condition caused by under secretion of corticosteroids hormones due to destruction of adrenal cortex.	A condition caused by excessive production of corticosteroids due to a pituitary tumor.
Symptoms	➢ General metabolic disturbance ➢ Weakness of muscle action and loss of salts ➢ Darkening of the skin (hyperpigmentation) ➢ Low blood pressure.	➢ Excessive protein breakdown ➢ Muscle and bone weakness ➢ High blood sugar disturbs metabolism ➢ high blood pressure and weight gain

GONADS

- Special types of endocrine gland which also produce gametes.
- Male gonads are **Testes** while female gonads are called **Ovaries.**

Male Gonads (Testes)

Hormone	Production site	Functions
Testosterone & 17-β hydroxy testosterone	Leydig cells (interstitial cells)	➢ Stimulates development of male reproductive organs (penis, prostate, seminal vesicles). ➢ Promotes spermatogenesis (sperm production). ➢ Develops secondary sexual characteristics (e.g., deep voice, facial/body hair, increased muscle and bone mass). ➢ Maintains libido.
Inhibin	Sertoli cells (in the seminiferous tubules)	➢ Inhibits secretion of Follicle Stimulating Hormone (FSH) from the anterior pituitary. ➢ Regulates spermatogenesis by feedback control.

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Female Gonads (Ovaries)

Hormone	Production site	Functions
Estrogen	Graafian follicle / Granulosa cells of ovarian follicles	➢ Stimulates the development of female reproductive organs (uterus, fallopian tubes, vagina). ➢ Regulates the menstrual cycle (promotes the proliferative phase). ➢ Initiate the formation of endometrium. ➢ Develops secondary sexual characteristics (e.g., breast development, widening of hips). ➢ Maintains bone density.
Progesterone	Corpus luteum (after ovulation) / Placenta	➢ Prepares the uterus for implantation of a fertilized egg. ➢ Complete the endometrium for reception of embryo. ➢ Supports the early stages of pregnancy. ➢ Regulates the menstrual cycle (secretory phase). ➢ Inhibits uterine contractions during pregnancy. ➢ Suppress the ovulation ➢ Major constituent of birth control pills.
Inhibin	Granulosa cells and corpus luteum	➢ Inhibits secretion of Follicle Stimulating Hormone (FSH) from the anterior pituitary. ➢ Regulates the growth of ovarian follicles.
Relaxin	Corpus luteum and placenta	➢ Relaxes the uterus and helps prepare the cervix for labor. ➢ During pregnancy, it helps to relax the pelvic ligaments.

HORMONAL FEEDBACK MECHANISM

- Type of interaction in which a controlling mechanism is itself controlled by products of reactions it is controlling.

Types of feedback Mechanism

Feature	Positive Feedback	Negative Feedback
Definition	Amplifies or enhances the original stimulus to achieve a specific outcome.	Reduces or inhibits the original stimulus to maintain homeostasis.
Purpose	It takes the system away from set point temporarily during specific conditions (e.g. childbirth)	Maintains stability and prevents excessive deviation from a set point.
Occurrence	Less common in the body.	More common in the body.
Effect on System	May destabilize the system temporarily (necessary for specific outcomes).	Stabilizes the system and maintains balance (homeostasis).
Examples in the Body	➢ Action of Oxytocin during childbirth and milk ejection. ➢ Blood Clotting (Coagulation).	➢ Regulation of blood glucose by insulin and glucagon. ➢ Maintenance of body temperature via sweat and shivering.

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Nervous Coordination

1. _____ comprises sensory neurons and motor neurons:
(A) CNS (B) Spinal cord
(C) PNS (D) None of them

2. How many nerve pairs arise from brain in humans?
(A) 12 pairs (B) 21 pairs
(C) 31 pairs (D) None of them

3. To dominate during times of "Rest and rumination" is the function of
(A) Sympathetic Division
(B) Parasympathetic Division
(C) Somatic Nervous System
(D) Both A and B

4. The effectors in the human body which respond to a stimulus are:
(A) Glands only
(B) Muscles only
(C) Both muscles and glands
(D) Bones

5. A mix nerve consists of:
(A) Motor and sensory nerve fibres
(B) Sensory and associative nerve fibres
(C) Motor and associative nerve fibres
(D) Dendron and dendrites

6. Schwann cell contains:
(A) Nucleus (B) Neurolemma
(C) Cytoplasm (D) All of these

7. Outer meninges of brain are called:
(A) Dura mater (B) Pia mater
(C) Arachnoid (D) Grey mater

8. The function of neuroglia cells are:
(A) Nutritive (B) Protection
(C) Excretory (D) Both A & B

9. Myelin sheath in central nervous system is formed from cells:
(A) Schwann cells
(B) Soma
(C) Neurolemma
(D) Dendrites and axons

10. Nervous system is provided protection by:
(A) Bones (B) Meninges
(C) CSF (D) All

11. White matter of CNS is made up of:
(A) Myelinated nerve fibre
(B) Non-myelinated fibre
(C) Cell bodies
(D) Neuroglia

12. When you look at an intact human brain, what you see the most is a large, highly convoluted outer surface. This is the:
(A) Cerebral cortex (B) Medulla
(C) Cerebellum (D) Reticular system

13. The parasympathetic nervous system has what effect on the heart's pacemaker?
(A) Excites it
(B) Inhibits it
(C) Has no effect at all
(D) Has a variable effect; sometimes excites it, sometimes inhibits it

14. A deer is frightened by a predator and runs away. Which of the following would not occur due to the action of epinephrine and norepinephrine:
(A) There would be increased blood flow to the skeletal muscles.
(B) There would be increased activity of the digestive system.
(C) There would be increased blood flow to the lungs and heart.
(D) Blood pressure would increase.

15. In man the osmotic centres are situated in:
(A) Cerebrum
(B) Hypothalamus
(C) Pituitary gland
(D) Medulla oblongata

16. Which of the following is not correctly matched?
(A) Cerebrum – Olfaction
(B) Hypothalamus – Pituitary
(C) Cerebellum – Balance
(D) Mid brain –Temperature regulation

17. The correct sequence of meninges of brain from outside to inside is:
(A) Dura mater, arachnoid, pia mater
(B) Arachnoid, dura mater, pia mater
(C) Pia mater, dura mater, arachnoid
(D) Dura mater, pia mater, arachnoid

18. Information from the sympathetic nervous system follows a different structural path than the parasympathetic nervous system. Which of the following accurately describes the flow of sympathetic nervous system information?
(A) A sympathetic nerve originates in the bottom of the spinal cord and has a long axon to the synapse of another neuron. From the second cell, there is a short axon that goes to the target

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neuron

(B) A sympathetic nerve originates in the middle of the spinal cord and has a short axon to the synapse of another neuron. From the second cell, there is a long axon that goes to target neuron

(C) A sympathetic nerve originates in the brain stem and has a short axon to the synapse of another neuron. From the second cell, there is a long axon that goes to the target neuron.

(D) A sympathetic nerve originates in the middle of the spinal cord and has a long axon to the synapse of a second neuron. From the second cell, there is a short axon that goes to the target neuron

19. **Which of the following statements correctly describes the activation of autonomic nervous system function within the circulatory system?**
(A) Sympathetic nervous system activation decreases cardiac output.
(B) Parasympathetic nervous system activation constricts arteries found within erectile tissue.
(C) Sympathetic nervous system activation constricts arteries found within the salivary glands.
(D) Parasympathetic nervous system activation increases heart rate.

20. **Brain is protected by:**
(A) Two layers of meninges
(B) Single layer of meninx
(C) Three layers of meninges
(D) Four layers of meninges

21. **A person entering an empty room suddenly finds a snake right in front on opening the door. Which one of the following is likely to happen in his neurohormonal control system?**
(A) Hypothalamus activates the parasympathetic division of brain.
(B) Sympathetic nervous system is activated releasing epinephrin and norepinephrine from adrenal cortex.
(C) Sympathetic nervous system is activated releasing epinephrin and norepinephrine from adrenal medulla.
(D) Neurotransmitters diffuse rapidly across the cleft and transmit a nerve impulse.

22. **How do parasympathetic neural signals affect the working of the heart?**
(A) Reduce both heart rate and cardiac output.
(B) Heart rate is increased without affecting the cardiac output.
(C) Both heart rate and cardiac output increase
(D) Heart rate decreases but cardiac output increases.

23. **A mixed nerve consists of:**
(A) Motor and sensory nerve fibres
(B) Sensory and associative nerve fibres
(C) Motor and associative nerve fibres
(D) Dendrons and dendrites

24. **Activities, like riding a bicycle, drawing sketches and playing sports require controlled and precise movements of body parts. Which part of the brain controls such precise body movements?**
(A) Medulla (B) Cerebellum
(C) Cranium (D) Cerebrum

25. **Which part of the brain performs these involuntary life-sustaining activities?**
(A) Medulla (B) Cerebellum
(C) Pons (D) Cerebrum

26. **Which part of your brain is currently performing the function of thinking as you answer this question?**
(A) Forebrain (B) Midbrain
(C) Hindbrain (D) Both A & C

27. **Which of the following are controlled by limbic system?**
1-Emotional reaction
2-Sexual behaviour
3-Respiration
4-Olfaction
5-Body balance
Choose the correct option:
(A) 1, 2, 3, 4, 5 (B) 1, 2, 4
(C) 1, 2, 3, 4 (D) 1, 2, 4, 5

28. **In emergency condition, all changes occur in our body except:**
(A) Heartbeat increases
(B) Dilates blood vessels of brain, lungs, heart and striated muscle
(C) Bronchodilation
(D) More gastric secretions

29. **The reflex action is the phenomena which only involves:**
(A) Brain, receptor, spinal cord
(B) Receptor, neuron, brain
(C) Receptor, effectors, spinal cord
(D) Receptors and effectors only

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30. Respiratory centre is located in:
(A) Cerebrum (B) Medulla
(C) Cerebellum (D) Hypothalamus

31. White matter of spinal cord is made up of
(A) Sensory nerve fibres
(B) Motor nerve fibres
(C) Myelinated nerve fibres
(D) Mixed nerve fibres

32. Reflexes of eyes is detected by which part of brain:
(A) Forebrain
(B) Midbrain
(C) Hindbrain
(D) Cerebral hemisphere

33. It seems to be the centre of most unconscious emotional behaviour such as love, hatred, hunger, sexual response, and fear:
(A) Thalamus (B) Cerebral cortex
(C) Limbic system (D) Mid brain

34. Which of following is largest part of brain?
(A) Medulla (B) Cerebellum
(C) Pons (D) Cerebrum

35. Which of following activity is not performed by sympathetic nervous system:
(A) Accelerate heartbeat (B) Dilate the pupil
(C) Promote digestion (D) Both A & C

36. Dorsal root ganglion contains:
(A) Axon of sensory neurons
(B) Cell bodies of motor neurons
(C) Cell body of sensory neurons
(D) Axon of motor neurons

37. Which of following true for parasympathetic system
(A) It includes few cranial nerves
(B) It includes vagus nerve
(C) Nerves arise from bottom portion of spinal cord
(D) All are correct

38. Lateral ventricles (1st and 2nd) of brain located between:
(A) Limbic system and cerebrum
(B) Cerebellum and cerebrum
(C) Limbic system and thalamus
(D) In brainstem

39. Which of the following structures or regions is incorrectly paired with its function:
(A) Medulla oblongata: controls respiration and cardiovascular reflexes.
(B) Limbic system: consists of fibre tracts that interconnect different regions of brain; controls movement.
(C) Hypothalamus: production of releasing hormones and regulation of temperature, hunger and thirst.
(D) Corpus callosum: band of fibers connecting left and right cerebral hemispheres

40. A hole in the bottom of skull from where spinal cord continuous with medulla:
(A) Corpus callosum (B) Brainstem
(C) Foramen magnum (D) Corpus luteum

41. In case of sympathetic division, the spinal nerves arise from:
(A) Last cervical to first thoracic segment
(B) First thoracic to second lumber segment
(C) Sacral portion
(D) Last thoracic to last lumber segment

42. The midbrain, pons and medulla oblongata are housed in the:
(A) Diencephalon (B) Hypothalamus
(C) Brain stem (D) Cerebellum

43. The term central nervous system refers to the:
(A) Autonomic and peripheral nervous systems
(B) Brain, spinal cord, and cranial nerves
(C) Brain and cranial nerves
(D) Brain and spinal cord

44. In humans and other primates, the hemispheres of the cerebrum are connected by a nerve tract called the:
(A) Pons (B) Nerve net
(C) Corpus callosum (D) Cerebral cortex

45. Which of the following is not part of the hindbrain?
(A) Pons
(B) Medulla oblongata
(C) Cerebrum
(D) Cerebellum

46. Which area of brain interprets or analyse the incoming information:
(A) Sensory area (B) Association area
(C) Motor area (D) Reticular system

47. Which of following brain layer (meninges) is present next to cranium?
(A) Dura matter
(B) Arachnoid matter
(C) Pia matter
(D) Gray matter

48. CSF in brain present between:
(A) Dura matter and pia matter

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(B) Arachnoid matter and pia matter
(C) Dura matter and arachnoid matter
(D) cranium and dura matter

49. _____ is a complex set of structures that lies on both sides of thalamus:
(A) Cerebrum (B) Limbic system
(C) Mid brain (D) Corpus callosum

50. What is the area of contact between the neuron and the muscle cell called?
(A) Dendrite (B) Axon
(C) Neuromuscular junction (D) Cell body

51. Which cranial nerves are sensory?
(A) 1, 2, 8 (B) 3, 4, 6, 11, 12
(C) 5, 7, 9, 10 (D) 10,11,2,1

52. Smallest cranial nerve is:
(A) X-cranial nerve (B) IV-cranial nerve
(C) VII-cranial nerve (D) II-cranial nerve

53. Purely motor cranial nerve includes:
(A) I, V, VII (B) I, II, IV
(C) III, IV, VI, XI (D) II, V, XI

54. Which has H-shaped grey matter?
(A) Cerebrum
(B) Spinal cord
(C) Cerebellum
(D) Medulla oblongata

55. Ventral root of spinal nerve has:
(A) Sensory fibres
(B) Motor fibres
(C) Sensory and motor fibres both
(D) Inter neurons fibres

56. All spinal nerves are:
(A) Motor (B) Sensory
(C) Mixed (D) Inter

57. Find out the correct sequence of a simple reflex are:
(A) Brain-spinal cord - nerves – effector
(B) Effector - CNS - sensory nerves – receptor
(C) Muscles - spinal cord - brain – receptor
(D) Receptor - sensory nerves - CNS – effector

58. Tactition, gustation, olfaction and pain reception are sensations detected by following receptors, respectively:
i. Mechanoreceptors
ii. Chemoreceptors
iii. Nociceptors
(A) i, ii, ii, iii (B) i, ii, iii, i
(C) i, i, ii, iii (D) i, iii, ii, i

59. Before Stimulus can be transmitted to brain it must always be:
(A) Transduced (B) Integrated
(C) Amplified (D) Modulated

60. Which of following found in subcutaneous tissues:
(A) Krause end bulb
(B) Meissner's corpuscles
(C) Pacinian corpuscles
(D) Merkel's disc

61. Pacinian corpuscles present in the skin detects?
(A) Pain (B) Movement
(C) Pressure contact (D) Temperature

62. In humans, Color reception is done by:
(A) Rods cell only
(B) Cones cells only
(C) Both rods and cone cells
(D) Choroid layer cells

63. The receptors of light touch present in the skin is called:
(A) Pacinian corpuscles
(B) Meissner's corpuscles
(C) Krause end bulb
(D) All

64. Free nerve ending present in the perceives the sensation of:
(A) Touch (B) Pain
(C) Pressure (D) All

65. The receptor may be a:
(A) Cell (B) Nerve ending
(C) An organ (D) All correct

66. Olfactory, gustatory and osmoreceptors are the types of:
(A) Thermoreceptors (B) Chemoreceptors
(C) Mechanoreceptors (D) Photoreceptors

67. Which of following receptors are also located in hypothalamus?
(A) Nociceptors (B) Thermoreceptors
(C) Chemoreceptors (D) Both B and C

68. Which receptors found in the carotid and aortic arteries of tetrapod's and have important role of regulation of blood pressure.
(A) Electromagnetic (B) Stretch
(C) Chemoreceptors (D) Nociceptors

69. The detection of vibration of the ground by terrestrial vertebrates is probably achieved by receptors found in:
(A) Blood vessels (B) Joints
(C) Bones (D) Lungs

70. The nervous system is derived from which embryonic layer:

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(A) Ectoderm
(B) Endoderm
(C) Mesoderm
(D) Ectoderm and Mesoderm

71. Which cell stop dividing after birth?
(A) Epithelium (B) Neuron
(C) Glial cells (D) Liver

72. Function of nervous tissue is:
(A) Irritability or Excitability
(B) Sensitivity
(C) Elasticity
(D) Contraction

73. Afferent nerve fibre conducts impulse from:
(A) C.N.S. to effector
(B) Receptor to C.N.S.
(C) Receptor to effector
(D) Effector to receptor

74. The parts of the neurons that perform basic cellular functions such as protein synthesis etc:
(A) Axons (B) Dendrites
(C) Synaptic knobs (D) Soma

75. What is the primary function of dendrites in a neuron?
(A) Transmit electrical impulses
(B) Generate action potentials
(C) Receive and relay incoming signals
(D) Produce neurotransmitters

76. The fatty substance that wraps around the axon to insulate and speed up nerve impulses is called:
(A) Neurotransmitter (B) Cell body
(C) Myelin sheath (D) Dendrite

77. Which one of the following types of neurons is most numerous in the body:
(A) Unipolar (B) Bipolar
(C) Multipolar (D) Pseudounipolar

78. Which cell organelle absent in neurons?
(A) Mitochondria (B) Ribosome
(C) Centriole (D) Nucleus

79. Non-Myelinated axons differ from myelinated in that they:
(A) Are more excitable
(B) Lack nodes of Ranvier
(C) Are not capable of regeneration
(D) Are not associated with Schwann cells

80. Myelin sheath is produced by:
(A) Astrocytes and Schwann cells
(B) Oligodendrocytes and Osteoclasts
(C) Osteoclasts and Astrocytes
(D) Schwann cells and Oligodendrocytes

81. Which part of the neuron contains the nucleus and most of the cell's organelles?
(A) Axon (B) Dendrite
(C) Soma (cell body) (D) Synapse

82. Neurons transmit information through:
(A) Electrical signals
(B) Chemical signals
(C) Both electrical and chemical signals
(D) Magnetic signals

83. Which type of neuron carries information from the sensory organs to the central nervous system?
(A) Motor neuron (B) Interneuron
(C) Sensory neuron (D) Relay neuron

84. The tiny gaps or spaces between segments of the myelin sheath on the axon are called:
(A) Nodes of Ranvier (B) Synapses
(C) Soma (D) Axon hillock

85. Which part of the neuron is responsible for releasing neurotransmitters to transmit signals to the next neuron?
(A) Dendrite (B) Axon
(C) Soma (D) Axon terminal

86. Which of following statement is incorrect for sensory neurons?
(A) They are also called afferent neuron
(B) They form the dorsal path in reflex arc
(C) They are called efferent neuron
(D) They have long dendron

87. Neurons responsible for processing and integrating information within the central nervous system are called:
(A) Motor neurons (B) Sensory neurons
(C) Interneurons (D) Bipolar neurons

88. Which type of neuron is commonly found in sensory organs like the retina and olfactory epithelium?
(A) Unipolar neurons
(B) Multipolar neurons
(C) Bipolar neurons
(D) Motor neurons

89. Which type of neuron carries information from the CNS to muscles and glands, enabling voluntary movements and glandular secretions?
(A) Sensory neuron (B) Interneuron
(C) Pyramidal neuron (D) Motor neuron

90. Which type of neuron has multiple dendrites

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and a single axon, making up the majority of neurons in the central nervous system?
(A) Bipolar neuron (B) Sensory neuron
(C) Multipolar neuron (D) Interneuron

91. Which of the following statement is correct for interneuron?
(A) They usually have long dendron
(B) They axon is long and myelinated
(C) The axon is comparatively thin and non-myelinated
(D) The dendrite ending may act as receptors

92. Neurons are unable to divide why?
(A) They enter in G_0 phase permanently
(B) They lack centriole
(C) Unable to form mitotic apparatus
(D) All of above correct

93. Most of the brain tumours are caused by the uncontrolled mitotic divisions of:
(A) Neurons (B) Schwann cells
(C) Nodes of Ranvier (D) Neuroglial cells

94. What differentiates dendrites from an axon?
(A) Dendrites are shorter than axons.
(B) Dendrites are more in number than axons
(C) Dendrites carry information towards the cell body whereas an axon carries information away from the cell body.
(D) Information in the axons travels in the form of electrical signal whereas in the dendrites it travels in the form of chemical signals.

95. Which neurons are rare found:
(A) Bipolar (B) Multipolar
(C) Unipolar (D) Polar

96. Sensory neurons are examples of:
(A) Bipolar neurone
(B) Multipolar neuron
(C) Unipolar neuron
(D) Pseudo neuron

97. Which one of them is one meter long?
(A) Axons (B) Dendrites
(C) Cell body (D) Neuron

98. Nissl's granules are:
(A) Groups of E.R associated with lysosomes
(B) Groups of ribosome associated with smooth E.R & Golgi apparatus
(C) Groups of ribosomes associated with rough E.R & Golgi apparatus
(D) None of them

99. Which one of them plays an important role in the nutrition of neurons?
(A) Nerve impulse (B) Neuroglia
(C) Sensory nerve (D) Nissl's granules

100. It is not true about cell body or neuron:
(A) Main nutritional part
(B) It contains axoplasm
(C) Biosynthesis of materials
(D) Regenerate axonal and dendrite fibre

101. The nerves are:
(A) The bundles of axons bounded by connective tissue
(B) the bundles of axons or dendrites bounded by connective tissue
(C) The bundles of dendrites bounded by connective tissue
(D) The bundles of cell bodies bounded by connective tissue

102. Which type of neuron has long Dendron?
(A) Sensory (B) Motor
(C) Intermediate (D) All

103. Primary function of myelin sheath around vertebrate axon:
(A) Regulate Na-K pump
(B) Increase in speed of conduction
(C) Increase in size of action potential
(D) Deactivate the release of neurotransmitter

104. Which is stored in axon endings?
(A) ADH (B) Oxytocin
(C) Acetylcholine (D) All of these

105. Which is concerned with biosynthesis of materials?
(A) Axons (B) Dendrites
(C) Schwan cells (D) Soma

106. Which could be called afferent nerves?
(A) Autonomic (B) Paratonic
(C) Sympathetic (D) Sensory

107. In myelinated nerves fibers, impulse jumps from node to node called:
(A) Salutatory conduction
(B) Ion tropic movement
(C) Electric impulse
(D) None

108. Which branch of motor neuron is lengthier?
(A) Dendrite (B) Axon
(C) Dendron (D) Central branch

109. The peripheral nervous system consists of:
(A) Spinal nerves only
(B) The brain only
(C) Cranial nerves only
(D) The spinal and cranial nerves

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110. **Nerve impulse is generated when nerve cell is undergoes:**
(A) Polarization (B) Depolarization
(C) Repolarization (D) Resting potential

111. **Nerve impulse initiate the movement of:**
(A) K^+ (B) Na^+
(C) Ca^+ (D) Mg^+

112. **The membrane potential of cell favors the:**
(A) Action of proton pump
(B) Action of an electrogenic pump
(C) Movement of anion into the cell
(D) Movement of cation into the cell

113. **Nerve impulses are initiated by nerve fibres only when the membrane shall become more permeable to:**
(A) Adrenaline (B) Phosphorus
(C) Sodium ions (D) Potassium ions

114. **Na+/K+ pump in a cell is an example of:**
(A) Osmosis (B) Diffusion
(C) Passive transport (D) Active transport

115. **Conduction of nerve impulse is:**
(A) Faster in non-myelinated fibres
(B) Faster in myelinated fibres
(C) No difference in the rate of conduction in myelinated & non myelinated fibres
(D) None of the above

116. **During propagation of nerve impulse:**
(A) K^+ ions from extracellular fluid to intracellular fluid
(B) Na^+ ions from extracellular fluid to intracellular fluid
(C) K^+ ions from intracellular fluid to extracellular fluid
(D) Na^+ ions from intracellular fluid to extracellular fluid

117. **During repolarization of nerve:**
(A) Na^+ channels are closed and K+ channels are open
(B) K^+ gates close and Na^+ gates open
(C) Both Na^+ and K^+ gates closed
(D) Both gates remain open

118. **An action potential in the nerve fibre is produced when positive and negative charges on the outside and inside of the axon membrane are reversed because:**
(A) More K^+ enters the axon as compared to Na^+ leaving it
(B) More Na^+ enters the axon as compared to K^+ leaving it
(C) All K^+ leave the axon
(D) All Na^+ leave the axon

119. **During the transmission of nerve impulse through the nerve fibre, the potential on the inner side of the plasma membrane has which type of electric change:**
(A) First negative, then positive and continue to be positive
(B) First positive, then negative and again back to negative
(C) First negative, then positive and again back to negative
(D) First positive, then negative and continue to be negative

120. **The end of the rising phase of an action potential occurs when the:**
(A) Potassium channels close
(B) Sodium channels close
(C) Potassium channels open
(D) Chloride channels open

121. **Neuron membrane allows the diffusion of:**
(A) Cl (B) Na^+
(C) Large anions (D) K^+

122. **When a neuron is not conducting any impulse i.e. resting, the axonal membrane is:**
(A) Comparatively more permeable to K+ and impermeable (nearly impermeable) to Na+
(B) Impermeable to negatively charged proteins present in the axoplasm
(C) More permeable to Na+ ions than K+ ion
(D) Both A and B Correct

123. **Which of these can increase the speed of nerve impulse?**
(A) Diameter of fibre
(B) Thickening of myelin sheath
(C) Both A and B
(D) Speed cannot be increased

124. **A short period during which a nerve is unable to conduct nerve impulse is called:**
(A) Synaptic delay
(B) Refractory period
(C) Resting potential
(D) Critical period

125. **Which is important in generating nerve impulse?**
(A) Change in membrane permeability
(B) Change in potential
(C) Movement of ions
(D) All are correct

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126. Depolarization is caused by:
(A) K^+ influx (B) Na^+ Influx
(C) Na^+ efflux (D) all of these

127. At ATPase Na-k pump the no. of binding sites for NA^+:
(A) 1 (B) 2
(C) 3 (D) 4

128. Under resting condition inner part of cell membrane of neuron is:
(A) Negatively charged
(B) Positively charged
(C) Neutral
(D) Variable

129. Maximum speed of nerve impulse in humans is:
(A) 100 m/sec (B) 120 cm/sec
(C) 100 cm/sec (D) 120 m/sec

130. A nerve impulse is passed from one to another neuron by:
(A) Jumping movements
(B) Neurotransmitters
(C) Hormones
(D) All

131. Out flux of K^+ causes:
(A) Depolarization (B) Repolarization
(C) Polarization (D) Passive transport

132. Inside of the neuronal membrane is negatively charged because of:
(A) Proteins (B) Organic acids
(C) Cl (D) All

133. Active transport occurs in:
(A) Na^+/K^+ gates (B) Carrer proteins
(C) Na^+/K^+ Pumps (D) All

134. Nerves are bundles of axons or dendrites are bounded by:
(A) Myelin sheath (B) CSF
(C) Connective tissues (D) Meninges

135. Which one of the following is the correct sequence of events that follows a threshold potential?
1. The membrane becomes depolarized
2. Sodium channels open and sodium ions diffuse inward
3. The membrane becomes repolarized
4. Potassium channels open and potassium ions
(A) 1234 (B) 2143
(C) 4312 (D) 3124

136. Sodium and potassium pumps are driven by:
(A) NADP (B) ATP
(C) Splitting of ATP (D) ADP

137. During active membrane potential, the inner membrane surface becomes:
(A) More positive than outside
(B) More negative than outside
(C) Less positive than outside
(D) Both B & C

138. Which term describes the cell membrane potential of a neuron at rest?
(A) Polarized (B) Depolarized
(C) Hyperpolarized (D) Repolarized

139. How potassium ions are typically moved out of a neuron when the membrane is at rest?
(A) Electric gradient move potassium out of cell
(B) Sodium-potassium move potassium ions out of cell.
(C) Potassium ions are stable and do not move when membrane at rest
(D) Concentration gradient move potassium ions out of cell

140. Which of the following neuronal processes transmits an action potential?
(A) Axon
(B) Dendrite
(C) Soma
(D) All transmit an action potential

141. At a chemical synapse, neurotransmitters are released from the _____ and bind to receptors on the _____:
(A) Presynaptic neuron; postsynaptic neuron
(B) Postsynaptic neuron; presynaptic neuron
(C) Axon; dendrites
(D) Cell body; axon terminal

142. What type of synapse allows the electrical signal to pass directly from one neuron to another?
(A) Chemical synapse
(B) Electrical synapse
(C) Gap junction
(D) Synaptic cleft

143. The space between the presynaptic terminal and the postsynaptic membrane is called the _____.
(A) Synaptic cleft
(B) Axon terminal
(C) Neurotransmitter receptor
(D) Dendritic spine

144. Which part of a neuron typically contains synaptic vesicles filled with neurotransmitters?
(A) Cell body (B) Axon hillock

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(C) Dendrites (D) Axon terminal

5. Choose incorrect statements about synapse:
(A) Chemicals help in passing information through the synapse.
(B) A synapse can be formed only between two neurons.
(C) Synapse helps in delivering the message from the neuron to the muscles.
(D) An electrical signal is converted into a chemical signal at the synapse.

6. Which of the following statements does not accurately describe synapses?
(A) Chemical synapses have a gap between the neuron and target cell.
(B) Electrical synapses have very little gaps between the neuron and target cell
(C) Both chemical and electrical synapses relay information from neurons to target cells.
(D) Both chemical and electrical synapses relay information through similar mechanisms.

7. Which channel plays a role in release of neurotransmitter into synaptic cleft?
(A) Both voltage-gated potassium and sodium channels
(B) Voltage-gated sodium channels
(C) Voltage-gated potassium channels
(D) Voltage-gated calcium channel

8. Which of the following statements about action potentials and information transmission in the synaptic cleft is false?
(A) Action potentials determine the duration that neurotransmitters are released into the synaptic cleft.
(B) Action potentials determine the amount of neurotransmitters that are released into the synaptic cleft.
(C) Action potentials ultimately result in more calcium entering the neuron at the axon terminal.
(D) Action potentials ultimately result in more calcium leaving the target cell at the post synaptic membrane.

9. Which of the following statements is false about the electrical synapse?
(A) At electrical synapses, the membranes of pre and post synaptic neurons are in very close proximity.
(B) Electrical current can flow directly from one neuron into the other across the synapses.
(C) Transmission of an impulse across electrical synapses is very similar to impulse conduction along single axon.
(D) Electrical synapses pass electrical signal between cells with the use of Acetylcholine

150. Five events in the transmission of nerve impulse across the synapse are given below:
(A) Opening of specific ion channels allows the entry of ions, a new action potential is generated in the post-synaptic neuron.
(B) Neurotransmitter binds to the receptor on post synaptic membrane
(C) Synaptic vesicle fuses with pre-synaptic membrane, neurotransmitter releases into synaptic cleft.
(D) Depolarization of pre-synaptic membrane
(E) Arrival of action potential at axon terminal.
In which sequence to the events occur
A. E → D → C → B → A
B. A → B → C → D → E
C. A → B → D → C → E
D. E → D → C → A → B

151. What is the most common inhibitory neurotransmitter in the brain?
(A) Dopamine
(B) Gama-Aminobutyric acid
(C) Glycine
(D) Glutamate

152. Neurotransmitter release occurs through the process of:
(A) Endocytosis (B) Exocytosis
(C) Pinocytosis (D) Synthesis

153. Main neurotransmitter for peripheral synapsis is:
(A) Acetylcholine (B) Dopamine
(C) Serotonin (D) All

154. Norepinephrine is neurotransmitter of sympathetic nervous system, what type of neurons release it:
(A) Interneuron innervating the stomach
(B) Afferent neurons innervating the pupil
(C) Autonomic neurons innervating the heart
(D) Motor neurons innervating the bicep

155. Acetylcholinesterase is:
(A) A neurotransmitter
(B) An enzyme that breaks down a neurotransmitter
(C) A stimulant that triggers an action potential
(D) A hormone

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156. **Which of the following is NOT a common neurotransmitter in the human nervous system?**
(A) Serotonin (B) Epinephrine
(C) Acetylcholine (D) Insulin

157. **What is the primary function of the enzyme acetylcholinesterase at the neuromuscular junction?**
(A) It promotes the release of acetylcholine.
(B) It breaks down acetylcholine to terminate the signal.
(C) It enhances the sensitivity of the postsynaptic membrane to acetylcholine.
(D) It facilitates the reuptake of acetylcholine into the presynaptic neuron.

158. **In electrical synapse, the cells are separated by synaptic cleft of only_____:**
(A) 0.2 nm (B) 2 nm
(C) 20 nm (D) 50 nm

159. **Acetylcholinesterase enzyme splits acetylcholine into:**
(A) Acetone and choline
(B) Acetic acid and choline
(C) Amino acid and choline
(D) Aspartic acid and acetylcholine

160. **Which of the following is an inhibitory neurotransmitter:**
(A) Glycine (B) Acetylcholine
(C) Dopamine (D) Norepinephrine

161. **The neurotransmitter released into the synapse between neurons and muscle cell that produce excitatory post synaptic potential in skeletal muscles:**
(A) GABA (B) Acetylcholine
(C) Norepinephrine (D) Histamine

CHEMICAL COORDINATION

162. **Introduction and mode of Action of Hormones Which one of these is an example of polypeptide?**
(A) Insulin (B) Thyroxine
(C) Oestrogen (D) Oxytocin

163. **Which hormone exists in protein form?**
(A) Glucagon (B) Oxytocin
(C) Vasopressin (D) Cortisone

164. **Endocrine glands can be defined as those glands which pour their secretion:**
(A) Directly into blood
(B) Into blood or ducts
(C) When they are cut
(D) Into particular organ

165. **The receptor for protein hormones are prese on:**
(A) Nucleus
(B) Endoplasmic reticulum
(C) Cytoplasm
(D) Cell-surface

166. **Statement does not correct for hormones is that, they:**
(A) Are not all protein
(B) Are secreted in small amount
(C) Affect metabolism
(D) Acts as catalyst

167. **"Secondary messenger" is:**
(A) Cyclic A.M.P. (B) ATP
(C) ADP (D) DNA

168. **Which of the following is not a steroid hormone?**
(A) Androgen (B) Aldosterone
(C) Oestrogen (D) Relaxin

169. **Which of the following hormones is not proteinaceous is nature:**
(A) TSH (B) Aldosterone
(C) LH (D) FSH

170. **The mode of action of which hormone is simi to steroid hormones:**
(A) LH (B) FSH
(C) Insulin (D) Thyroxine

171. **Steroid hormones transmit their information by:**
(A) Stimulating the receptors present on cell membrane.
(B) Entering into the cell and modifying cellular contents.
(C) Entering into the cell and modifying nuclear organization.
(D) The help of an intracellular second messenger.

172. **If receptor molecule is removed from target organ for hormone action, the target organ wi**
(A) Continue to respond but require higher concentration of hormone.
(B) Continue to respond but in opposite way.
(C) Continue to respond without any difference.
(D) Not respond to hormone.

173. **A class of hormones whose chemical structure consists of four fused carbon rings with various functional groups is called?**
(A) Protein hormones

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(B) Steroid hormones
(C) Polypeptide hormones
(D) Amino acid and derivative hormones

174. **Growth factors and histamine are chemical agents released in small amounts that act locally on neighbouring cells. Which of the following best describes the function of growth factors and histamine?**
(A) Endocrine function
(B) Autocrine function
(C) Paracrine function
(D) None of the above

175. **Which one of the hormones is not steroid?**
(A) Testosterone (B) Androgen
(C) Corticosterone (D) Oxytocin

176. **Which of the following hormones would bind to receptors located on the inside of a cell?**
(A) Testosterone
(B) Insulin
(C) Epinephrine
(D) Follicle stimulating hormone

177. **Prostaglandins are:**
(A) Amino acid (B) Steroid
(C) Fatty acid (D) Carbohydrate

178. **Hypothalamus It is here that many of the sensory stimuli of nervous system are converted into hormonal responses?**
(A) Hypothalamus
(B) Pituitary glands
(C) Adrenal glands
(D) Hypophysis cerebri

179. **It is produced and transported for storage by neurosecretory cells?**
(A) STH (B) Oxytocin
(C) TSH (D) Aldosterone

180. **Which of the following are catecholamines:**
(A) Estrogen and progesterone
(B) Epinephrine and nor-epinephrine
(C) FSH and LH
(D) Insulin and Glucagon

181. **Hormones affect the target cells by:**
(A) Initiating new biochemical reaction
(B) By regulating biochemical reactions by enzyme
(C) Control long-term changes
(D) Both B & C

182. **Chemically hormones may be:**
(A) Proteins (B) Polypeptides
(C) Steroids (D) All of these

183. **Which of the following hormones is an amino acid or its derivative?**
(A) Thyroxine (B) Epinephrine
(C) Norepinephrine (D) All of these

184. **A steroid hormone is:**
(A) Cortisone (B) Vasopressin
(C) Glucagon (D) Epinephrine

185. **Pituitary gland after receiving nerve impulses oxytocin and antidiuretic hormones are released from?**
(A) Hypothalamus
(B) Anterior pituitary
(C) Middle pituitary
(D) Posterior pituitary

186. **It is ovoid structure, weighting about 0.5 gm in adult human being?**
(A) Hypothalamus
(B) Pituitary gland
(C) Adrenal gland
(D) Posterior pituitary

187. **Which lobe of pituitary gland is called master gland?**
(A) Anterior
(B) Middle
(C) Posterior
(D) Anterior and Posterior both

188. **All of the following are true of posterior pituitary hormones EXCEPT:**
(A) They include direct and tropic hormones
(B) They are released from the posterior pituitary
(C) A nerve signal from the hypothalamus stimulates their release
(D) They include antidiuretic hormone and oxytocin

189. **Which is not ductless gland?**
(A) Testis (B) Sub-maxillary
(C) Ovary (D) Pituitary

190. **Anterior lobe of pituitary secretes the following hormones EXCEPT:**
(A) FSH (B) LTH
(C) PIH (D) STH

191. **Somatotrophin releasing factor is secreted from hypothalamus:**
(A) During puberty
(B) Throughout life
(C) Upto puberty
(D) During growth and development

192. **In male, luteinizing hormone is called:**

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(A) Follicle stimulating hormone
(B) Interstitial cell stimulating hormone
(C) Luteotropic hormone
(D) Prolactin inhibiting hormone

193. Neurohypophyses releases:
(A) Vasopressin
(B) Oxytocin
(C) Oxytocin & Prolactin
(D) Vasopressin & Oxytocin

194. Prolactin stimulates:
(A) Milk ejection
(B) Release of milk
(C) Milk production
(D) Degeneration of corpus luteum

195. FSH in females stimulates:
(A) Follicle development
(B) Secretion of estrogens
(C) Follicle development and Secretion of estrogens
(D) Development of corpus luteum

196. Under-secretion of STH causes:
(A) Dwarfism
(B) Lack of thyroid & adrenal hormone
(C) Gigantism
(D) Both A and B

197. TSH is secreted throughout the life but particularly reaches high levels during the period of:
(A) Rapid growth & development
(B) Menstrual cycle
(C) Sexual maturity
(D) Both B & C

198. External light governs the secretion of:
(A) MSH (B) FSH
(C) LH (D) ACTH

199. Another name of ADH is:
(A) Oxytocin (B) Prolactin
(C) Vasopressin (D) None of these

200. Lack of this hormone produces diabetes insipidus:
(A) Luteinizing hormone
(B) Thyroid stimulating hormone
(C) Oxytocin
(D) Antidiuretic

201. One of the following is characterized by production of large quantities of dilute urine and great thirst:
(A) Prolactin
(B) Vasopressin
(C) Oxytocin
(D) Luteinizing hormone

202. If a person happens to take large amount of water, the amount of ADH in blood will:
(A) Increase
(B) First increase then decrease
(C) Decrease
(D) Will remain unchanged

203. If amount of ADH increase in blood, micturition:
(A) Remain unchanged (B) Increases
(C) Decrease (D) Stopped

204. Hormone secreted by thyroid gland is:
(A) T_3 (B) Calcitonin
(C) T_4 (D) All of these

205. Secondary male characters are produced by:
(A) Androgens (B) Gastrin
(C) Estrogens (D) Progesterone

206. Which of the following hormones would be expected to increase if you were studying all day for a test and skipped breakfast and lunch?
(A) Glucagon
(B) Growth Hormone
(C) Insulin
(D) Calcitonin

207. It is under the control of pituitary trophic hormones STH and ACTH and responds directly to the level of blood glucose." The statement is true for:
(A) Thyroid gland
(B) Islets of Langerhans
(C) Adrenals
(D) Gonads

208. Glucagon tends to:
(A) Help excrete glucose through urine
(B) Decrease the level of blood glucose
(C) Slow down the conversion of glucose to glycogen
(D) Promotes the conversion of glycogen to glucose

209. Failure to produce insulin leads to a condition called:
(A) Diabetes insipidus (B) Glucogenesis
(C) Diabetes mellitus (D) Myxoedema

210. The islets of Langerhans which secrete the hormones insulin and glucagon comprise a part of:
(A) Liver (B) Spleen
(C) Kidney (D) Pancreas

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211. Pancreas is:
(A) Exocrine gland
(B) Endocrine gland
(C) Both exocrine as well as endocrine glad
(D) Ectocrine gland

212. Glucagon is secreted from which cells of Islet of Langerhans?
(A) α-Cells (B) γ-Cells
(C) β-Cells (D) Both A & C

213. Which of the followings depresses blood glucose levels?
(A) Glucagon (B) Insulin
(C) Thyroxin (D) Epinephrine

214. Insulin depresses blood glucose level by:
(A) Increasing glycogen synthesis
(B) By increasing cell utilization of glucose
(C) By stimulating conversion of glucose into lipids and proteins
(D) All of these

215. Insulin inhibits hydrolysis of glycogen in:
(A) Muscles (B) Liver
(C) Islets of Langerhans (D) Liver + Muscle

216. Excess production of insulin causes:
(A) Hypoglycaemia
(B) Hyperglycaemia
(C) Diabetes mellitus
(D) Diabetes insipidus

217. Which of the following promotes breakdown of glycogen in muscles and liver?
(A) Insulin (B) Glucagon
(C) Prolactin (D) Oxytocin

218. Which of the following is a hormone?
(A) Gastric juice (B) Pancreatic juice
(C) Bile (D) Insulin

219. Insulin is a hormone produced by:
(A) Thyroid gland (B) Parathyroid
(C) Adrenaline gland (D) Pancreas

220. The disease diabetes mellitus is the result of:
(A) Under secretion of insulin
(B) Under secretion of estrogen
(C) Under secretion of thyroxin
(D) Under secretion of vasopressin

221. The organs effected by the disturbance of calcium metabolism are:
(A) Nerve (B) Blood
(C) Skeleton & muscle (D) All of these

222. All are related except:
(A) Pancreas (B) β-Cells
(C) Diabetes (D) Epinephrine

223. Gonads After puberty the supply of _____, and therefore, the level of _____, remains constant:
(A) FSH, LH (B) LH, Estrogen
(C) LH, testosterone (D) LH, progesterone

224. In human female some beard like hair may appear on the face due to excess of:
(A) Estrogens (B) Progesterone
(C) Androgens (D) FSH

225. Secretin is a hormone produced by
(A) Pancreas (B) Duodenum
(C) Liver (D) Both A & B

226. Which of the following hormone helps in water reabsorption by nephrons:
(A) MSH (B) FSH
(C) ADH (D) ACTH

227. Pituitary gland does not control the secretory activity of:
(A) Thyroid (B) Adrenal cortex
(C) Adrenal medulla (D) Testes

228. Which of the following controls spermatogenesis:
(A) FSH (B) LTH
(C) LH (D) Vasopressin

229. Growth hormones of pituitary glands is more effective in presence of:
(A) Secretin (B) Thyroxin
(C) Insulin (D) Glucagon

230. Name a peptide hormone which acts mainly on hepatocytes, adipocytes and enhances cellular glucose uptake and utilization.
(A) Secretin (B) Gastrin
(C) Insulin (D) Glucagon

231. Melatonin is secreted by:
(A) Pineal gland
(B) Parathyroid gland
(C) Pituitary gland
(D) Thyroid gland

232. The posterior pituitary gland is not a 'true' endocrine gland because:
(A) It is under the regulation of hypothalamus
(B) It secretes enzymes
(C) It is provided with a duct
(D) It only stores and releases hormones

233. Which one of the following hormones is not involved in sugar metabolism?
(A) Glucagon (B) Cortisone
(C) Aldosterone (D) Insulin

234. Which one of the following hormones though

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synthesised elsewhere, is stored and released by the master gland?
(A) Melanocyte stimulating hormone
(B) Antidiuretic hormone
(C) Luteinizing hormone
(D) Prolactin

235. Which of the following pairs of hormones are not antagonistic (having opposite effects) to each other?
(A) Parathormone – Calcitonin
(B) Insulin – Glucagon
(C) Aldosterone– Atrial Natriuretic Factor
(D) Relaxin– Inhibin

236. Identify A, B and C in the diagrammatic representation of the mechanism of hormone action. Select the correct option from the following:

(A) A-Steroid Hormone; B-Hormone-receptor Complex, C-Protein
(B) A-Protein Hormone, B-Receptor; C-Cyclic AMP
(C) A-Steroid Hormone; B-Receptor, C - Second Messenger
(D) A-Protein Hormone; B-Cyclic AMP, C-Hormone-receptor Complex

237. Pineal gland is not related with:
(A) Body temperature
(B) Defence capability
(C) Metabolism
(D) Kidney functions

238. In mammals the female secondary sexual characters are developed mainly by the hormone:
(A) HCG (B) Progesterone
(C) Estrogens (D) All of these

239. Which of the following is an accumulation and release centre of Neurohormones?
(A) Anterior Pituitary lobe (B) Neurohypophysis
(C) Pars intermedia (D) Hypothalamus

240. BMR and Temperature of body is controlled by which endocrine gland:
(A) Adrenal cortex (B) Thymus
(C) Thyroid (D) Pituitary

241. Which of the following hormone is not secreted by gastro-intestinal tract?
(A) Gastrin (B) Secretin
(C) Cholecystokinin (D) Erythropoietin

242. A group of compounds now recognised as local hormones are:
(A) Prostaglandins (B) Prostacyclin's
(C) Cytokinin's (D) Substance 'P'

243. The hormone that initiates milk ejection, stimulate milk production and growth of ovarian follicle:
(A) Prolactin, oxytocin, LH
(B) Oxytocin, prolactin, FSH
(C) LH, prolactin, FSH
(D) LH, LTH, FSH

244. Its primary action is on smooth muscles, particularly in the uterus during childbirth, and also causes milk ejection from mammary glands:
(A) ADH (B) Oxytocin
(C) MSH (D) FSH

245. An excessive protein breakdown resulting in muscular and bone weakness is consequence of:
(A) Under secretion of corticosteroids
(B) Addison's disease
(C) Over secretion of corticosteroids
(D) Over secretion of corticosteroids and Cushing's disease

246. Which of the following scenarios describes a positive feedback mechanism?
(A) Several hours after a meal, blood glucose levels begin to drop, prompting the pancreas to secrete glucagon. Glucagon causes the liver to convert stored glycogen into glucose, raising blood glucose levels.
(B) During exercise, an increase in body temperature causes the body to produce sweat. As the sweat vaporizes, the body cools down due to evaporative cooling.
(C) After eating, blood glucose levels rise, stimulating the release of insulin from the pancreas. Insulin causes cells to uptake glucose from the blood, lowering blood glucose levels.
(D) After childbirth, high levels of prolactin induce lactation in the mother. During nursing, infant suckling triggers the release of more prolactin, which further stimulates lactation.

247. Which of the following correctly describes how positive and negative feedback are different?
(A) Negative feedback reverses changes in a

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system, while positive feedback amplifies changes in a system.
(B) Positive feedback occurs only in response to stimuli, while negative feedback can occur in the absence of stimuli.
(C) Negative feedback requires the detection of stimuli, while positive feedback functions independently of stimuli.
(D) Positive feedback moves a system closer to its set point, while negative feedback moves a system further from its set point.

248. **The receptor for protein hormones are present in:**
(A) Nucleus
(B) Endoplasmic reticulum
(C) Cytoplasm
(D) Cell-surface

249. **First discovered hormone:**
(A) Thyroxine (B) Adrenaline
(C) Secretin (D) Insulin

250. **Hypophysis cerebri is the other name of:**
(A) Adenohypophysis
(B) Islets of Langerhans
(C) Neurohypophysis
(D) Pituitary gland

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251. **Overactivity of sympathetic nervous system causes: (2011)**
(A) Disturbance of vision
(B) Constipation
(C) Decrease in blood pressure
(D) Increase in heartbeat

252. **Which structure responds when they are stimulated by impulse coming through motor neuron? (2011)**
(A) Receptors (B) Effectors
(C) Response (D) Transducers

253. **Respiratory center is located in: (2011)**
(A) Cerebrum (B) Medulla
(C) Cerebellum (D) Hypothalamus

254. **A neurological condition characterizes by involuntary tremors, diminished motor activity and rigidity is called: (2011)**
(A) Epilepsy
(B) Alzheimer's disease
(C) Parkinsons disease
(D) Cerebellar tremors

255. **The part of neuron fiber which conducts nerve impulse away from the cell body id called: (2012)**
(A) Dendron
(B) Axon
(C) Dendrites
(D) Peripheral branch

256. **The number of cranial nerves in human is: (2012)**
(A) 31 pairs (B) 24 pairs
(C) 12 pairs (D) 62 pairs

257. **The part of brain which controls breathing, heart rate and swallowing is: (2012)**
(A) Cerebrum (B) Medulla
(C) Cerebellum (D) Hypothalamus

258. **Cause of Parkinson's disease is death of brain cells that produce: (2012)**
(A) Dopamine (B) ADH hormone
(C) Acetylcholine (D) Oxytocin

259. **Thalamus and cerebrum are the parts of: (2013)**
(A) Spinal cord (B) Hind brain
(C) Forebrain (D) Mid brain

260. **There is also evidence that the high level of _____ may contribute to the onset of Alzheimer's disease: (2013)**
(A) Ca (B) Mo
(C) Mg (D) Al

261. **L-Dopa or levodopa is used to get some relief from: (2013)**
(A) Epilepsy
(B) Alzheimer's disease
(C) Parkinsons disease
(D) Dementia

262. **The structure responds when they are stimulated by impulse coming through motor neuron: (2013)**
(A) Receptors (B) Effectors
(C) Response (D) Transducers

263. **The right and left cerebral hemisphere are connected by a thick band of nerve fibers called (2014)**
(A) Pons (B) Medulla
(C) Corpus callosum (D) Hippocampus

264. **The part of brain which guides smooth and accurate motion and maintains body position is called: (2014)**
(A) Cerebrum (B) Medulla
(C) Cerebellum (D) Pons

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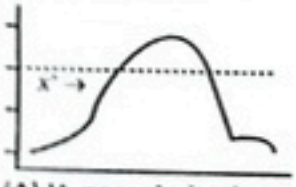
265. Which of the following is the effect of sympathetic nervous system: (2014)
(A) Constriction of bronchi
(B) Promote digestion or peristalsis
(C) Decrease in heart rate
(D) Dilate the pupil

266. High level of aluminum may contribute to the onset of which of the following disease: (2014)
(A) Epilepsy
(B) Alzheimer's disease
(C) Parkinsons disease
(D) Graves disease

267. Neurotransmitter secreted at synapse outside the central nervous system is: (2015)
(A) Dopamine (B) Androgen
(C) Polypeptide (D) Acetylcholine

268. Conduction of action potential from one node of Ranvier to another in myelinated neurons is through: (2015)
(A) Hyperpolarization
(B) Depolarization
(C) Resting membrane potential
(D) Saltatory conduction

269. "X" depicts in the action potential of following diagram: (2015)



(A) Hyperpolarization (B) Depolarization
(C) Repolarization (D) Polarization

270. Random uncontrolled activity of some cells in the brain leading to the chaotic activity in both sensory and motor nerves cause patient of to see and hair different strange things: (2015)
(A) Epilepsy
(B) Alzheimer's disease
(C) Parkinsons disease
(D) Huntington's disease

271. Part of hind brain responsible for balance and equilibrium of body is called: (2016)
(A) Cerebrum (B) Thalamus
(C) Cerebellum (D) Pons

272. Brain is protected and enclosed in: (2016)
(A) Lumber vertebrae
(B) Vertebral column
(C) Coccyx
(D) Cranium

273. Human have homeostatic thermostat present in a specified portion of brain that is: (2016)
(A) Hypothalamus (B) Thalamus
(C) Lateral ventricle (D) Spinal cord

274. The disease in which death of small number of cells in the ganglia leads to inability to select and initiate pattern of movement is known as: (2016)
(A) Fever
(B) Alzheimer's disease
(C) Parkinsons disease
(D) Epilepsy

275. A neurological disorder characterized by the decline in brain functions is_____, its symptoms are similar to those that cause dementia: (2016)
(A) Diabetes
(B) Alzheimer's disease
(C) Parkinsons disease
(D) Epilepsy

276. The nerve impulse which jumps from one node of Ranvier to another in myelinated neurons is through: (2017)
(A) threshold stimulus
(B) Initiate nerve impulse
(C) Resting membrane potential
(D) Saltatory conduction

277. The CNS is protected by: (2017)
(A) Two layers of meninges
(B) Three layers of meninges
(C) Four layers of meninges
(D) One layers of meninx

278. White matter of spinal cord is made up of: (2017)
(A) Sensory nerve fibers
(B) Myelinated nerve fibers
(C) Motor nerve fibers
(D) Mixed nerve fibers

279. This is evident that the high level of aluminum may contribute to the onset of which of the following disease: (2017)
(A) Alzheimer's disease
(B) Parkinsons disease
(C) Lesch-Nyhan syndrome
(D) Fragile X syndrome

280. Pick out the pressure receptors: (2017 Retake)
(A) Chemoreceptors
(B) Thermoreceptors
(C) Mechanoreceptors

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(D) Photoreceptors

281. Which of the following produce response: (2017 Retake)
(A) Effectors (B) Brain
(C) Stimulators (D) Nerves

282. Band of axons between two hemispheres are called: (2017 Retake)
(A) Corpus callosum (B) Synapse
(C) Corpus luteum (D) Ganglia

283. Reflexes of eye control by which part of brain: (2017 Retake)
(A) Mid brain
(B) Cerebral hemisphere
(C) Fore brain
(D) Hind brain

284. Spinal cord protected by how many layers of meninges: (2017 Retake)
(A) 1 (B) 3
(C) 2 (D) 4

285. When the nerve impulse jump from one node of Ranvier to the next in myelinated neuron, it is called: (2018)
(A) Synapse
(B) Resting potential
(C) Saltatory conduction
(D) Membrane Potential

286. In nervous system, chemical messengers are called: (2018)
(A) Neurotransmitter (B) Enzymes
(C) Hormones (D) Chemoreceptors

287. _____ hormone is released from posterior pituitary lobe: (2018)
(A) Adrenaline (B) FSH
(C) TSH (D) ADH

288. The hormone which controls the uptake of Sodium ion in kidney and its maintenance in blood plasma: (2018)
(A) Somatotrophic (B) Gonadotrophin
(C) Aldosterone (D) Thyroxin

289. How many sodium ions are pumped out in response to two potassium ions transported into the membrane: (2018)
(A) 1 (B) 2
(C) 3 (D) 4

290. Parathormone hormones production is controlled by the blood: (2018)
(A) Ca level (B) Sugar level
(C) Na level (D) Mg level

291. Taste buds on tongue are example of: (2018)
(A) Pressure receptors
(B) Thermoreceptors
(C) Chemoreceptors
(D) Photoreceptors

292. If stimulation is above _____, impulse travel to brain along the sensory neuron: (2019)
(A) Action potential (B) Resting potential
(C) Threshold (D) Recovery period

293. The main neurotransmitter for synapse is _____ which lies outside the CNS: (2019)
(A) Choline
(B) Acetaldehyde
(C) Acetylcholine
(D) Phosphatidylcholine

294. In an action potential, the permeability of sodium ion in the neuron increases due to: (2019)
(A) Repolarization
(B) The action of acetylcholinesterase enzymes
(C) Opening of sodium channel/gate
(D) Sodium ion forming an ionic bond

295. Which body function is controlled through positive feedback mechanism: (2020)
(A) Labor contraction
(B) Insulin production
(C) Body temperature
(D) Thyroxin release

296. Which of the following is common to all neurons: (2020)
(A) A cell which contains a nucleus
(B) A thick myelin sheaths
(C) Nodes of Ranvier
(D) Presence of Schwann cells

297. Neurons are the cells adaptive for rapid transmission of electric impulse. To do they have long thin process called: (2020)
(A) Axon (B) Myelin sheath
(C) Dendrites (D) Schwann cell

298. _____ is a junction between two neurons or between a motor neuron and muscle cells: (2020)
(A) Impulse (B) Axon
(C) Synapse (D) Cleft

299. There is no clear difference between dendrites and axon in sensory neuron EXCEPT: (2022)
(A) Thickness (B) Terminal portion
(C) Length (D) None

300. The neurotransmitter active outside CNS is: (2022)

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Answer Key

1. C	2. A	3. B	4. C	5. A	6. D	7. A	8. D	9. A	10. D
11. A	12. A	13. B	14. B	15. B	16. D	17. A	18. B	19. C	20. C
21. C	22. A	23. A	24. B	25. A	26. A	27. B	28. D	29. C	30. B
31. C	32. B	33. C	34. D	35. C	36. C	37. D	38. A	39. B	40. C
41. C	42. C	43. D	44. C	45. C	46. B	47. A	48. B	49. B	50. C
51. A	52. B	53. C	54. B	55. B	56. C	57. D	58. A	59. A	60. C
61. C	62. B	63. B	64. D	65. D	66. B	67. D	68. B	69. B	70. A
71. B	72. A	73. B	74. D	75. C	76. C	77. C	78. C	79. B	80. D
81. C	82. C	83. C	84. A	85. D	86. C	87. C	88. C	89. D	90. D
91. C	92. D	93. D	94. C	95. A	96. C	97. A	98. C	99. B	100. B
101. B	102. A	103. B	104. D	105. D	106. D	107. A	108. B	109. D	110. B
111. B	112. D	113. C	114. D	115. B	116. B	117. A	118. B	119. C	120. B
121. D	122. D	123. C	124. B	125. D	126. B	127. C	128. A	129. D	130. B
131. B	132. D	133. C	134. C	135. B	136. C	137. A	138. A	139. D	140. A
141. A	142. B	143. A	144. D	145. A	146. D	147. D	148. D	149. D	150. A
151. B	152. B	153. A	154. C	155. B	156. D	157. B	158. A	159. B	160. A
161. B	162. D	163. A	164. A	165. D	166. D	167. A	168. D	169. B	170. D
171. C	172. D	173. B	174. C	175. D	176. A	177. C	178. A	179. B	180. B
181. D	182. D	183. D	184. A	185. D	186. B	187. A	188. A	189. B	190. C
191. B	192. B	193. D	194. C	195. C	196. D	197. A	198. A	199. C	200. D
201. B	202. A	203. C	204. D	205. A	206. A	207. B	208. D	209. C	210. D
211. C	212. A	213. B	214. D	215. D	216. A	217. B	218. D	219. D	220. A
221. D	222. D	223. C	224. C	225. B	226. C	227. C	228. A	229. B	230. D
231. A	232. D	233. C	234. B	235. D	236. B	237. D	238. C	239. D	240. C
241. D	242. A	243. B	244. B	245. D	246. D	247. A	248. A	249. C	250. D
251. D	252. B	253. B	254. C	255. B	256. C	257. B	258. A	259. C	260. D
261. C	262. B	263. C	264. C	265. D	266. B	267. D	268. D	269. B	270. A
271. C	272. D	273. A	274. C	275. B	276. D	277. B	278. B	279. A	280. C
281. A	282. A	283. A	284. B	285. C	286. A	287. D	288. C	289. A	290. A
291. C	292. C	293. C	294. C	295. A	296. A	297. A	298. C	299. C	300. A
301. B	302. B	303. A	304. C	305. D	306. C	307. B	308. D	309. B	310. A
311. B	312. A	313. A	314. B	315. A	316. A	317. A	318. B	319. D	320. C
321. C	322. D	323. C	324. D	325. A	326. B	327. B	328. B	329. B	330. D
331. B	332. C	333. C	334. D	335. D	336. A	337. D	338. D		

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UNIT # 06

DIVERSITY AMONG ANIMALS

High Yield Content:

- Basic terminology
- Characteristics of Phylum porifera, Coelentrata, Annelida, Arthropoda, Mollusca, Chordata.
- Larval forms of all Phyla's
- Parasitic importance of Aschelminthes and Platyhelminthes

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"Diversity Among Animals"

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Dr. Muhammad Sohail, PhD

COMPARISON OF INVERTEBRATE PHYLA,S

Phylum Features	Porifera (Sponges)	Coelentrata (Cnidarians)	Platyhelminthes (Flatworms)	Aschelminthes Nematoda / Roundworms	Annelida (Segmented worms)	Arthropoda (Jointed appendage)	Mollusca (Soft bodied)	Echinodermata (Spiny skinned)
Unique Characters	Pores No tissues Simplest Evolve from choanoflagellates (Protozoans	Cnidocils Nematocysts Poly and medusae Alternation of generations	Ribbon like Dorsoventrally compressed Mostly parasite (endoparasite) except planaria (Dugesia)	Body pointed at ends Tube within tube Mostly endoparasite	Metameric segmentation	Largest phylum Largest class insecta	Foot, mantle, visceral mass Radula	Exclusively marine Actual classification based on complexity (below Annelida) Top of invertebrate Resemblance with chordates and hemichordates
Symmetry	No symmetry	Radial	Bilateral	Bilateral	Bilateral	Bilateral	Bilateral	Duplicity in symmetry. Radial: Adults Bilateral: Larval
Germ Layers	Pinacoderm (outer) Choanoderm (inner) (collar like) flagellated cells	Diploblastic- 1-Ectoderm Mesoglea (jelly like) 2-endoderm	Triploblastic 1-ectoderm 2-mesoderm 3-endoderm	Triploblastic 1-ectoderm 2-mesoderm 3-endoderm	Triploblastic 1-ectoderm 2-mesoderm 3-endoderm	Triploblastic 1-ectoderm 2-mesoderm 3-endoderm	Triploblastic 1-ectoderm 2-mesoderm 3-endoderm	Triploblastic 1-ectoderm 2-mesoderm 3-endoderm
Coelom	N/A	N/A	Acoelomates (No body cavity), Space filled by parenchyma/mesenchyme	Pseudocoelomates (False coelom) Blastocoel of blastula	Coelomates	Haemocoel (Open circulatory system)	Haemocoel (Open circulatory system)	Coelomates
Skeleton	Calcareous or siliceous	Hard, calcium carbonates	Cilia: underside-movement	Hydrostatic skeleton, circular muscle absent, only longitudinal Muscle- 4 bands- 2DL, 2VL	Hydrostatic skeleton, both circular and long. Muscle- setae's	Exoskeleton, chitin Modified appendages	Internal: hydrostatic skeleton, shell (External, Internal, Reduced)	Endoskeleton, tube feet in start fish
Digestive System	Choanoderm-flagellated endocytosis	Tube like gut, only mouth, Tentacles (Mobile), gastrovascular cavity	Tube like gut, intestine branched, gastrovascular cavity	Tube like gut (First time)	Tube like gut, prostomium	Tube like gut, differentiated	Tube like	Tube like
Nervous System	Neurons	Neuron network (Diffused nervous sys.)	Well developed (Ganglia). Centralized nervous system (First time)	Papillae (Sensory organs)	Brain, Ventral double nerve cord.	Brain, sensory organs efficient (Antenna, Compound eyes)	Ganglion distributed in parts (Head, foot, body organs)	Poorly developed nervous sys.

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Phylum / Features	Porifera	Coelentrata	Platyhelminthes	Aschelminthes	Annelida	Arthropoda	Mollusca	Echinodermata
Respiratory System	Absent By diffusion	Absent By diffusion	Absent By diffusion	Absent By diffusion	Absent By diffusion	Tracheal system, gills, book lungs	Gills and lungs (developed from the mantle cavity	No respiratory system
Excretory System	Absent	Absent	Flame cell, protonephridia	longitudinal canal	Metanephridia: pair Repeated in each segmented	Malpighian tubules Solid uric acid Linked with digestive system	Paired nephridia	No specialized
Circulatory System	No Water vascular system Ostia (water enter) Osculum (Leave)	No	Absent	Absent	Closed circulatory system (First time) Haemoglobin	Open circulatory system No pigment Not linked with respiratory system	Open circulatory system except Cephalopoda hemocyanin	Water vascular system Ambulacral system Madreporite (Sieve area)
Reproductive System	Budding, gemmules, hermaphrodite , protandrous , fertilization in mesenchyme.	Budding, alternation of generation	Hermaphrodite , regeneration	Sexes separate	Mostly hermaphrodite , some sexes separate	Sexes separate	Sexes separate	Sexes separate, regeneration
Larval Stage	Amphiblastula	Planula	Miracidium	filariform	Trochophore	Nauplius	Trochophore	Bippinaria and brachiolaria.
Examples	Sycon Leucoselenia Euplectella Spongilla	Hydra Jelly fish Obelia Sea anemone Madrepora	Planaria Liver fluke (fasciola) Taenia (tape worm)	Ascaris lubricoides (Intestinal parasite) Rhabditids Enterobius vermicularis (Large intestine) Ancyclostoma duodenale (Small intestine)	Earthworm (Pheretima posthuma.) Lumbricus terrestris. Neries (Marine) Stylaria(Freshwater) Leech (Hirudo med) (Ectoparasite) Anticoagulant (Inhibit blood clotting)	Insects Crustaceans (Aquatic arthropods) Cyclops Daphnia Shrimps Crabs Lobster	Snail (helix aspersa) Slug (limax) Mytilus (marine mussels) Anodonta)freshwater M.) Oysters (Ostrea) Squid (loligo) Giant squid: largest invertebrate : 15 meters (50 feet) Cuttle fish (Sepia) Octopus	Star fish Brittle start Sea urchin Sea cucumber Cake urchin

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Dr. Muhammad Sohail, PhD

Comparison of Vertebrate Phyla's

Character	Pisces			Amphibia	Reptilia	Aves	Mammalia
	Cyclostomata (Jawless Fish)	Chondrichthyes (Cartilaginous fish)	Osteichthyes (Bony Fish)	An-amniotes, cold blooded	Amniotes and cold blooded	Lack bladder in excretory system, warm blooded	Highest brain capacities warm blooded
Body	Long and eel like	Fusiform body	Streamlined body	Variable with or without tail	Moveable Neck, embryo protect by amnion, allantois and chorion	Stream-lined, with four divisions head, neck, trunk and tail	With hairs and mammary glands
Movement	No paired appendages	No swim bladder enlarges pectoral Fins	Fins and swim bladder	Tetrapod Pentadactyl limbs or legless (Caecilians), webbed feet	Better developed Pentadactyl limbs for efficient locomotion	Flight and walking, pentadactyl limbs	Pentadactyl limbs adaptive for walking, running, burrowing & swimming
Digestion	Lacks stomach Ventral sectorial mouth	J-shaped stomach, Ventral mouth & olfactory sacs not connected	Terminal mouth, teeth may be found	Tube like and complete	Complete digestive system	No teeth but have gizzard for crushing food	Complete and specialized, two sets of teeth
Respiration	6-14 pairs of gills	5-7 pairs of gills	4-5 pairs of gills, operculum present	Gills in larva & lungs in adults, metamorphosis	Lungs	Syrinx for voice, Lungs, extended to form air sacs, have parabronchi and one way air flow	Lungs & larynx at the top of trachea
Circulation	Single circuit & Heart with one auricle	Single circuit & Multiple aortic arches	Single circuit with one auricle and one atrium	Three chambered heart and double circuit circulation	Incomplete Four chambered heart except crocodile	Four chambered heart and double circuit circulation, right aortic arch	Four chambered heart and left aortic arch, non-nucleated RBCs
Skeleton	Cartilaginous skeleton and scales absent	Cartilaginous and Placoid scales	Bony, Cycloid, Ganoid or ctenoid scales	Bony skeleton, smooth skin with glands and chromatophores, scales absent	Bony endoskeleton , Dry scaly skin	Epidermal exoskeleton, feathers, scales on legs, hollow bones, large skull sockets, jaws extend to form a beak	Bony Endoskeleton & two body cavities due to diaphragm, inner ear ossicles
Reproduction	Sexual, separate sexes lampreys, hag fishes are hermaphrodite	Sexual & separate sexes, oviparous or viviparous	Separate sexes external fertilization	Separate sexes, external fertilization	Copulatory organ for internal fertilization, oviparous, large yolky eggs	Separate sexes, internal usually without copulatory organ, only one ovary and oviduct is functional (except eagle)	Separate sexes, Viviparous, internal fertilization
Examples	Hag fish and lamprey	Skate, Rays and Sharks	Perch, trout, Rohu	Frog, toad , salamander	Lizard, snake, sphenodon, crocodiles, gavials	Ostrich, Kiwi, Robin, Kestel, kingfisher , sparrow, Mallard	Prototheria or egg laying (Duck bill and platypus) Metatheria or pouched (kangaroo, opossum & Tasmanian Wolf) Eutheria (placental mammals, human, whale, elephant , horse, rat, mice, bat & dolphin)
Importance	Primitive chordates Agnathans	Predator, Food, source of vitamin A and D by liver oil	Important in food chain, Biodiversity, Developed into Dipnoi	Food chain, biodiversity	Adapted to land	Evolved from archaeopteryx	

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1. Which of the group is not included in kingdom animalia:
(A) Protozoa (B) Metazoan
(C) Eumetazoa (D) Parazoa

2. Which of the following feature is shared by all animals:
(A) Motile lifestyle
(B) Aquatic lifestyle
(C) Heterotrophic mode of nutrition
(D) All of the above

3. Animals of grade radiata are:
(A) Diploblastic (B) Triploblastic
(C) Acoelomates (D) Coelomates

4. Reproductive system, excretory, circulatory, and respiratory system are developed from:
(A) Ectoderm (B) Mesoderm
(C) Endoderm (D) Both A and B

5. Bilateral symmetrical animals are:
(A) Lesser developed
(B) Lack mesoderm
(C) Placed in one phylum only
(D) Triploblastic

6. In coelomates, layer that surrounds endoderm is:
(A) Coelomic epithelium
(B) Ectoderm
(C) Visceral mesoderm
(D) Parietal mesoderm

7. All are correct about acoelomates except:
(A) Sac type digestive system
(B) Parenchyma fills the body space
(C) Well-developed respiratory system
(D) Well-developed excretory system

8. Which of the following are pseudocoelomates:
(A) Platyhelminthes (B) Mollusca
(C) Echinodermata (D) Aschelminthes

9. A fluid filled cavity which is mesodermal in origin but absent in nematodes:
(A) Coelom (B) Pseudocoelom
(C) Gastrocoel (D) Spongocoel

10. Indeterminate cleavage is not the characteristics of:
(A) Echinodermata (B) Chordata
(C) Mollusca (D) Hemichordata

11. Spiral and determinate cleavage is absent in:
(A) Hookworm (B) Star fish
(C) Amphioxus (D) Vertebrates

12. Which of following feature is common to both Annelida and Mollusca:
(A) Triploblastic
(B) Radial symmetry
(C) Acoelomates
(D) Pseudocoelomates

13. The phyla included in grade bilateria are:
(A) Porifera to Cnidaria
(B) Porifera to Platyhelminthes
(C) Platyhelminthes to Chordata
(D) Platyhelminthes to Echinodermata

14. The system which develops from ectoderm is/are:
(A) Integumentary system
(B) Nervous system
(C) Both integumentary and nervous system
(D) Muscular system

15. In contrast to Annelids the Platyhelminths show:
(A) Absence of body cavity
(B) Presence of pseudocoel
(C) Radial symmetry
(D) Bilateral symmetry

16. Which one of the following groups of animals is bilaterally symmetrical and triploblastic:
(A) Porifera (Sponges)
(B) Coelenterates (Cnidarians)
(C) Aschelminthes (Round worms)
(D) All of the above

17. Sponges are classified into:
(A) Parazoans and Protozoans
(B) Metazoans and Parazoans
(C) Parazoans and Eumetazoans
(D) Metazoans and Eumetazoans

18. The animal which has false coelom:
(A) Spongilla (B) Obelia
(C) Hookworm (D) Planaria

19. An Acoelomate is:
(A) Flatworm (B) Roundworm
(C) Pinworm (D) Earthworm

20. Which of the following is free living carnivorous flatworm:
(A) Liver fluke (B) Tape worm
(C) Dugesia (D) Schistosoma

21. Sponges have special mobile cells called:
(A) Pinacocytes (B) Choanocytes
(C) Flagellated cells (D) Amoebocytes

22. Body of Porifera is tubular which is opened at its anterior end called:
(A) Osculum (B) Ostia
(C) Madreporite (D) Spongocoel

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23. A barrel like glass sponges of Antarctica is more than a meter tall:
(A) Spongilla
(B) Scolymastra joubini
(C) Euplectella
(D) Leucoselenia

24. Asexual reproduction is more in Cnidarians. It is performed by:
(A) Budding
(B) Regeneration
(C) Rarely by fragmentation
(D) All are correct

25. Which one of the following is Coelenterate:
(A) Sea anemone (B) Sea cucumber
(C) Sea urchin (D) Sea horse

26. Which of following is odd among the rest:
(A) Aurellia (B) Actinia
(C) Madrepore (D) Dugesia

27. _____ develop gonads in which egg or sperms are formed:
(A) Polyp (B) Medusae
(C) Gastrozoids (D) Blastostyle

28. The animals in grade Bilateria and triploblastic are all except:
(A) Platyhelminthes, nematodes
(B) Annelida and Mollusca
(C) Cnidaria and Porifera
(D) Arthropoda and Chordata

29. The most developed system in Platyhelminthes is:
(A) Respiratory system
(B) Excretory system
(C) Circulatory system
(D) All of above

30. Ascaris is which one of the following:
(A) Ectoparasite
(B) Intestinal parasite
(C) Respiratory tract parasite
(D) Urinogenital tract parasite

31. Body of _____ Consists of segments called proglottids, which contains mainly sex organs:
(A) Planaria (B) Tape worm
(C) Fasciola (D) Ascaris

32. System arising from endoderm in animals is:
(A) Nervous system
(B) Skeletal system
(C) Digestive system
(D) Reproductive system

33. Which system is developed in acoelomates:
(A) Tube-like digestive system
(B) Excretory system
(C) Special transport system
(D) None of these

34. Pseudocoelom is not considered as true coelom because:
(A) It develops from splitting of mesoderm
(B) It develops as an outpouching of archenteron
(C) It develops from blastocoel
(D) It is surrounded by mesoderm

35. In sponges, there is a single cavity in the body called:
(A) Gastrovascular cavity
(B) Spongocoel
(C) Pseudocoelom
(D) Coelom

36. Fertilization in sponges occurs in:
(A) Water (B) Spongocoel
(C) Mesenchyme (D) Enteron

37. Radial symmetry is found in animals belonging to phylum:
(A) Porifera (B) Cnidaria
(C) Platyhelminthes (D) Both A & B

38. Free swimming forms in coelenterates are:
(A) Polyps (B) Gastrozoids
(C) Medusae (D) All of these

39. The embryo of tape worm is round in shape and has ____ chitinous hooks:
(A) 1 (B) 3
(C) 6 (D) 10

40. Following is parasite of human large intestine:
(A) Enterobius vermicularis
(B) Fasciola hepatica
(C) Ancyclostoma duodenale
(D) None of these

41. Excretory system of nematodes contains:
(A) Flame cells
(B) Longitudinal canals
(C) Nephridia
(D) Malpighian tubules

42. Which system is absent in nematodes?
(A) Digestive (B) Muscular
(C) Respiratory (D) Excretory

43. Tube-like digestive system first time appeared in:
(A) Platyhelminthes (B) Nematodes
(C) Annelids (D) Arthropods

44. The nematocyst are the organs of defense in:

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(A) Cnidaria (B) Porifera
(C) Arthropoda (D) Chordata

45. It is not true for the phylum Aschelminthes:
(A) Bilaterally symmetrical
(B) Triploblastic metazoans
(C) Dorsoventrally compressed
(D) Pseudocoelomates

46. _____ is the human parasite commonly known as pinworm:
(A) *Fasciola hepatica*
(B) *Taenia solium*
(C) *Enterobius vermicularis*
(D) *Aurelia aurelia*

47. Name the gut roundworm parasite of human and pig:
(A) *Fasciola hepatica*
(B) *Ascaris lumbricoides*
(C) *Taenia solium*
(D) *Pheretima posthuma*

48. Which of following is the primary host of liver fluke:
(A) Man (B) Sheep
(C) Snail (D) Pig

49. Which of the following is secondary host of tape worm:
(A) Man (B) Earthworm
(C) Snail (D) Pig

50. The nervous system in Aschelminthes consists of nerve ring that encircles the:
(A) Mouth (B) Pharynx
(C) Larynx (D) Anus

51. Molluscs are soft bodied, triploblastic animals, most of which are protected by a shell of calcium carbonates secreted by:
(A) Mantle (B) Ectoderm
(C) Mesoderm (D) Endoderm

52. Locomotory organs are _____ in earthworm and _____ in Neries respectively:
(A) Setae, parapodia
(B) Parapodia, setae
(C) Setae, chaetae
(D) Parapodia, chaetae

53. The most successful group and largest phylum of kingdom animalia:
(A) Porifera (B) Coelentrata
(C) Arthropoda (D) Annelida

54. The larva formed during the life cycle of annelids:
(A) Glochidium larva (B) Trochophore larva
(C) Bipinnaria larva (D) Tornaria larva

55. Which of following is a diagnostic character of phylum Mollusca:
(A) Blood pigment is hemoglobin
(B) Haemocoel is present
(C) Chitin in exoskeleton
(D) Deuterostomes

56. Member of this phylum are exclusively marine:
(A) Platyhelminthes (B) Echinodermata
(C) Arthropoda (D) Annelida

57. Which one of the following is not a characteristic of phylum Annelida:
(A) Closed circulatory system
(B) Segmentation
(C) Pseudocoelom
(D) Ventral nerve cord

58. Which of the following is incorrect matching of larva with their phylum:
(A) Trochophore: Arthropoda
(B) Amphiblastula: Sponges
(C) Planula: Cnidaria
(D) Bipinnaria: Echinodermata

59. Identify the excretory system of Annelida:
(A) Flame cell system
(B) Nephridia
(C) Malpighian Tubules
(D) Excretory canals

60. Which one of the following is a matching set of a phylum and its three examples:
(A) Porifera: Spongilla, Euplectella, Obelia
(B) Cnidaria: Planaria, Physalia, Aurelia
(C) Platyhelminthes: Planaria, Schistosoma, Enterobius
(D) Mollusca: Loligo, Teredo, Octopus

61. In contrast to Annelids the Platyhelminths show:
(A) Absence of body cavity
(B) Presence of pseudocoel
(C) Radial symmetry
(D) Bilateral symmetry

62. The mouth is overhung by a lobed structure, the Prostomium is the characteristic feature of:
(A) Arthropoda (B) Mollusca
(C) Annelida (D) Echinodermata

63. With few exceptions the Platyhelminthes are:
(A) Saprobes (B) Symbionts
(C) Endoparasites (D) Ectoparasites

64. Pig or cattle is the intermediate host of:
(A) *Dugesia* (B) *Taenia solium*

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(C) *Fascoila hepatica* (D) Planaria

65. The parasite remains embedded in the voluntary muscles of cow are that of:
(A) Planaria (B) *Liver fluke*
(C) Tape worm (D) *Schistosoma*

66. For disinfestation of Taenia, besides treatment with drugs, physicians also give to the patient to fully remove the parasite:
(A) Anemia (B) Anema
(C) Chemotherapy (D) Radiotherapy

67. Aschelminthes is important from the point of view of its:
(A) Free living (B) Parasites
(C) Symbionts (D) Mutualists

68. Scientific name of pinworm is:
(A) *Ascaris lubricoides*
(B) *Rhabditids*
(C) *Enterobius vermicularis*
(D) *Ancyclostoma duodenale*

69. During feeding they produce an anticoagulant to prevent clotting of blood and after feeding leave the wound bleeding:
(A) *Ancyclostoma duodenale*
(B) *Taenia solium*
(C) *Enterobius vermicularis*
(D) *Ascaris lubricoides*

70. Billions thrive in each acre of top soil:
(A) *Ascaris lubricoides*
(B) *Rhabditids*
(C) *Enterobius vermicularis*
(D) *Ancyclostoma duodenale*

71. These have exploited every type of habitat on land and in water:
(A) Nematodes (B) Arthropods
(C) Poriferans (D) Platyhelminths

72. In Arthropods there is a primitive:
(A) Nervous system (B) Heart
(C) Excretory system (D) Sensory system

73. Pick up the example of crustacea:
(A) Daphnia (B) Mosquito
(C) Spiders (D) Millipedes

74. They are not only health hazard but also cause economic loss to man by destroying his property and crops:
(A) Platyhelminthes (B) Cnidarians
(C) Insects (D) Nematodes

75. It moves in large numbers from country to country, cause damage to standing crops and other plants:
(A) Tse-Tse fly (B) Locusts
(C) Housefly (D) Mosquito

76. Some insects eat up the dead animals and vegetable matter and are called:
(A) Predators (B) Vector
(C) Scavengers (D) Pathogens

77. The annelid of medicinal importance is:
(A) Nerles (B) Leech
(C) Stylaria (D) Earthworm

78. Which one is considered as a natural plough:
(A) Pheretima posthuma
(B) Hirudo medicinalis
(C) Chaetopterus
(D) Nerles

79. Internal and external segmentation corresponds with each other in phylum:
(A) Arthropoda (B) Mollusca
(C) Annelida (D) Nematoda

80. The rasping organ of molluscs is called:
(A) Tongue (B) Radula
(C) Tentacles (D) Palp

81. Hemocyanin is a:
(A) Red pigment (B) Green pigment
(C) Blue pigment (D) Purple pigment

82. Which one of the following is considered a delicacy:
(A) *Mytilus* (B) *Ostrea*
(C) *Limax* (D) *Helix aspersa*

83. Wooden parts of ships are damaged by:
(A) Loligo (B) Sepia
(C) Limax (D) Teredo

84. Taenia solium is commonly called as:
(A) Tapeworm (B) Liver Fluke
(C) Blood fluke (D) Planaria

85. It has suckers used for attachment to host tissue:
(A) Dugesia (B) *Fasciola hepatica*
(C) *Taenia Solium* (D) Planaria

86. Which of the following is absent in parasitic Platyhelminthes:
(A) The epidermis (B) Cuticle
(C) Platyhelminthes (D) Digestive system

87. Round worms belong to phylum:
(A) Porifera (B) Cnidaria
(C) Platyhelminthes (D) Aschelminthes

88. *Ascaris lumbricoides* is a:
(A) Parasite
(B) Saprobe
(C) Parasite or saprobe

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(D) Parasite or symbiont

89. *Ancyclostoma duodenale* is commonly known as:
(A) Pin worm (B) Hook worm
(C) Round worm (D) Flat worm

90. A single rotting apple may contain:
(A) 90,000 roundworms
(B) 9,000 roundworms
(C) 900,000 roundworms
(D) 900 roundworms

91. In Arthropods if the larva resembles the adult it is called:
(A) Nymph (B) Instar
(C) Nymph or instar (D) Adult larva

92. A polysaccharide secreted by the epidermis of insect is:
(A) Cellulose (B) Starch
(C) Pectin (D) Chitin

93. Segmentation in Arthropods is:
(A) Metameric (B) Non-metameric
(C) False (D) Anteroposterior

94. Malaria is transmitted to healthy human being by:
(A) Tse-Tse fly (B) *Plasmodium*
(C) Anopheles female (D) *Trypanosoma*

95. Triploblastic animals cannot be:
(A) Acoelomate (B) Pseudocoelomates
(C) Coelomate (D) Asymmetrical

96. The gut is sac type in:
(A) Acoelomates (B) Coelomates
(C) Pseudocoelomates (D) Bilateral animals

97. Coelom is a cavity lined by:
(A) Ectoderm (B) Mesoderm
(C) Endoderm (D) Gut

98. Pick up the marine annelid:
(A) *Neries*
(B) *Stylaria*
(C) *Pheretima posthuma*
(D) *Leech*

99. The formation of trochophore larva is the characteristic of phylum:
(A) Annelida
(B) Mollusca
(C) Nematoda
(D) Annelida and Mollusca both

100. Which one of the following secretes an anticoagulant:
(A) *Pheretima posthuma*
(B) *Hirudo medicinalis*
(C) *Neries*
(D) *Chaetopterus*

101. In molluscs mantle secretes:
(A) Visceral part (B) Shell
(C) Radula (D) Hormones

102. Which one of the following is a garden snail:
(A) *Limax* (B) *Helix aspersa*
(C) *Mytilus* (D) *Sepia*

103. Animals have their body cavity filled with parenchyma are:
(A) Acoelomates (B) Coelomates
(C) Pseudocoelomates (D) None of these

104. Trypanosoma causes the disease:
(A) Malaria (B) Sleeping sickness
(C) Cholera (D) None of these

105. In annelids, the organs for excretion ais:
(A) Flame cells (B) Nephridia
(C) Kidneys (D) None of these

106. Parasitic example of annelid is:
(A) Neries (B) Stylaria
(C) Earthworm (D) Leech

107. Closed circulatory system first time appeared in:
(A) Platyhelminthes (B) Nematodes
(C) Annelids (D) Arthropods

108. Contraction of circular muscles produces a pressure in the coelomic fluid that forces the body to:
(A) Shorten (B) Elongate
(C) Both (D) None

109. Largest phylum of animal kingdom whose members are in all types of habitats is:
(A) Annelida (B) Arthropoda
(C) Mollusca (D) Chordata

110. Body cavity of arthropods is:
(A) Coelom
(B) Pseudocoelom
(C) Haemocoel
(D) Body cavity not present

111. Excretion in Arthropoda take place by means of:
(A) Protonephridia (B) Metanephridia
(C) Malpighian tubules (D) Kidneys

112. Nitrogenous wastes in Arthropods are excreted in the form of:
(A) Ammonia (B) Urea
(C) Uric acid (D) Creatinine

113. Blood of_____ cannot carry oxygen and carbon dioxide:

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(A) Annelida (B) Arthropoda
(C) Cephalopoda (D) Chordates

114. **Largest invertebrate animal is:**
(A) Elephant
(B) Giant squid
(C) Brachioceranthus
(D) *Scolymostra joubini*

115. **Respiratory pigment in molluscs is:**
(A) Haemoglobin (B) Myoglobin
(C) Haemoeyanin (D) None of these

116. **Loligo is:**
(A) Snail (B) Slug
(C) Squid (D) Cuttle fish

117. **The brain of_____ is exceptionally large and complex for an invertebrate:**
(A) Giant squid (B) Octopus
(C) Cuttlefish (D) Slug

118. **Helix aspersa is commonly known as:**
(A) Squid (B) Slug
(C) Fresh water mussel (D) Garden snail

119. **Presence of _____ shows certain biochemical peculiarities among echinoderms and chordates:**
(A) Cytochrome c
(B) Phosphocreatine
(C) Haemoglobin
(D) Mesodermal skeleton

120. **Madreporite is:**
(A) Sieve-like plate through which water enters in canals
(B) A part of tube feet used for locomotion
(C) Spiny structure present only in sea urchin
(D) A network of canals through which water circulates

121. **Echinoderms are placed close to chordates because:**
(A) Mesoderm is derived from the cells close to blastopore
(B) They possess mesodermal skeleton
(C) They show radial cleavage
(D) Both b & c

122. **Notochord is present throughout life in:**
(A) Urochordates (B) Cephalochordates
(C) Pre-chordates (D) Chordates

123. **Which is not the example of tunicate?**
(A) Oikopleura (B) Ascidia
(C) Salpa (D) Branchiostoma

124. **Character that belongs to class Chondrichthyes:**
(A) No scale of body
(B) Placoid scales
(C) Cycloid scales
(D) Presence of swim bladder

125. **The pairs of gills present in cyclostomata are:**
(A) 6-14 (B) 5-7
(C) 10-12 (D) 4-5

126. **_____ is the largest fish:**
(A) Whale (B) Lamprey
(C) Shark (D) Sting ray

127. **_____ muscles of electric ray are specialized produce electric shock in water:**
(A) Ventral (B) Dorsal
(C) Both (D) None

128. **Shark liver oil is a source of vitamin:**
(A) A & K (B) B & D
(C) A & D (D) A & E

129. **Swim bladder is present in:**
(A) Cyclostomata (B) Chondrichthyes
(C) Osteichthyes (D) All

130. **The scales of cartilaginous fishes are:**
(A) Placoid (B) Cycloid
(C) Ganoid (D) Both B & C

131. **Fishes can respire without water:**
(A) Cyclostomata (B) Chondrichthyes
(C) Osteichthyes (D) Dipnoi

132. **Which is not the adaptation for aquatic mode of life in fishes:**
(A) Swim bladder
(B) Paired fins
(C) Sensory organs are more developed than terrestrial animals
(D) Afferent & efferent branchial system

133. **Amphibians are evolved from:**
(A) Cartilaginous fishes (B) Reptiles
(C) Dipnoi (D) Cyclostomata

134. **Pigment cells called chromatophores present in:**
(A) Reptiles (B) Amphibian
(C) Chondrichthyes (D) Mammals

135. **Amnion is not present around the embryo of:**
(A) Reptiles (B) Amphibian
(C) Birds (D) Mammals

136. **Which of following statement is correct for Bony fishes:**
(A) Body is long eel like
(B) Digestive system with no stomach
(C) Ventral mouth
(D) Terminal mouth

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137. Which of following group of animals are all amniotes:
(A) Fish, amphibians, reptiles
(B) Reptiles, Birds, mammals
(C) Fish Reptiles, birds
(D) Amphibians, Reptiles, Birds

138. Which of following is an adaptation in animals to cope with land conditions:
(A) Streamlined Body
(B) Respiratory organs are gills
(C) Shelled egg
(D) Swim bladder

139. It is mainly a hydrostatic organ and can change the gravity of fish by filling itself with gas:
(A) Lungs (B) Gills
(C) Swimm bladder (D) Kidney

140. Which of the following is a connecting link between Fish and Amphibians:
(A) Hemichordates (B) Dipnoi
(C) Archaeopteryx (D) Cotylosaurs

141. Jawless fishes are placed in:
(A) Gnathostome (B) Agnathostomes
(C) Amniotes (D) Both B and C

142. Which of the following is not a basic feature of chordates:
(A) Notochord (B) Vertebral column
(C) Gill Slits (D) Postanal tail

143. Chordates in which notochord converted into backbone after development:
(A) Urochordates (B) Cephalochordates
(B) Vertebrates (D) All of above

144. Reptiles flourished throughout the _____era:
(A) Cenozoic (B) Mesozoic
(C) Proterozoic (D) Devonian

145. Birds do not have teeth, so functions of teeth are performed by:
(A) Beak (B) Pharynx
(C) Stomach (D) Gizzard

146. Which of them is not poikilotherms?
(A) Lizard (B) Snake
(C) Spiny ant eater (D) Crocodile

147. The character which is shared among reptiles, Birds, and Mammals:
(A) Warm blooded (B) Cold blooded
(C) Internal fertilization (D) Viviparity

148. In contrast with mammals, birds do not have:
(A) Four chambered heart
(B) Right aorta functional
(C) Hairs on skin
(D) Syrinx

149. Opossum and Koala bear belongs to sub-class:
(A) Prototheria (B) Metatheria
(C) Eutheria (D) Eukarya

150. Which of the following character in birds do not have their adaptations for flight:
(A) Presence of wings
(B) Hollow and light bones
(C) No urinary bladder
(D) Gizzard in digestive system

151. In which one of the following sets of animals all the four-give birth to young ones:
(A) Kangaroo, Hedgehog, Dolphin, Rat
(B) Lion, Bat, Whale, Ostrich
(C) Platypus, Penguin, Bat, Hippopotamus
(D) Shrew, Bat, Cat, Kivi

152. The mammal-like reptile that was found as fossil in Texas:
(A) Archaeopteryx
(B) Duck bill platypus
(C) Varanops
(D) Opossum

153. The lower jaw is composed of only one large bone:
(A) Reptiles (B) Amphibian
(C) Chondrichthyes (D) Mammals

154. The organ of voice in bird called syrinx is situated:
(A) At upper side of trachea
(B) At lower end of trachea
(C) Just behind the pharynx
(D) In the middle of trachea

155. In _____ both ovaries and oviducts are functional:
(A) Robin (B) Kestrel
(C) Eagle (D) Kingfisher

156. Air bladder is:
(A) A respiratory organ in birds
(B) Digestive organ in Cnidarians
(C) Excretory organ in mammals
(D) Hydrostatic organ in fishes

157. Kangaroo is *a:*
(A) Eutherian (B) Bird
(C) Prototherian (D) Metatherian

158. *Which set of insects is useful to man?*
(A) *Honeybee, locust, Lac insect*
(B) *Lac insect, silk moth, honey be*
(C) *Silk moth, honeybee, dragonfly, locust*

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(D) Weevil, silk moth, honeybee

159. The gizzard of birds is:
(A) Analogous to teeth
(B) Homologous to stomach
(C) Homologous to teeth
(D) Both A & B

160. The difference between the mammalian heart and that of birds is:
(A) Chambers
(B) Blood circulation
(C) Valves
(D) Direction of aortic arch

161. The mammal without fur on their body surface is:
(A) Porcupine (B) Pangolin
(C) Both A & B (D) Horse

162. The amphibians evolved from the Dipnoi during:
(A) Jurassic period (B) Cretaceous period
(C) Both A & B (D) Devonian period

163. Hibernation is a _____ character:
(A) Homeothermic (B) Heterothermic
(C) Poikilothermic (D) Ectothermic

164. The vertebrates in which placenta is formed during the development of fetus are:
(A) Pisces (B) Aves
(C) Mammals (D) None of these

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165. Body cavity of round worms is called: (2011)
(A) Pseudocoelom (B) Acoelom
(C) Coelom (D) Enteron

166. Fasciola is endoparasite of: (2011)
(A) Colon (B) Small intestine
(C) Liver (D) Bile duct

167. Trypanosoma is transmitted in human beings by: (2011)
(A) Plasmodium (B) House fly
(C) Anopheles (D) Tse-tse fly

168. The nervous system develops from which of the following layer during embryonic development in animals: (2011)
(A) Mesoderm
(B) Endoderm
(C) Ectoderm
(D) Mesoderm and endoderm

69. Fasciola is the name given to: (2012)
(A) Tapeworm (B) Liver fluke
(C) Planaria (D) Earthworm

'0. Ascaris is: (2012)
(A) Diploblastic (B) Haploid
(C) Triploblastic (D) Acoelomate

171. During development in an animal, mesod layer gives rise to: (2012)
(A) Nervous system
(B) Muscular and skeletal system
(C) Alimentary canal lining
(D) Mouth

172. Polymorphism is characteristic feature (2012)
(A) Porifera (B) Annelida
(C) Cnidaria (D) Nematodes

173. When beef which is not properly cooked consumed by humans, they may becom infected by: (2013)
(A) Hook worm (B) Tape worm
(C) Pin worm (D) Round worm

174. Sleeping sickness in humans is caused b (2013)
(A) Anopheles (B) Trypanosoma
(C) Aedes (D) Plasmodium

175. Schistosoma is a parasite that lives in the ___ host: (2013)
(A) Liver (B) Intestine
(C) Blood (D) Kidney

176. The cavity between body wall and alimentar canal is: (2013)
(A) Pseudocoelom
(B) Coelom
(C) Acoelom
(D) Gastrovascular cavity

177. The layer which forms the lining of the digestiv tract and glands of digestive system: (2013)
(A) Endoderm (B) Mesoderm
(C) Ectoderm (D) Mesoglea

178. Ascaris is which one of the following? (2014)
(A) Ectoparasite
(B) Respiratory tract parasite
(C) Intestinal parasite
(D) Urinogenital tract parasite

179. Polymorphism is a feature exhibited b members of: (2014)
(A) Coelenterates (B) Porifera
(C) Arthropoda (D) Platyhelminthes

180. Which one of the following is the primary host of liver fluke? (2014)
(A) Man (B) Snail
(C) Sheep (D) Dog

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181. Which one of the following is free living carnivorous flatworm? (2014)
(A) Liver fluke (B) Tapeworm
(C) Dugesia (D) Schistosoma

182. ____ is a triploblastic organism: (2015)
(A) Jelly fish (B) Tapeworm
(C) Sea anemone (D) Corals

183. In arthropods, the body cavity is in the form of: (2015)
(A) Coelom (B) Pseudocoelom
(C) Haemocoel (D) Enteron

184. ____ is a good example of polymorphism: (2015)
(A) Hydra (B) Obelia
(C) Star fish (D) Euplectella

185. Name common gut roundworm parasite of human and pig: (2015)
(A) *Ascaris lubricoides*
(B) *Pheretima posthuman*
(C) *Lumbricus terrestris*
(D) *Hirudo medicinalis*

186. ____ is also called liver fluke: (2015)
(A) Dugesia (B) Fasciola
(C) Taenia (D) Coral

187. Taenia is an endoparasite of human, pig and cattle which belongs to phylum: (2016)
(A) Cnidaria (B) Annelida
(C) Aschelminthes (D) Platyhelminthes

188. Body of the _____ consists of segments called proglottids which contain mainly sex organs: (2016)
(A) Planaria (B) Acaris
(C) Liver fluke (D) Tapeworm

189. ____ is a common parasite of the intestine of human and pig which belongs to phylum Nematoda: (2016)
(A) *Taenia solium*
(B) *Ascaris lumbricoides*
(C) *Schistosoma*
(D) *Fasciola hepatica*

190. In radial symmetry all body parts are arranged around the central axis. Radial symmetry represents_____the mode of life: (2016)
(A) Sessile (B) Active
(C) Streamlined (D) Parasitic

191. Pseudocoelomates have a body cavity, but it is not true coelom. Which one of the following is included in the group? (2016)
(A) Planaria (B) Earthworm
(C) Tapeworm (D) Ascari

192. Snails are the intermediate hosts in: (2017)
(A) *Fasciola hepatica*
(B) *Schistosoma*
(C) *Taenia solium*
(D) *Ancylostoma duodenale*

193. _____ is an intestinal parasite of man belonging to phylum Nematoda: (2017)
(A) *Taenia solium*
(B) *Ascaris lumbricoides*
(C) *Wuchereria bancrofti*
(D) *Schistosoma*

194. *Ascaris lubricoides* is parasite of: (2017-Retake)
(A) Mouth (B) Intestine
(C) Liver (D) Lungs

195. Which of the following stage of metamorphosis resembles to its mother: (2017-Retake)
(A) Egg (B) Tadpole
(C) Nymph (D) Pupa

196. Following is the example of acoelomate: (2018)
(A) Platyhelminthes (B) Aschelminthes
(C) Molluscs (D) Annelids

197. The larva formed during the life cycle of annelids: (ETEA 2019)
(A) Glochidium (B) Bipinnaria
(C) Trochophore (D) Tornaria

198. Platyhelminthes are: (ETEA 2019)
(A) Bilateral symmetrical & diploblastic
(B) Bilateral symmetrical & Triploblastic
(C) Radial symmetrical & Tripleblastic
(D) Radial symmetrical & Diploblastic

199. Opossum and Koala bear belongs to sub-class: (ETEA 2019)
(A) Prototheria (B) Eutheria
(C) Metatheria (D) Monotremata

200. Select the anamniotes from the following: (2020)
(A) Snake (B) Frog
(C) Parrot (D) Crocodile

201. Definite Nervous system is absent in: (2021)
(A) Sycon (B) Jelly fish
(C) leucoselenia (D) Both A & C

202. Proglottids are present in: (2021)
(A) Dugesia (B) Taenia
(C) Schistosoma (D) Fascia

203. Respiratory pigment in molluscs: (2021)
(A) Hemoglobin (B) Hemocyanin
(C) Myoglobin (D) Chlorophyl

204. Syrinxes are the features of: (2021)
(A) Vertebrates (B) Hemichordates

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(C) Chordates (D) Aves

205. Water vascular or ambulacral system is a unique and complex system especially present in: (2022)
(A) Sponges (B) Echinoderms
(C) Arthropods (D) Fishes

206. Roundworms belongs to which phylum: (2022)
(A) Annelida (B) Platyhelminthes
(C) Coelentrata (D) Nematoda

207. Silver fish is an: (2022)
(A) Insect (B) Jawless fish
(C) Cartilaginous fish (D) Molluscs

208. Tissues are not found in which of the following animals: (2022)
(A) Flatworms (B) Cnidarians
(C) Sponges (D) Roundworms

209. Enteron is characteristics feature of: (2023)
(A) Annelida (B) Sponges
(C) Cnidarians (D) Nematoda

210. The body of which is metamerically segmented: (2023)
(A) Cnidarians (B) Sponges
(C) Annelida (D) Nematoda

211. Excretion in planaria takes place by: (2023)
(A) Malpighian Tubules (B) Metanephridia
(C) Protonephridia (D) Nephrons

212. Four chambered heart with only right systemic arch is present in: (2023)
(A) Amphibia (B) Birds
(C) Reptiles (D) Mammals

213. Which of the following belongs to chordates: (UHS 2024)
(A) Spider (B) Trout fish
(C) Star fish (D) Earthworm

214. Malpighian tubules are found in: (ETEA 2024)
(A) Earthworm (B) Grasshopper
(C) Leech (D) Slug

215. Shark belongs to class_____: (ETEA 2024)
(A) Chondrichthyes (B) Echinodermata
(C) Osteichthyes (D) Urochordata

216. Canal system is a characteristic of: (ETEA 2024)
(A) Cnidarians (B) Protozoans
(C) Porifera (D) Segmented worm

217. Mantle is the feature of: (ETEA 2024)
(A) Annelids (B) Chordates
(C) Echinoderms (D) Mussel

218. Which size of sponge can filter an entire residential pool in one day: (DUHS 2024)
(A) Tennis ball-sized (B) Basket ball-sized
(C) Hockey ball-sized (D) Teaspoon-sized

219. Animals that have a ladder-type nervous system, consisting of two nerve cords and connecting nerves that look like a ladder, belong to the phylum: (DUHS 2024)
(A) Platyhelminthes (B) Coelentrata
(C) Porifera (D) Cnidarian

220. Which of the following animal is usually Ambisexual: (DUHS 2024)
(A) Earthworm (B) Ascaris
(C) Cyclopes (D) Daphnia

221. Which one of the following is the acoelomates: (SZABMU 2024)
(A) Aurelia (B) Chaetopterus
(C) Euplectella (D) Taenia

222. Hemichordates belongs to: (BUMHS 2024)
(A) Deuterostomes
(B) Protostomes
(C) Both Protostomes and Deuterostomes
(D) None of the given option

223. Parazoa are: (BUMHS 2024)
(A) Multicellular
(B) Radial symmetrical
(C) Bilateral symmetrical
(D) Asymmetrical

224. Which of the following is true about triploblastic animals: (BUMHS 2024)
(A) Their body consists of two layers
(B) They have non-cellular mesoglea present
(C) They have great degree of specialization in cells
(D) They are radial symmetry

225. A disadvantage of animal cloning is: (BUMHS 2024)
(A) Rapid growth
(B) Rapid aging
(C) Identical offsprings
(D) Absence of mitosis

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Answer Key

1. A	2. C	3. A	4. B	5. D	6. C	7. C	8. D	9. A	10. C
11. A	12. A	13. C	14. C	15. A	16. C	17. B	18. C	19. A	20. C
21. D	22. A	23. B	24. D	25. A	26. D	27. B	28. C	29. B	30. B
31. B	32. C	33. B	34. C	35. B	36. C	37. B	38. C	39. C	40. A
41. B	42. C	43. B	44. A	45. C	46. C	47. B	48. B	49. D	50. B
51. A	52. A	53. C	54. B	55. B	56. B	57. C	58. A	59. B	60. D
61. A	62. C	63. C	64. B	65. C	66. B	67. B	68. C	69. A	70. B
71. B	72. B	73. A	74. C	75. B	76. C	77. B	78. A	79. C	80. B
81. C	82. B	83. D	84. A	85. B	86. A	87. D	88. A	89. B	90. A
91. C	92. D	93. B	94. C	95. D	96. A	97. B	98. A	99. D	100. B
101. B	102. B	103. A	104. B	105. B	106. D	107. C	108. B	109. B	110. C
111. C	112. C	113. B	114. B	115. B	116. C	117. B	118. D	119. B	120. A
121. D	122. B	123. D	124. B	125. A	126. C	127. B	128. C	129. C	130. A
131. D	132. C	133. C	134. B	135. B	136. D	137. B	138. C	139. C	140. B
141. B	142. B	143. B	144. B	145. D	146. C	147. C	148. C	149. B	150. D
151. A	152. C	153. D	154. B	155. C	156. D	157. D	158. B	159. D	160. D
161. B	162. D	163. C	164. C	165. A	166. D	167. D	168. C	169. B	170. C
171. B	172. C	173. B	174. B	175. C	176. B	177. A	178. C	179. A	180. C
181. C	182. B	183. C	184. B	185. A	186. B	187. D	188. D	189. B	190. A
191. D	192. A	193. B	194. B	195. C	196. A	197. C	198. B	199. C	200. B
201. D	202. B	203. B	204. D	205. B	206. D	207. A	208. C	209. C	210. C
211. C	212. B	213. B	214. B	215. A	216. C	217. D	218. B	219. A	220. A
221. D	222. A	223. D	224. C	225. C					

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UNIT # 07

ENZYMES

High Yield Content:

- Characteristics of enzymes
- Classification of enzymes
- Mechanism of enzyme action
- Inhibitor

SCAN QR CODE To Watch MDCAT Lectures, Test Discussions, and Past Papers Discussion on "Enzymes"

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ENZYMES: KEY CONCEPTS

- Enzymes are **biological catalysts** that speed up biochemical reactions without being consumed in the process (Accelerators).
- Enzymes are primarily composed of **globular proteins.**
- **Ribozymes (Exception to Protein-Based Enzymes):** RNA molecules that exhibit catalytic activity. For example, **peptidyl transferase** which from peptide bond during translation.
- **Anselme Payen (1833)** discovered the first enzyme, **diastase**, which catalyzes the breakdown of starch into maltose.
- **Wilhelm Kühne (1878)** Coined the term **enzyme.**
- **James B. Sumner (1926)** Isolated and crystallized the enzyme urease.

CHARACTERSTICS OF ENZYMES

- Most enzymes are **globular proteins.**
- Enzymes remain unchanged after the reaction and **can be reused.**
- Their presence does not affect the nature of end products.
- **Small quantity** of enzyme is enough for chemical reaction.
- Some enzymes require **non-protein components** for activity.
- Each enzyme acts on a specific substrate.
- They can catalyze reactions in both **forward and reverse directions** under equilibrium.
- Enzymes function best at specific **temperatures** and **pH** levels; extremes can denature them.
- Enzymes speed up biochemical reactions by **lowering the activation energy** required for the reaction.
- They require **aqueous medium** for their activity.
- They can work ***in-vivo*** (Natural conditions) as well as ***in-vitro*** (Laboratory Conditions).
- Some enzymes are **potentially damaging** if they are manufactured in their active form (e.g. Pepsin).
- The **turnover number** refers to the number of substrate molecules that a single enzyme molecule can convert into product **per second** under optimal conditions.

STRUCTURE OF ENZYMES

- Enzymes composed of **hundreds of amino acids** and molecular weight **10,000 to over one million Daltons.**
- They exhibit **tertiary** or **quaternary** structure.
- Most of amino acids maintain **globular structure** and enzymes while few are involved in catalysis.
- **Active Site** is a pocket or groove on the enzyme where the substrate binds. Active site consists of **3-12 amino acids.**
- The substrate molecules are attached to the active site by **non-covalent interactions** like hydrogen bonding, ionic bonds and hydrophobic interactions.
- **Binding sites** region in active site which make bond with substrate, thus involved in recognition and formation of ES complex.
- **Catalytic site** is the region in active site which convert substrate into products.

COFACTORS

- **Non protein part** of enzyme that is required for its proper functioning.
- Cofactors act as **bridge** between enzyme and substrate, **source of energy** and also help to drive reactions (catalysis).
- An enzyme with its cofactor removed is called **Apoenzyme** (Non-functional Enzyme).
- An activated enzyme consisting of polypeptide chain and a cofactor is called **Holoenzyme** (Functional Enzyme).

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Types Of Cofactors

Feature	Activator	Co-Enzymes	Prosthetic group
Definition	Inorganic detachable cofactor	Organic detachable cofactor	Non-detachable cofactor
Binding Nature	Weak and reversible binding.	**Temporarily binds** during the reaction and is released afterward.	**Permanently bound to the** enzyme.
Type	Always inorganic **(Metal ions)**	Always organic, often **derived from vitamins.**	Organic or inorganic.
Examples	**Mg^{2+}** (Hexokinase), **Zn^{2+}** (Carbonic anhydrase), **Fe^{2+}** (Catalase), **Cu^{2+}** (Cytochrome Oxidase)	**NAD^+** (Nicotinamide Adenine Dinucleotide), **$NADP^+$** (Nicotinamide Adenine Dinucleotide Phosphate), **FAD** (Flavin Adenine Dinucleotide), **ATP** (Non-vitamin Coenzyme)	**Haem group/ Iron containing porphyrin ring attach to some** enzymes like cytochrome.

Vitamins are Raw Material for Co-enzymes

Vitamin	Co-enzyme	Associated Enzymes	Function
Vitamin B2 (Riboflavin)	Flavin Mononucleotide (FMN), Flavin Adenine Dinucleotide (FAD)	Succinate Dehydrogenase, NADH Dehydrogenase	Acts as an electron carrier in redox reactions in the Krebs cycle and electron transport chain.
Vitamin B3 (Niacin)	Nicotinamide Adenine Dinucleotide (NAD^+), NAD Phosphate ($NADP^+$)	Lactate Dehydrogenase, Glucose-6-Phosphate Dehydrogenase	Transfers electrons in oxidation-reduction reactions.
Vitamin B7 (Biotin)	Biotin	Facilitates carboxylation reactions by transferring CO_2 groups.	Pyruvate Carboxylase, Acetyl-CoA Carboxylase
Vitamin B12 (cyanocobalamin)	Methylcobalamin, Deoxyadenosylcobalamin	Methionine Synthase, Methylmalonyl-CoA Mutase	Transfers methyl groups and facilitates fatty acid and amino acid metabolism.

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MECHANISM OF ENZYMES ACTION

Step	Description
1. Substrate Binding	The substrate binds to the enzyme's active site, forming an **enzyme-substrate complex**. The active site is highly specific for the substrate due to its unique shape and chemical properties.
2. Formation of the Enzyme-Substrate Complex	Once the substrate binds, the enzyme undergoes a slight conformational change (induced fit) to better hold the substrate in place. This maximizes interactions between the enzyme and substrate.
3. Catalysis	The enzyme catalyzes the conversion of the substrate into the product. This may involve breaking bonds, forming new bonds, or rearranging the structure of the substrate. Enzymes lower the activation energy required for the reaction.
4. Product Release	After the reaction, the enzyme releases the product(s) from the active site. The enzyme itself remains unchanged and is ready for another reaction cycle.
5. Enzyme Recycling	The enzyme returns to its original state and is free to catalyze subsequent reactions with new substrate molecules.

- **Feedback inhibition:** Activity of enzyme can be inhibited by its own products.
- **Precursor activation:** Increase in substrate concertation can cause increase in rate of reaction.

Models of Enzyme Action

Feature	Lock and Key Model	Induce Fit Model
Definition	Propose that the enzyme's active site is a perfect match for the substrate, like a key **(Substrate)** fitting into a lock **(Enzyme).**	Suggests that the enzyme's **active site molds** itself around the substrate upon binding. **Modified form** of lock and key model.
Scientist	Proposed by **Emil Fischer** in 1894.	Proposed by **D. Koshland** in 1959.
Active Site Shape	**Rigid** and pre-formed to fit the substrate exactly.	**Flexible** and adjusts to the substrate's shape.
Enzymes	Enzymes which follow this model are called **non-regulatory enzymes.**	Enzymes which follow this model are called **Regulatory or Allosteric enzymes.**
Specificity	Highly specific; catalyze only one substrate type or specific reaction (absolute specificity).	It allows more than one type of related reactions.
Examples	Amylase, Urease, Maltase, Lactase, Sucrase	Carbonic anhydrase, Hexokinase, DNA Polymerase, Adenylate cyclase

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ENERGY OF ACTIVATION

- Energy of activation **(Ea)** is the minimum amount of energy required to convert reactants into products by transitioning through an unstable intermediate state **(transition state).**
- **Enzymes lower the activation energy** of biochemical reactions, enabling them to occur faster and more efficiently under physiological conditions.

How Enzymes Lower Ea?

- **Substrate Orientation:** Enzymes properly align substrates to facilitate reaction.
- **Stabilizing the Transition State:** Enzymes form temporary bonds with the substrate, reducing the energy required to reach the transition state.
- **Microenvironment:** Enzymes create an optimal environment (e.g., correct pH, charge) for the reaction.
- **Strain on Bonds:** Enzymes weaken specific bonds in the substrate, making them easier to break.
- Enzymes lower the activation energy but **do not alter the overall free energy change (ΔG)** of the reaction.

Km (Michaelis Constant)

- Km is the substrate concentration at which the reaction rate is half of the maximum velocity (Vmax/2).

Significance

- Indicates the enzyme's **affinity for its substrate.**
- **Lower Km** = High substrate affinity (enzyme binds substrate effectively even at low concentrations).
- **Higher Km** = Low substrate affinity (enzyme requires higher substrate concentration to achieve activity).

Vmax (Maximum Velocity)

- Vmax is the **maximum rate** of reaction when all enzyme **active sites are saturated** with substrate.

Significance

- Reflects the **catalytic efficiency** of the enzyme when working at full capacity.
- Depends on the enzyme concentration and **turnover number** (number of reactions catalyzed per second by an enzyme molecule).

FACTORS AFFECTING THE RATE OF ENZYME ACTION

- The rate of enzymatic reaction is measured by the amount of substrate changed or amount of product formed during a period of time.

Temperature

- Temperature affects the kinetic energy of molecules, impacting the rate of enzymatic reactions.
- At **low temperatures**, enzyme activity is slow due to reduced molecular motion, its temperature is near or below freezing, **enzymes are inactivated not denatured.**
- As temperature **increases**, the rate of reaction rises because molecules collide more frequently.
- Every **10 °C rise** in temperature doubles the rate of reaction.
- All Human enzymes have a optimum temperature of about **37°- 38° C.**
- Beyond the **optimum temperature**, enzymes **denature** due to destruction of globular structure of enzymes.
- Most of enzymes of higher organisms have optimum temperature between **25 °C to 42 °C.**
- Some bacteria survive in hot springs **(Thermophilic)** they have optimum temperature of **70 °C or higher.**

pH Value

- Enzyme work at **narrow range of pH** and work maximum at optimum pH.
- Enzyme configuration is sensitive to pH fluctuations because pH influences the charges on the amino acid side chains that are involved in maintaining globular structure.
- **Slight change** in pH changes the ionization of amino acids at active site.
- **Extreme change** in pH disrupts the ionic bonding which causes denaturation of enzymes.
- Majority of human digestive enzyme work in the range of **7-8 pH.**

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Optimum pH Of Some Common Enzymes

Enzyme	Site of Action	Optimum pH	Functions
Pepsin	Lumen of stomach	2.00	Hydrolysis of proteins.
Sucrase	Small intestine	4.50	Convert sucrose into glucose and fructose.
Enterokinase	Small intestine	5.50	Conversion of trypsinogen into trypsin.
Salivary Amylase	Oral cavity	6.80	Breaks down starch into maltose.
Catalase	Liver	7.60	Decomposition of H_2O_2.
Chymotrypsin	Small intestine	7.00-8.00	Cleaves peptide bonds in proteins.
Pancreatic lipase	Small intestine	9.00	Breaks down fats into glycerol and fatty acids.
Arginase	Liver	9.70	Catalysis of arginine into urea.
Lactase	Small intestine	6.00	Convert lactose into glucose and galactose
Carbonic Anhydrase	Red blood cells	7.00	Converts carbon dioxide and water into carbonic acid, aiding in pH regulation.

Enzyme Concentration

- The reaction rate is directly proportional to enzyme concentration if the **substrate concentration is unlimited, or enzyme concentration is limited.**
- If substrate concentration is **low**, the reaction rate will not increase significantly with additional enzymes because there aren't enough substrate molecules to bind with all the enzymes.
- The rate is directly proportional to enzyme concentration until substrate becomes limiting factor.

Substrate Concentration

- **At low substrate levels**, enzyme activity is directly proportional to the substrate concentration because more active sites are available for binding.
- When all the active sites are occupied by substrate and no more active sites are available, this state is called **state of saturation.**

ENZYME INHIBITORS

- Inhibitors are **chemical substances** which react with enzyme in place of substrate but not transformed into products and block the active site **temporarily** and **permanently.**
- Molecules that act as **inhibitors includes** poisons, cyanides, antibiotics, antimetabolites, some drugs and heavy metals.
- Based on their mechanism, enzyme inhibitors are classified into **reversible** and **irreversible** inhibitors.

Reversible inhibitors

- These inhibitors bind to enzymes temporarily and can dissociate, restoring enzyme activity.

Irreversible inhibitors

- They occupy active sites by forming **covalent bonds** and permanently inactivating the enzyme.
- **Examples:** Cyanides and ions of heavy metals
- **Cyanide** inhibits cytochrome c oxidase in the respiratory chain.
- **Heavy metals** such as Hg^{2+}, Ag^{2+}, Cu^{2+} can combine with **thiol group** in the enzymes and breaking **disulphide bridges.**

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Types of Reversible Inhibitors	
Types	**Mechanism**
Competitive	➢ Structurally similar to substrate. ➢ Competes with the substrate for the **active site**. ➢ Their effect can be neutralized by increasing substrate concentration. ➢ **Example:** Malonic acid
Non-Competitive	➢ Inhibitor binds to an **allosteric site**, causing conformational changes. ➢ Cannot be overcome by increasing substrate concentration. ➢ **Example**: ATP (as feedback inhibitor) Inhibits glycolysis during high-energy conditions by binding allosterically.
Uncompetitive	➢ Inhibitor binds only to the **enzyme-substrate complex**, preventing the reaction from completing.

CLASSIFICATION OF ENZYMES

- Enzymes can be classified on the **basis of reaction type and substrates.**
- **International union of biochemistry (1961)** has classified enzymes into **six groups** on the basis of reactions.

Classification of Enzymes Based on Type of Reaction		
Enzyme Class	**Type of Reaction Catalyzed**	**Examples**
1. Oxidoreductases	Catalyze oxidation-reduction reactions (transfer of electrons or hydrogen).	**Dehydrogenase** (e.g., Lactate Dehydrogenase) **Oxidase** (e.g., Cytochrome Oxidase)
2. Transferases	Transfer a functional group (e.g., methyl, phosphate, or amino group).	**Kinase** (e.g., Hexokinase) **Aminotransferase** (e.g., Alanine Transaminase)
3. Hydrolases	Catalyze hydrolysis reactions (breaking bonds with water).	**Lipase** (e.g., Pancreatic Lipase) **Protease** (e.g., Trypsin)
4. Lyases	Catalyze the breakdown of specific covalent bond and removal of group without hydrolysis.	**Decarboxylase** (e.g., Pyruvate Decarboxylase, Histidine decarboxylase) **Aldolase** (e.g., Fructose-1,6-bisphosphate Aldolase)
5. Isomerases	Catalyze the rearrangement of atoms within a molecule to from isomers.	**Isomerase** (e.g., Phosphohexose Isomerase) **Mutase** (e.g., Phosphoglycerate Mutase)
6. Ligases	Catalyze the joining of two molecules with the use of ATP.	**DNA Ligase** **Carboxylase** (e.g., Pyruvate Carboxylase)

Classification of Enzymes Based on Substrate		
Enzyme Class	**Type of Reaction Catalyzed**	**Examples**
Proteases (Peptidases)	Break down proteins into smaller peptides or amino acids.	Pepsin, Trypsin, Amino peptidase, Carboxy-peptidase.
Carbohydrases	Hydrolyze the carbohydrates	Amylase, Cellulase, Maltase, Sucrase, Lactase
Lipases	Hydrolyze triglycerides into glycerol and free fatty acids.	Pancreatic Lipase
Nucleases	Break down DNA or RNA into nucleotides.	Deoxyribonuclease (DNase) Ribonuclease (RNase)

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1. First discovered Enzyme was:
(A) Diastase (B) Urease
(C) Pepsin (D) Transferase

2. Enzyme were discovered for the first time in:
(A) Bacteria (B) Yeast
(C) Algae (D) Spinach

3. Who coined the term enzyme:
(A) Pasteur (B) Buchner
(C) Kuhne (D) Sumner

4. The first enzyme isolated in crystalline form was:
(A) Catalase (B) Urease
(C) Peroxidase (D) Amylase

5. Which of the following is a coenzyme:
(A) NAD (B) NADP
(C) FAD (D) All the above

6. Both can be used again and again:
(A) Hormones & Antibodies
(B) Enzyme& Substrates
(C) Enzymes & Co-enzymes
(D) Substrates& Products

7. The enzyme that is produced in its active form:
(A) Trypsin (B) Chymotrypsin
(C) Pepsin (D) EcoR1

8. The substrate molecule attached to active site by:
(A) Hydrogen Bonding
(B) Hydrophobic interactions
(C) Covalent Bonding
(D) Both A & B

9. Combination of apoenzyme and coenzyme produces:
(A) Prosthetic group (B) Holoenzymes
(C) Isoenzyme (D) Enzymes

10. Phosphatases belongs to which group of enzymes:
(A) Lyases (B) Ligases
(C) Hydrolases (D) Isomerases

11. Conversion of glucose 6-Phosphate into fructose 6-Phosphate is done by:
(A) Transferases (B) Oxidoreductases
(C) Isomerases (D) Hydrolases

12. Enzymes catalyze the condensation reaction like DNA and RNA Polymerase:
(A) Lyases (B) Ligases
(C) Hydrolases (D) Isomerases

13. The enzymes catalyze the breakdown of specific covalent bond and removal of group without hydrolysis:
(A) Transferases (B) Oxidoreductases
(C) Lyases (D) Hydrolases

14. Group of enzymes that bring about intra-molecular rearrangement of atoms:
(A) Lyases (B) Ligases
(C) Hydrolases (D) Isomerases

15. Which of following has a coenzyme activity:
(A) Ca^{++}
(B) Porphyrin
(C) NAD
(D) All of these correct

16. Vitamin is a precursor for:
(A) Haem (B) ATP
(C) FAD (D) Mg^{2+}.

17. Ribozymes consists of:
(A) Only protein
(B) Protein + Non protein part
(C) Only RNA
(D) Both A & C

18. Many enzymes are secreted in inactive form to protect:
(A) Cell membrane (B) Mitochondria
(C) Cell proteins (D) Cell DNA

19. The specificity of enzyme is due to their:
(A) Surface configuration (B) pH
(C) Hydrogen bonding (D) Molecular weight

20. An enzyme with its co-enzyme or prosthetic group removed is designated as:
(A) Apoenzyme (B) Co-enzyme
(C) Holoenzyme (D) Co-factor

21. Adding correct concentrated of co-enzyme to the apoenzyme will:
(A) Restore enzyme activity
(B) Expedite enzyme activity
(C) Inhibit enzyme activity
(D) Pull down enzyme activity

22. The reaction rate of salivary amylase with starch decreases as the concentration of chloride ions is reduced. Which of the following describes the role of chloride ion:
(A) Allosteric inhibitor
(B) Co-factor
(C) Co-enzyme
(D) Competitive inhibitor

23. The enzyme important in photosynthesis are found in:
(A) Mitochondria (B) Ribosomes
(C) Chloroplast (D) Golgi Apparatus

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24. Pick up an enzyme that catalyze two different substrates together but produces a single type of products:
(A) Pepsin
(B) DNase
(C) Carbonic anhydrase
(D) Reverse transcriptase

25. Which of the following cofactor is used for enzyme carbonic anhydrase:
(A) Zn^{2+} (B) Cu^{2+}
(C) Mg^{2+} (D) Fe^{2+}

26. How does an enzyme increase the rate of reaction:
(A) By bringing the reacting molecules into precise orientation
(B) By increasing the rate of random collision of molecules
(C) By shifting the point of equilibrium of the reaction
(D) By supplying the energy required to start the reaction

27. Enzyme lower the _____ of the reaction:
(A) pH (B) Activation energy
(C) Temperature (D) Speed

28. Pepsin is a powerful _____ digesting enzyme:
(A) Carbohydrates (B) Lipids
(C) Proteins (D) Nucleic acid

29. The active site of the enzyme is made up of _____ definite regions:
(A) Two (B) Four
(C) Three (D) Five

30. The enzyme catalyzes the breakdown of specific covalent bonds and removal of groups without hydrolysis:
(A) Lyases (B) Transferases
(C) Hydrolases (D) Isomerases

31. Erypsin is an example of:
(A) Proteases (B) Nucleases
(C) lipases (D) Carbohydrases

32. Heavy metal ions that act as inhibitors break which bond in enzyme?
(A) Peptide bond (B) Hydrogen bond
(C) Disulphide bridges (D) Ionic bond

33. Enzyme require _____ medium for its activity:
(A) Aqueous (B) Solid
(C) Liquid (D) Dry

34. Which enzyme is utilized in the brewing industry to break down starches into fermentable sugars?
(A) Lipase (B) Protease
(C) Nuclease (D) Amylase

35. Who proposed lock and key model to visualize substrate and enzyme action:
(A) Koshland (B) Edward Bucher
(C) Emil Fischer (D) J.B Summer

36. The active site is a rigid structure according to:
(A) Koshland's Model
(B) Koshland's Lock and key model
(C) Induced Fit model
(D) Emil Fischer's Lock and key model

37. By increasing the enzyme molecules an increase in the number of _____ takes place:
(A) Substrate molecules
(B) Active site
(C) Product molecules
(D) Inhibitor molecules

38. The role of enzyme-controlled reaction may increase with increase in temperature:
(A) Up to a certain limit
(B) Up to minimum level
(C) Up to maximum level
(D) Up to infinite level

39. Increased temperature above optimum usually does not effect _____ of enzymes:
(A) Primary structure
(B) Secondary structure
(C) Tertiary Structure
(D) Quaternary structure

40. At high substrate level, further increase in the substrate does not increase the reaction rate because:
(A) There is no enzyme
(B) All the active site of the enzyme are occupied
(C) There is no active site
(D) All the active site of the enzyme are free

41. For most of the enzymes of human body, the optimum temperature is:
(A) 37 C° (B) 37 F°
(C) 35 C° (D) 98.6 C°

42. Temperature required to activate any inactivated enzyme is called as:
(A) Optimum (B) Maximum
(C) Minimum (D) Ideal

43. _____ the reaction rate is directly proportional to the substrate available:
(A) At high conc. of substrate
(B) At low conc. of substrate
(C) At low conc. of enzyme
(D) All are correct

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44. If the enzyme concentration is ____and amount of substrate is _____ a point is reached when a further increase in the substrate does not because the rate of reaction, anymore:
(A) Increased, increased,
(B) Decreased, increased
(C) Increased, Decreased
(D) Keep constant, increased

45. Enzyme is denatured when temperature is increase beyond:
(A) Minimum range (B) Optimum range
(C) Maximum range (D) Moderate

46. Which of the following is an important non-vitamin coenzyme?
(A) NAD (B) ATP
(C) FAD (D) Both A and C

47. It is a chemical substance which can react in place of substrate, with enzyme but is not transformed into products:
(A) Cyanide (B) Antibodies
(C) Inhibitor (D) Antimetabolites

48. Basic types of inhibitors are:
(A) Irreversible and competitive inhibitors
(B) Reversible and non-competitive inhibitors
(C) Reversible and competitive
(D) Irreversible and reversible inhibitor

49. They check the reaction rate by occupying the active sites or destroying the globular structure:
(A) Irreversible inhibitors
(B) Competitive inhibitors
(C) Reversible inhibitors
(D) Non-competitive inhibitors

50. They make weak linkages with the enzymes:
(A) Irreversible inhibitors
(B) Competitive inhibitors
(C) Reversible inhibitors
(D) Non-competitive inhibitors

51. Their effect can be neutralized completely or partially by an increase in the concentration of the substrate:
(A) Irreversible inhibitors
(B) Cyanide
(C) Reversible inhibitors
(D) Non-competitive inhibitors

52. Pick up the enzyme:
(A) Succinic acid (B) Malonic acid
(C) Fumaric acid (D) Dehydrogenase

53. Which one of the following is secreted in inactive form:
(A) Pepsin (B) Ptyalin
(C) Amylopsin (D) Lipase

54. The enzyme having slightly acidic pH as optimum pH is called:
(A) Pepsin (B) Salivary Amylase
(C) Arginase (D) Sucrase

55. Select the proenzyme?
(A) Pepsinogen and pepsin
(B) Pepsinogen and amylase
(C) Pepsinogen and catalase
(D) Pepsinogen and trypsinogen

56. Match the column:

Column I	Column II
1) Collagen	1. Hormone
2) Trypsin	2. Enzyme
3) Insulin	3. Fight Infectious agent.
4) Antibody	4. Intercellular ground substance

(A) 1-1, 2-3, 3-4,4-2
(B) 1-4, 2-2, 3-1, 4-3
(C) 1-1, 2-2, 3-3, 4-4
(D) 1-4, 2-3, 3-1,4-2

57. There are some nucleic acids that behaves like enzymes and are called:
(A) DNase (B) Endonuclease
(C) RNase (D) Ribozymes

58. Which one is correct?
(A) $E+S \rightarrow ES \rightarrow EP \rightarrow EP$
(B) $E+S \rightarrow ES \rightarrow EP \rightarrow E-P$
(C) $E+S \rightarrow ES \rightarrow EP \rightarrow E+P$
(D) $E+S \rightarrow ES \rightarrow EP \rightarrow E-P$

59. Inhibition of succinate dehydrogenase by malonate is an example of:
(A) Non-competitive inhibition
(B) Allosteric inhibition
(C) Negative feedback
(D) Competitive inhibition

60. Which one of the following statements about enzymes is true?
1. Enzymes are proteins whose three-dimensional shape is key to their functions
2. Enzymes speed up reactions by lowering activation energy
3. Enzymes are highly specific for reactions.
4. Enzyme activity affected by change in temperature and pH
(A) All except 2 (B) All except 3
(C) All except 4 (D) All

61. Arrange the steps of catalytic action of an enzyme in order and choose the correct option:

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I. The enzyme releases the products of the reaction, and the enzyme is free for another substrate.
II. The active site of enzyme is in proximity of the substrate and breaks of chemical bonds of the substrate.
III. The binding of substrate induces the enzyme to alter its shape fitting more tightly around the substrate.
IV. The substrate binds to the active site of the enzyme fitting into the active site.

(A) IV, III, II, I (B) III, II, I, IV
(C) IV, II, I, III (D) II, I, IV, III

62. Such types of inhibitors which form Enzyme-Inhibitor Complex at another point than the active site called:
(A) Competitive inhibitors
(B) Irreversible inhibitors
(C) Non-competitive inhibitors
(D) Reversible inhibitors

63. The catalytic activity of an enzyme is restricted to its small portion called:
(A) Active site (B) Allosteric site
(C) Passive site (D) Catalytic site

64. An activated enzyme made of polypeptide chain and a co-factor is:
(A) Coenzyme (B) Apoenzyme
(C) substrate (D) Holoenzyme

65. Koshland in 1959 proposed:
(A) Fluid mosaic model
(B) Induce fit model
(C) Lock and key model
(D) Reflective index model

66. Enzymes are largely _____ in their chemical nature:
(A) Lipids (B) Proteinaceous
(C) Steroids (D) Glycoprotein

67. Who proposed "lock and key" model to study enzyme – substrate interaction?
(A) Koshland (1959)
(B) Wilhelm Kuhne (1878)
(C) Fischer (1898)
(D) Waston (1953)

68. Which type of bond is mostly affected in an enzyme molecule when there are pH fluctuations:
(A) Ionic bond (B) Disulphide bond
(C) Hydrogen bond (D) Peptide bond

69. Competitive inhibitors stop an enzyme from working by:
(A) Changing the shape of the enzyme.
(B) Merging with the substrate instead.
(C) Blocking the active site of the enzyme.
(D) Combining with the product of the reaction.

70. The enzymes are sensitive to:
(A) Changes in pH
(B) Changes in temperature
(C) Change in inhibitors
(D) Both A and B

71. Enzyme B requires Zn^{2+} to catalyze the conversion of substrate X. The zinc is been identified as:
(A) Coenzyme (B) Substrate
(C) Activator (D) Product

72. The enzyme minus its coenzyme is referred to as the:
(A) Isoenzyme (B) Apoenzyme
(C) Metalloenzyme (D) All of these

73. The "lock and key" model of enzyme action illustrates that a particular enzyme molecule:
(A) Forms a permanent enzyme-substrate complex
(B) May be destroyed and resynthesized several times
(C) Interacts with a specific type of substrate molecule
(D) Reacts at identical rates under all conditions

74. An inhibitor that changes the overall shape and chemistry of an enzyme is known as a/an:
(A) Allosteric inhibitor
(B) Competitive inhibitor
(C) Steric inhibitor
(D) Noncompetitive inhibitor

75. Non-protein components loosely attached with enzymes are known as:
(A) Coenzymes (B) Prosthetic group
(C) Activators (D) Both A & C

76. The reaction within the cells to prevent the accumulation of hydrogen peroxide. In this reaction, catalase functions as an:
(A) Enzyme in the breakdown of hydrogen peroxide
(B) Enzyme in the synthesis of hydrogen peroxide
(C) Emulsifier in the digestion of hydrogen peroxide
(D) Indicator in the detection of hydrogen peroxide

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77. An enzyme is generally named by adding _____ to the end of the name of the _____:
(A) "-ase". Coenzyme
(B) "-ase". Cell in which it is found.
(C) "-ose". Substrate
(D) "-ase". Substrate

78. The minimum amount of energy needed for a process to occur is called the:
(A) Minimal energy theory
(B) Process energy
(C) Kinetic energy
(D) Activation energy

79. $C_4H_4O_4$ is the formula of which of the following?
(A) Succinic acid (B) Malonic acid
(C) Citric acid (D) Fumaric acid

80. How many amino acids are there in the active site?
(A) 2-4 (B) 20-30
(C) 10-20 (D) 30-40

81. FAD (Flavin adenine dinucleotide) is a/an:
(A) Coenzyme (B) Prosthetic group
(C) Activator (D) All of these

82. Active site of an enzyme consists of:
(A) Bulk of amino
(B) Non protein part
(C) Few amino acids
(D) All the amino acids

83. The most unstable of the following is:
(A) Enzyme
(B) Substrate
(C) Enzyme substrate complex
(D) Product

84. The cofactor usually acts as bridge between
(A) Enzyme and substrate:
(B) Enzyme and Product
(C) Coenzyme and substrate
(D) Co factor and substrate.

85. Which leads to the formation of E-S complex:
(A) Binding site (B) Catalytic site
(C) Active site (D) Allosteric site

86. Which can destroy the cell's internal structure:
(A) Pepsin (B) Pepsinogen
(C) Ligase (D) Polymerase

87. Which enzyme is not a protein:
(A) Hexokinase (B) Synthetase
(C) Endonuclease (D) Ribozyme

88. An organic substance bound to an enzyme and essential for its activity is called:
(A) Apoenzyme (B) Isoenzyme
(C) Coenzyme (D) Holoenzyme

89. The essential chemical components of many coenzymes are:
(A) Vitamins (B) Proteins
(C) Nucleic acids (D) Carbohydrates

90. Transition state structure of the substrate formed during an enzymatic reaction is:
(A) Permanent and stable
(B) Transient but stable
(C) Permanent but unstable
(D) Transient and unstable

91. Enzymes, which catalyze the transfer of hydrogen (H^+) between two substrates, are called:
(A) Transferases (B) Oxidoreductases
(C) Isomerases (D) Hydrolases

92. Substrate concentration at which an enzyme attains half of its maximum velocity is:
(A) Half-life of enzyme
(B) Km-constant of enzyme
(C) Concentration ratio
(D) Turn over number (TON) of enzyme

93. Enzymes related to fatty acid oxidation are present in:
(A) Plasma membrane (B) Chloroplast
(C) Mitochondria (D) Nucleolus

94. Function of succinate dehydrogenase is aided by:
(A) NAD (B) FAD
(C) Metal ion (D) Vitamin

95. An enzyme which is not protein in nature:
(A) Amylopsin (B) Arginase
(C) Peptidyl transferase (D) BAM H1

96. Lock and key model for enzyme action proposed by Emil Fischer suggested that:
(A) Enzymes are unbiased for substrate
(B) Enzyme can modify their active sites
(C) Enzymes are restricted to one type of reaction
(D) Enzyme can catalyze variety of reactions

97. Enzyme which follows the induce fit mechanism are called:
(A) Regulatory enzymes
(B) Allosteric enzymes
(C) Non-regulatory enzymes
(D) Both A and B

98. If the number of substrates is limited in system, the rate of reaction will directly be proportional to:
(A) Enzymes (B) Substrates
(C) Activation energy (D) Both A and B

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99. Optimum pH of enterokinase is:
(A) 5.50 (B) 9.70
(C) 4.40 (D) 9.0

100. Change in temperature from 30 C to 40 C in human body will cause:
(A) Increase in rate of reaction
(B) Decrease in rate of reaction
(C) First Increase the decrease in rate of reaction
(D) First Increase then become constant

101. Which of the following bond is mostly affected in an enzyme molecule when there are pH fluctuations:
(A) Ionic bond (B) Hydrogen bond
(C) Disulphide bond (D) Peptide bond

102. Most of enzyme have an optimum temperature of around:
(A) 20 C (B) 30 C
(C) 40 C (D) 50 C

103. Which of following is common in both competitive and non-competitive inhibition:
(A) Irreversible inhibition
(B) Feedback inhibition
(C) Reversible inhibition
(D) Non- Reversible inhibition

104. Heavy metal ions (mercury, silver and copper) break _____ in enzymes
(A) Peptide bond (B) Hydrogen bond
(C) Disulphide bridges (D) Ionic bond

105. Which of the following inhibitor binds with the ES Complex:
(A) Competitive inhibitor
(B) Non-Competitive inhibitor
(C) Uncompetitive inhibitor
(D) Non-reversible inhibitors

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106. An enzyme and substrate react through a specific feature or site present in enzyme known as: (2011)
(A) Building site (B) Catalyst site
(C) Active site (D) Inhibition site

107. The non-protein part of enzyme which is covalently and permanently bonded is called:(2011)
(A) Prosthetic group (B) Co-enzyme
(C) Co-factor (D) Activator

108. One of the following pyrimidine bases is absent in DNA: (2011)
(A) Uracil (B) Cytosine
(C) Thymine (D) Adenine

109. Enzymes increase the rate of reaction by: (2011)
(A) Increasing temperature
(B) Decreasing activation energy
(C) Decreasing pH
(D) Increasing activation energy

110. The type of inhibition in which inhibitor has no structural similarity to substrateand combines with enzyme at other than the active site is called: (2012)
(A) Irreversible inhibition
(B) Non-competitive and reversible inhibition
(C) Cementation inhibition
(D) Reversible inhibition

111. The inhibitors that bind tightly and permanently to enzymes and destroy their globular structure as catalytic activity are: (2012)
(A) Reversible inhibitor
(B) Competitive inhibiters
(C) Irreversible inhibitor
(D) Non-competitive inhibitors

112. Enzyme succinate dehydrogenase converts succinate into: (2012)
(A) Malate (B) Citrate
(C) Malonic acid (D) Fumarate

113. If the detachable co-factor is an inorganic ion, then it is designated as: (2012)
(A) Coenzyme (B) Holoenzyme
(C) Prosthetic group (D) Activator

114. The view that active site of an enzyme is flexible and when a substrate combines with it, causes change in enzyme structure is known as: (2013)
(A) Lock and key mode
(B) Induce fit model
(C) Sliding filament model
(D) Specificity model

115. All coenzymes are derived from: (2013)
(A) Proteins (B) Nucleic acids
(C) Vitamins (D) Carbohydrates

116. If the cofactor is covalently or tightly and permanently bonded to enzyme, then itwill be called: (2013)
(A) Coenzyme (B) Apoenzyme
(C) Activator (D) Prosthetic group

117. Optimum pH value for the working of pancreatic lipase is: (2013)
(A) 4.50 (B) 9.0
(C) 7.60 (D) 2.00

118. All coenzymes are derived from:(2014)

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(A) Proteins (B) Metal ions
(C) Carbohydrates (D) Vitamins

119. The competitive inhibitors have structural similarity with: (2014)
(A) Active site (B) Substance
(C) Binding site (D) Co-enzyme

120. Which one of the following is the optimum pH of pancreatic lipase enzyme? (2014)
(A) 7.60 (B) 9.00
(C) 8.00 (D) 9.70

121. A co-factor tightly bound to the enzyme on the permanent called: (2014)
(A) Activator (B) Prosthetic group
(C) Co-enzyme (D) Apo-enzyme

122. Which molecular structure of an enzyme is essential for the activity of enzyme? (2015)
(A) Quaternary structure
(B) Secondary structure
(C) Primary Structure
(D) Tertiary structure

123. Some enzymes require helper which is a non-protein part for its efficient functioning; that is called: (2015)
(A) Accelerator (B) Prosthetic group
(C) Cofactor (D) Apoenzyme

124. Pepsin, protein digesting enzyme acts best at pH: (2015)
(A) 3.00 (B) 2.0
(C) 4.5 (D) 6.0

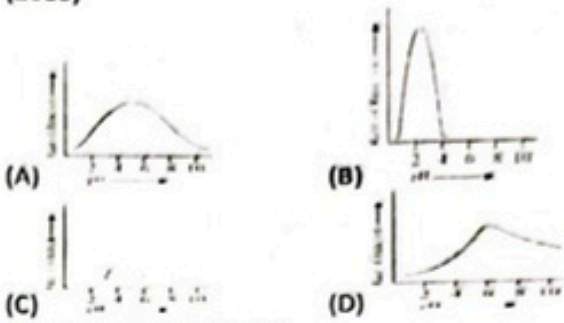
125. Which one of the following is an example of a competitive inhibitor? (2015)
(A) Glucose (B) Succinic acid
(C) Fumarate (D) Malonate

126. An enzyme required Mg^{++} to catalyze the substrate. The Mg^{++} is best identified as: (2016)
(A) Prosthetic group (B) Co-enzyme
(C) Activator (D) Inhibitor

127. This Figure represents____inhibitor: (2016)
(A) Non-competitive (B) Irreversible
(C) Competitive (D) Isosteric

128. According to_____model the active site of enzyme is modified as the substrate interacts with enzyme: (2016)
(A) Induced fit (B) Emil Fischer
(C) Lock and key (D) Fluid mosaic

129. Which one of the following graphs shows how the rate of reaction of pepsin is affected by pH? (2016)



130. All enzymes are: (2017)
(A) Fibrous proteins
(B) Lipoproteins
(C) Low molecular weight proteins
(D) Globular Proteins

131. The reactants on which enzyme works are: (2017)
(A) Products (B) Substrates
(C) Metabolites (D) Catabolites

132. Which one of the following comprises of inorganic ions? (2017)
(A) Coenzymes (B) Prosthetic group
(C) Activators (D) Apoenzyme

133. Which of the following type of inhibitor can be neutralize by adding more substrate into reaction: (2017)
(A) Irreversible inhibitor
(B) Irreversible non-competitive
(C) Reversible inhibitor
(D) Irreversible competitive

134. What is true about enzymes: (2017-Retake)
(A) Fibrous proteins
(B) No effect on end product
(C) Use in reaction
(D) Non-specific

135. Modified form of Lock and key model was proposed by: (2017-Retake)
(A) Koshland (B) Watson
(C) Fischer (D) Rosa

136. If molecule can bind to another site of enzyme rather than the true active site, it is referred as: (2018)
(A) Non-competitive inhibitor
(B) Competitive inhibitor
(C) Reversible inhibitor
(D) Irreversible inhibitor

137. What is the common in both competitive and non-competitive inhibition: (2019)

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(A) Reversible inhibition
(B) Feedback inhibition
(C) Non-reversible inhibition
(D) Irreversible inhibition

138. A student of chemical engineering mistakenly engulfed the toxic compound which was potent inhibitor of certain enzymes. He was immediately taken to the hospital where the doctor injected intravenously substance "B" to minimize the toxic effect of compound "A". His life was saved from serious damage. The treatment method shown that compound "A" was a _____ inhibitor: (2019)
(A) Non-competitive reversible
(B) Competitive reversible
(C) Temperature sensitive
(D) Irreversible inhibitor

139. The type of energy reduced by the enzymes for biological reaction to occur is called: (2019)
(A) Light energy (B) Active energy
(C) Activation energy (D) Heat energy

140. Which enzyme is administrated to the patient of Severe Combined Immunodeficiency Disease (SCID): (2019)
(A) Pancreatic enzyme (B) β-galactosidase
(C) Adenosine deaminase (D) β-lactamase

141. Lock and key model of enzyme action proposed by Emil Fischer suggested that: (2020)
(A) Enzymes are unbiased for substrate
(B) Enzymes can modify their active sites
(C) Enzymes are restricted to one type of reaction
(D) An enzyme can catalyze variety of reactions

142. Most of enzyme have an optimum temperature of around: (2020)
(A) 20 C (B) 30 C
(C) 40 C (D) 50 C

143. What is the effect of enzyme DNA ligase? (2020)
(A) DNA is broken up at specific site
(B) DNA fragments are joined together
(C) DNA replication occurs
(D) DNA transcription occurs

144. Enzymes work by lowering _____ of the reaction they catalyze: (2021)
(A) Kinetic energy (B) Heat energy
(C) Activation energy (D) Potential energy

145. The enzymes, integrase, protease, and reverse transcriptase are found in which virus? (2022)
(A) Hepatitis A virus (B) HIV
(C) Herpes virus (D) Influenza virus

146. Enzymes lower the activation energy by stabilizing the transition state of a metabolic reaction due to: (2022)
(A) Changing condition within the active site
(B) Changing condition within the protein framework
(C) Rearranging the fatty acids in active site
(D) Distorting the molecules in the allosteric site

147. Non-Competitive inhibitor molecules have: (2022)
(A) A similar structure to the normal substrate molecule
(B) A quite different structure from the substrate molecule
(C) A different combination but fit into the active site
(D) A similar conformation but does not fit into the active site

148. Zinc ion is attached at the active site of enzyme carboxypeptidase. The zinc ion function as: (2022)
(A) A co enzyme molecule
(B) An inhibitor molecule
(C) An activator
(D) Controller of allosteric site

149. What is the best physiological pH for optimum functions for most of cellular enzymes of human: (2022)
(A) 2-3 (B) 6-8
(C) 3-5 (D) 8-10

150. The major enzyme involved transfer of phosphate group form ATP to glucose is: (2023)
(A) Isomerase (B) Dehydrogenase
(C) Kinase (D) Decarboxylase

151. NAD is an important: (2023)
(A) Enzyme (B) Hormone
(C) Co-enzyme (D) Vitamin

152. The active site of an enzyme is composed of: (2023)
(A) Few nucleotides (B) Few saccharides
(C) Few nucleosides (D) Few amino acids

153. Competitive inhibitors are _____? (2023)
(A) Homologous to substrate
(B) Analogous to substrate
(C) Smaller than substrate
(D) Larger than substrate

154. Which enzyme is different from others: (2023)
(A) Pepsin (B) Chymotrypsin
(C) Trypsin (D) Lactase

155. Which of the following statement is incorrect regarding rate of enzyme action: (UHS 2024)
(A) Increase in enzyme concentration increase the rate

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(B) Increase in enzyme concentration reduce the rate
(C) All enzyme work at their maximum rate at optimum temperature
(D) All enzyme work at their maximum at optimum pH

156. Induce fit model of enzyme activity suggested that an enzyme: (UHS 2024)
(A) Cannot modify its active sites
(B) Can bind to single substrate
(C) Can catalyze related reactions
(D) Usually belongs to non-regulated enzymes

157. What happens to the enzyme after an enzyme catalysed reaction: (ETEA 2024)
(A) Reduced to inactive form
(B) Becomes inert
(C) Change into substrate
(D) Used for another reaction

158. Catalase can be activated at pH: (ETEA 2024)
(A) 1 (B) 3
(C) 5 (D) 7

159. Enzymatic activity can be inhibited by: (ETEA 2024)
(A) Heavy metal ions (B) Methane
(C) Mutase (D) Noble gases

160. A competitive inhibitor: (ETEA 2024)
(A) Accelerates the chemical reaction
(B) Competes with the enzyme
(C) Is irreversible
(D) Is reversible

161. Which enzyme is secreted in the active form: (ETEA 2024)
(A) Amylase (B) Trypsin
(C) Peptidase (D) Protease

162. How do enzymes enable the conversion of substrates into products by: (ETEA 2024)
(A) Change equilibrium in the direction of the substrate
(B) Increase the activation energy
(C) Increase the substrate concentration
(D) Lowering the activation energy

163. Optimum pH for pancreatic lipase is: (ETEA 2024)
(A) 2 (B) 4
(C) 6 (D) 8

164. Ions of heavy metal are harmful for living organisms because of their ability to: (NUMS 2024)
(A) Cleave nucleic acid
(B) Interfere with fat metabolism
(C) Break glycosidic bonds
(D) Destabilize proteins

165. An enzyme is capable of acting on a wide range of related substrates. Which of the following is a property of this enzyme: (NUMS 2024)
(A) Inflexible active site
(B) Regulatory enzyme
(C) Non regulatory enzyme
(D) Highly specific enzyme

166. Activation of all of the following enzymes need a regulatory molecule except: (NUMS 2024)
(A) Pepsinogen (B) Trypsinogen
(C) Erypsin (D) Chymotrypsinogen

167. Enzyme catalase protects the plants cell from: (NUMS 2024)
(A) Dehydration
(B) Photorespiration
(C) Toxic effect of alcohol metabolism
(D) Protein Loss

168. The term enzyme was coined by: (DUHS 2024)
(A) Darwin (B) Lamarck
(C) Wilhelm Kuhn (D) Mendel

169. A covalently bonded inorganic ion with protein part of an enzyme is termed as: (SZABMU 2024)
(A) Coenzyme (B) Prosthetic group
(C) Apoenzyme (D) Holoenzyme

170. Lock and key model (1890), was modified by: (SZABMU 2024)
(A) Emil Fischer (B) Erwin Chargaff
(C) Koshland (D) Lorenz Oken

171. Cyanides occupy the active site of enzymes by forming covalent bond, thus comes under the _____ inhibitors: (SZABMU 2024)
(A) Competitive (B) Irreversible
(C) Reversible (D) Non-competitive

172. Which of the following is not an enzyme: (BUMHS 2024)
(A) Pepsin (B) Insulin
(C) Sucrase (D) Catalase

173. The detachable ____ is called as an activator, if it is an inorganic ion: (BUMHS 2024)
(A) Substrate (B) Cofactor
(C) Product (D) None of the given options

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Answer Key

1. A	2. B	3. C	4. B	5. D	6. C	7. D	8. D	9. B	10. C
11. C	12. B	13. C	14. D	15. C	16. C	17. C	18. C	19. A	20. A
21. A	22. B	23. C	24. C	25. A	26. A	27. B	28. C	29. A	30. A
31. A	32. C	33. A	34. D	35. C	36. D	37. B	38. A	39. A	40. B
41. A	42. C	43. B	44. D	45. C	46. B	47. C	48. D	49. A	50. C
51. C	52. D	53. A	54. B	55. D	56. B	57. D	58. C	59. D	60. D
61. A	62. C	63. A	64. D	65. B	66. B	67. C	68. A	69. C	70. D
71. C	72. B	73. C	74. A	75. D	76. A	77. D	78. D	79. D	80. A
81. A	82. C	83. C	84. A	85. A	86. A	87. D	88. C	89. A	90. D
91. B	92. B	93. C	94. B	95. C	96. C	97. D	98. B	99. A	100. C
101. A	102. C	103. C	104. C	105. C	106. C	107. A	108. A	109. B	110. B
111. C	112. D	113. D	114. B	115. C	116. D	117. B	118. D	119. B	120. B
121. B	122. D	123. C	124. B	125. D	126. C	127. A	128. A	129. B	130. D
131. B	132. C	133. C	134. B	135. A	136. A	137. A	138. B	139. C	140. C
141. C	142. C	143. B	144. C	145. B	146. A	147. B	148. C	149. B	150. C
151. C	152. D	153. A	154. D	155. B	156. C	157. D	158. D	159. A	160. D
161. A	162. D	163. D	164. D	165. B	166. C	167. C	168. C	169. B	170. C
171. B	172. B	173. B							

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UNIT # 08

EVOLUTION

High Yield Content:

- Origin of life on earth
- Contribution of Scientists
- Darwin theory
- Evidence of evolution
- Types of speciation

SCAN QR CODE To Watch MDCAT Lectures, Test Discussions, and Past Papers Discussion on

"Evolution"

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EVOLUTION: KEY CONCEPTS

- Evolution refers to the processes that have transformed life on earth from its earliest form to the vast diversity.
- Evolutionary changes are mainly based on interaction between populations of organism and their environments.
- In the early 19th century, there were **two schools of thoughts** about origin of life.
- **Theory of Special Creation (Divine Creation):** According to this theory, all living things came into existence in their present form especially and specifically created by nature (God). **Father Suarez** and **Carlous Linnaeus** were believer of Divine Creation.
- **Theory of Natural Selection:** According to this theory, organisms evolve through time e.g. one type of organism gives rise to another type of organism. It is ancient one starting from the days of **Aristotle** to **Darwin. George Buffon** was the first to implement the **geological time scale** and develop the idea that living beings evolved constantly.

Scientists Contributions

Scientist Name	Achievements
Carl Linnaeus	Developed the **binomial nomenclature** system for naming organisms.
Lamarck	Proposed the theory of **inheritance of acquired characteristics** (use and disuse theory). **"Philosophie Zoologique"**
Thomas Malthus	His essay on **'Principle of Population'** influenced Darwin's thinking about competition and survival.
Georges Cuvier	Science of **Paleontology**, Earth history by **Catastrophism.**
Charles Lyell	Principle of Geology.
Charles Darwin	Voyage of Beagle, Theory of natural selection, Book on **origin of Species (1859)** and **The Descent of Man (1871).**
Gregor Mendel	Discovered the basic **principles of heredity** through pea plant experiments.
Russel Wallace	Independently conceived the idea of natural selection and **co-published with Darwin in 1858.**
James Hutton	Theory of **Uniformitarianism** (Proposed that Earth's geological features are shaped by continuous, slow processes (e.g., erosion, sedimentation) over vast time periods, rather than sudden catastrophic events.)
Lynn Margulis	Proposed the **Endosymbiotic theory.**
Hugo de Vries	Developed the **mutation theory** of evolution.
Ernst Haeckel	**Biogenetic Law (Ontogeny recapitulates phylogeny)** Haeckel's idea was that the embryonic development (ontogeny) of an individual organism passes through stages that resemble the evolutionary history (phylogeny) of its species.
August Weismann	Germplasm Theory
Aristotle	Theory of **Spontaneous Generation** (ancient belief that life could arise spontaneously from non-living matter)
J.B.S. Haldane	Contributed to the **mathematical study of evolution** and **population genetics.**
Sewall Wright	Introduced the concept of **genetic drift.**
Ernst Mayr	Worked on **speciation** and **evolutionary biology**; contributed to the **modern synthesis.**
Theodosius Dobzhansky	Authored *Genetics and the Origin of Species* (1937), **linking genetics with evolutionary theory.**

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ORIGIN OF LIFE ACCORDING TO CONCEPT OF EVOLUTION

Hydrothermal Vent Hypothesis

- Life originated in deep oceans, in hot springs.
- Vents supplied the energy and raw materials for origin and survival of early life.
- **Archaebacteria** (Prokaryotes) are considered as **first life** form which supports this vent hypothesis because they can tolerate temperature up to **120 °C.**
- The **first living organisms were heterotrophs** because they relied on consuming organic molecules available in their environment for energy and nutrients.
- **Stromatolites** are layered, rock-like structures formed by the activity of ancient cyanobacteria (photosynthetic microorganisms) in shallow water environments. These structures provide some of the earliest evidence of life on Earth.

Evolution of Photosynthetic Organisms

- First photosynthetic organism probably used hydrogen sulfide during photosynthesis.
- Later on, water served this same purpose and oxygen liberated during photosynthesis and begins to accumulate in atmosphere.

Evolution of Aerobic Respiration

- Due to accumulation of oxygen, **ozone** developed **(4.2 billion / 420 million** years ago) in upper atmosphere began to filter UV radiation.
- Some living organisms began to utilize oxygen and **reducing atmosphere changed to an oxidizing atmosphere.**

Evolution of Prokaryotes into Eukaryotes

- The prokaryotes may have arisen more than **3.5 billion** years ago.
- Eukaryotes may have evolved **1.5 billion** years ago.

Evolution of Prokaryotes into Eukaryotes

Feature	Endosymbiotic Hypothesis	Membrane Invagination Hypothesis
Definition	Explains the origin of organelles like mitochondria, chloroplasts and flagella through **symbiosis between prokaryotes.** Presented by **Lynn Margulis.**	Explains the origin of internal membrane structures like the nucleus and endoplasmic reticulum through **folding of the plasma membrane.**
Mechanism	Involves one prokaryotic cell engulfing another, leading to a symbiotic relationship.	Involves inward folding (invagination) of the plasma membrane to form internal compartments.
Structures Formed	**Mitochondria** (from aerobic bacteria) **Chloroplasts** (from photosynthetic bacteria) **Flagella** (from spiral-shaped bacteria)	**Nucleus** (from membrane around DNA) **Endoplasmic Reticulum and Golgi Apparatus** (from folded membranes)
Genetic Evidence	Mitochondria and chloroplasts have their own DNA, which resembles bacterial DNA.	No independent DNA evidence; associated structures (e.g., nucleus) rely on the cell's genome.

LAMARCKISM / INHERITANCE OF ACQUIRED CHARACTERS

- **Jean-Baptiste Lamarck** (1744–1829) was a French **naturalist and soldier.**
- He was in-charge of invertebrate collection at the **Natural History Museum, Paris.**
- In 1809, he published his book ***Philosophie Zoologique.***
- Developed a **first comprehensive model** that attempts to explain how life evolves.
- He pictures evolution as **ladder of life** from simple to most complex animals.

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Theory of Inheritance of Acquired Characteristics

- There are **two basic assumptions** of Lamarck theory.

Use and Disuse

- Organs that are used frequently become stronger and more developed.
- Organs that are not used weaken and may eventually disappear.
- **Example:** Giraffes stretched their necks to reach leaves on tall trees, leading to longer necks over generations.

Inheritance of Acquired Characteristics

- Traits acquired during an organism's lifetime are passed on to its offspring.
- **Example:** If a blacksmith develops strong arms from his work, his children will inherit strong arms.

Criticism on Lamarckism

- Acquired characteristics (e.g., muscle strength) cannot be inherited because they do not change the genetic material (DNA).
- Modern genetics (discovered by Gregor Mendel) proved that only genetic traits are passed on to offspring.

Examples for Understanding

- **Lamarck's Example:** Giraffes' long necks evolved because they stretched their necks to reach higher leaves.
- **Modern Explanation:** Giraffes with naturally longer necks survived and reproduced more (natural selection).

DARWINISM

- Charles Darwin was born in **Shrewsbury**, in western England, in **1809.**
- In **1831,** Darwin accepted the position of naturalist abroad for five years on the **HMS Beagle, a British naval ship.**
- His major mission was to expand the navy's knowledge about natural resources.
- He observed and collected thousands of specimens of diverse **fauna and flora of South America.**
- He noticed that the fauna and flora of different regions of the continents had a definite south American stamp, very distinct from the life forms of Europe.

Observation about Galapagos Islands

- Beagle spent almost **2 months at Galapagos Islands.**
- Darwin compares the animals and plants of Galapagos Islands with those of South American mainland.

Finches with Different Beak Shapes

- Darwin noticed that **13 species of finches** had distinct beak shapes and sizes.
- Each beak type was adapted to the bird's food source.
- **Large, strong beaks:** Suitable for cracking hard seeds.
- **Long, slender beaks:** Adapted for eating insects or cactus nectar.
- Darwin concluded that all finches likely descended from a **common ancestor,** but their beaks evolved to adapt to the food sources available on each island.

Tortoises with Unique Shell Shapes

- **Domed shells:** Found on islands with abundant low vegetation.
- **Saddle-shaped shells:** Found on islands with sparse vegetation; these tortoises could stretch their necks to reach higher food sources.
- This indicated that tortoises adapted to the specific environments of their islands.

Other Scientists

- In early **1830s Lyell** published **"Principles of Geology"** where he presented arguments to support a theory of geological changes proposed by **Hutton,** called **theory of uniformitarianism.**

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- Malthus wrote an assay on **"Principles of Population"** where he mentioned the human **populations** have the capacity to **increase exponentially**, and the **food supply** has the capacity to **increase arithmetically**. Such a relation could result only in the struggle for food and hence for existence itself.
- In **1836**, Darwin returns to Great Britain.
- In **early 1840s**, Darwin had worked out the major features of his theory.
- In **1844**, Darwin wrote a long essay on origin of species and natural selection but still was **unpublished.**
- In **1858, Darwin** received as essay from fellow naturalist, **A. R. Wallace**. In this essay Darwin found the theory of origin of species by means of natural selection. So, Both Scientists Published this essay with single Title, **"On the Tendency of Species to form Varieties; and on the Perpetuation of Varieties and Species by Natural Means of Selection"**. The paper was jointly presented at the **Linnean Society of London** on **July 1, 1858**.
- Wallace motivated Darwin to publish his book, the **origin of species** by means of natural selection. It appeared in **1859**, and **12 years** later Darwin's **Decent of Man** was published.
- According to Darwin, **new species** would arise from an ancestral form by gradual accumulation of adaptations to different environment, separated from original habitat by **geographical barriers.**

Darwin's Theory of Natural Selection

- In his book "Origin of Species" he developed **two main points.**
  1. Decent with modification
  2. Natural selection and adaptations

Decent with modification

- Darwin believed in **perceived unity in life**, with all organisms, no matter how different, share a **common ancestor** in the distant past.
- Over time, the accumulation of beneficial changes in organisms leads to significant changes in structure, function, and behavior.
- Darwin visualized evolution as a **branching tree**, where **trunk** represents a common ancestor, **branches** represent species that diverged over time and **twigs** are closely related species or individuals.

Natural selection and adaptations

- Darwin mechanism of evolution by natural selection consists of four observations about natural world.

1- **Overproduction**
- Organisms produce **more offsprings** than the environment can support.

2- **Variations**
- Within a population, individuals show **variations in traits** (e.g., size, color, speed).
- Some of these variations are beneficial for survival.

3- **Struggle for Existence**
- Due to **limited resources** (food, shelter, mates), individuals must compete to survive.

4- **Survival of the fittest**
- Individuals with **advantageous traits** are more likely to survive and reproduce.
- It is not random but depends in part on the heredity of the surviving individuals.
- According to Darwin word fitness is used for **"Reproductive Success"**.

NEO-DARWINISM (Modern Synthesis)

- Neo-Darwinism is the modern version of Darwin's theory of evolution, combining **natural selection** with the knowledge of **genetics** discovered by Gregor Mendel.
- **Birth of population genetics** is an important turning point for evolutionary theories.
- With the progress in population genetics, in **1930s Mendelism and Darwinism were reconciled.**
- In **early 1940s** a comprehensive theory of evolution that became known as the **modern synthesis** or **Neo-Darwinism.**
- It is **called synthesis because** it is integrated discoveries and ideas from many different fields, including **biochemistry, ecology, paleontology, taxonomy, biogeography and of course population genetics.**

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- Advances in these fields have enabled scientist to identify mutations, genetic drift and gene flow as other natural forces of evolutionary changes.

EVIDENCES OF EVOLUTION

- Darwinism was mainly based on the evidences from the geographical distribution of species and from the fossil records.
- As biology progressed, other evidences validate the evolutionary view of life.

Evidence from Biogeography

- Biogeography is the geographical distribution of species.
- First evidence that suggested idea of evolution to Darwin.
- **Armadillos (Armored mammals)** live only in America. The evolutionary view of biogeography predict that contemporary armadillos are modified descendants of earlier species that occupied these continents.
- **Similarly,** Darwin noticed that South America lacked rabbits, even though the environment was quite suitable to them. He concluded that there is no rabbit in South America because rabbit originated somewhere else, and they had no means to reach South America.

Evidence from Paleontology

- The succession of fossils form is **strong evidence** in favor of evolution as it provides **visual record.**
- Fossils are either actual remains or traces of organisms that lived in primitive geological times.
- Most fossils are found in **sedimentary rocks.**
- Prokaryotes are **oldest known fossils.**
- Chronological appearance of vertebrates as shown by fossils: **Fishes → Amphibians → Reptiles → Mammals + Birds.**
- Evolution of horse is best example of paleontology as evidence.
- **Modern day Horse** (Equus) has a large **central toe** that end into hoof. The **earliest horse** (Oehippus) had **four toes** and over the time the number of toes reduced to one.

Evidence from Comparative Anatomy

- Anatomical similarities between different species also provide evidence of evolution.
- It provides evidence for evolution by demonstrating how species share a common ancestry through homologous structures, vestigial organs, and analogous structures.

Feature	Homologous Structures	Analogous Structures
Definition	Structures with similar anatomy but different functions.	Structures with similar functions but different anatomy.
Habitat	Perform different functions adapted to **different environment.**	Perform similar functions to adapt to **similar environments.**
Anatomical Origin	Derived from a **common ancestor.**	Derived from a **different ancestor.**
Evolutionary Process	**Divergent evolution** (organisms evolve differently from a common ancestor).	**Convergent evolution** (organisms independently evolve similar traits).
Example	Forelimbs of humans, bats, whales, and cats (same bone structure, different uses). Pentadactyl limb in tetrapod's	Wings of birds and insects (used for flying, but different structures).

Vestigial Organs (oldest Homologous organs)

- Vestigial organs are structures in an organism that have lost most or all of their original function through the course of evolution.
- They are remnants of functional organs present in the organism's ancestors and provide strong evidence of evolutionary changes over time.

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- **Examples:** Skeleton of whales and some snakes retain vestiges of pelvis and leg bones of walking ancestors, vermiform appendix in carnivores.
- In human body **about 90** such vestigial structures are present.
- **Examples in Humans:** Appendix, Tailbone (Coccyx), Ear Muscles, Wisdom Teeth, Body Hair, Nictitating Membrane, Plica Semilunaris (part of the third eyelid), Male Nipples, Goosebumps (Arrector Pili Muscles) etc.

Evidence from Comparative Embryology

- Closely related organisms go through similar stages in their embryonic development.
- At embryonic stages of development, similarities between fishes, frogs, snakes, birds, humans and all other vertebrate are more apparent.
- **In Chordates,** similarities at embryonic level such as presence of gill slits, Notochord and postanal tail.
- **In fishes,** gill slits develop into gills; **In terrestrial vertebrates,** these embryonic structures become modified for other functions such as **eustachian tube** (connect the middle ear with throat) **in humans.**
- **Ontogeny Recapitulates Phylogeny (Haeckel's biogenetic law)** suggests that the development of an organism (ontogeny) reflects the evolutionary history (phylogeny) of its species.

Evidence from Molecular Biology

- Evolutionary relationship among species is reflected in their **DNA and Proteins / Genes and Gene products.**
- It provides **strong evidence** of evolution as the **basis for the unity and diversity of life.**
- **Examples:** Universal Genetic Code, Same 20 amino acids in proteins, Same type of introns, Cytochrome "C" a respiratory protein.

HARDY-WEINBERG PRINCIPLE

- The Hardy-Weinberg Principle is a **mathematical model** that describes the genetic equilibrium of a population where **allele** and **genotype frequencies remain constant** over generations, provided certain conditions are met (except sexual reproduction and meiosis).
- Allele Frequency Equation: $p + q = 1$
- Genotype Frequency Equation: $p^2 + 2pq + q^2 = 1$
- **p:** Frequency of the dominant allele (e.g., A).
- **q:** Frequency of the recessive allele (e.g., a).
- **p^2:** Frequency of the homozygous dominant genotype (AA).
- **2pq:** Frequency of the heterozygous genotype (Aa).
- **q^2:** Frequency of the homozygous recessive genotype (aa).

Conditions for Hardy-Weinberg Equilibrium

Factor	Effect
Large Population Size	Reduces genetic drift.
Random Mating	No preference for specific traits in mate selection.
No Mutations:	No new alleles were introduced into the gene pool.
No Migration:	No gene flow into or out of the population.
No Natural Selection:	All individuals have equal reproductive success.

Example Problem:

If 9% of a population is homozygous recessive (q^2=0.09), calculate the frequencies of the alleles and other genotypes.

Solution:

1. $q = \sqrt{q^2} = \sqrt{0.09} = 0.3$
2. $p = 1-q = 1-0.3 = 0.7$
3. Genotype frequencies:

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- $p^2 = (0.7)^2 = 0.49$ (homozygous dominant, AA)
- $2pq = 2(0.7)(0.3) = 0.42$ (heterozygous, Aa)
- $q^2 = 0.09$ (homozygous recessive, aa)

GENETIC DRIFT (Natural Selection)

- Genetic drift is entirely random, meaning the **changes in allele frequencies happen by chance**, not because of an organism's survival or reproduction success.
- Genetic drift occurs purely due to chance events, particularly in **small populations**, such fluctuations may lead to the **loss of particular alleles.**

Causes of Genetic drift

Feature	Bottleneck Effect	Founder Effect
Definition	A sharp reduction in population size due to a **catastrophic event**, leading to reduced genetic diversity.	A new population is established by a small number of individuals from a larger population, leading to limited genetic diversity.
Cause	**Natural disasters**, environmental changes, human activities, or other events that drastically reduce the population size.	**Migration or isolation** of a small group of individuals from a larger population.
Population Size	Population size is dramatically reduced, often by 50% or more.	A small, often random, group of individuals establishes a new population.

SPECIATION

- The evolutionary process by which **new biological species arise** is called speciation.

Types of Speciation

Feature	Sympatric Speciation	Allopatric Speciation	Parapatric Speciation
Definition	Formation of new species within the **same geographic area.**	Formation of new species due to **geographic isolation.**	Speciation occurs in populations that are adjacent to each other but occupy **slightly different habitats.**
Mechanism	**Reproductive isolation** occurs due to genetic changes. It is more commonly occurs through **polyploidy.**	**Physical barriers** (e.g., mountains, rivers) prevent gene flow between populations.	**Reduced gene flow** due to environmental gradients or partial geographic separation; hybrids often have low fitness.
Examples	**Cichlid fish** in African lakes evolve into multiple species within the same habitat.	**Darwin's finches** on the Galápagos Islands evolved into different species due to isolation.	**Grass species** evolving along polluted mine sites versus nearby uncontaminated areas.

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BIOLOGY

1. Which scientist does not match his achievements:
(A) Lamarck: published his theory of evolution
(B) Lyell: published principles of geology
(C) Malthus: published essay on principle of population
(D) Cuvier: published papers on inheritance

2. Theory of Spontaneous generation was proposed by:
(A) Aristotle (B) Carolus Linnaeus
(C) Malthus (D) James Hutton

3. Who proposed the theory of uniformitarianism?
(A) James Hutton (B) Russel Wallace
(C) Malthus (D) Darwin

4. The phrase "ontogeny recapitulates phylogeny" was coined by:
(A) Ernst Haeckel (B) Russel Wallace
(C) Lamarck (D) Darwin

5. The continuity of germplasm theory was given:
(A) August Weismann (B) Ernst Haeckel
(C) Wallace (D) Cuvier

6. The theory on human population which inspired Darwin was proposed by:
(A) Malthus (B) Ernst Haeckel
(C) Wallace (D) Lyell

7. Who was the first to implement the geological time scale and developed the idea that living things evolve constantly:
(A) August Weismann (B) Charles Darwin
(C) Alfred Wallace (D) George Buffon

8. The scientists believed that the existing continent were once a single piece of land termed as:
(A) Infra Continent (B) Pangea
(C) Clan (D) Demes

9. Life originated in:
(A) Air (B) Land
(C) Water (D) Space

10. Which of the following is the most widely accepted hypothesis for the origin of eukaryotes from prokaryotes?
(A) Endosymbiosis hypothesis
(B) Natural selection hypothesis
(C) Gradualism hypothesis
(D) Catastrophism hypothesis

11. What was the source of hydrogen for first photosynthetic organisms?
(A) Water
(B) Hydrogen present in soil
(C) Hydrogen sulphate
(D) Hydrogen sulphide

12. Prokaryotes are considered to be evolved:
(A) 3.5 billion years ago
(B) 4.5 billion years ago
(C) 1.5 billion years ago
(D) 1000 million years ago

13. Archaebacteria can survive at:
(A) 150°C (B) 300°C
(C) 120°C (D) 200°C

14. Flagella might have arisen through the ingestion of
(A) Cyanobacteria (B) Chlamydomonas
(C) Spirochetes (D) Paramecium

15. Lamarck was the incharge of invertebrate collection at the Natural history museum in:
(A) London (B) Paris
(C) New York (D) Berlin

16. Darwin observed and collected thousands of specimens of diverse fauna and flora of:
(A) North America (B) Australia
(C) South America (D) South Africa

17. In the Darwinian view, the history of life is like a:
(A) Sun (B) Mountain
(C) Tree (D) Book

18. Production of more individuals than the environment can support, leads to a:
(A) Struggle for existence among individuals of a population
(B) Survival of fraction of off-springs of each generation
(C) Increase the chances of survival of all species
(D) Both (A) & (B)

19. Armadillos, the armored mammals, live only in:
(A) Africa (B) Australia
(C) America (D) Britain

20. The earliest vertebrates were fossil:
(A) Fishes (B) Reptiles
(C) Amphibians (D) Mammals

21. Ear muscles are vestigial organs in:
(A) Man (B) Fish
(C) Rabbit (D) Snake

22. Evolutionary changes among species are reflected in:
(A) DNA & protein
(B) Their genes & gene products
(C) Proteins Only
(D) Both A & B

23. Natural selection can amplify or diminish only

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those variations that are:
(A) Heritable (B) Continuous
(C) Non-heritable (D) Discontinuous

24. Which organs are retained in the whale as useless vestiges:
(A) Pelvis and leg bone (B) Ear muscles
(C) Vermiform appendix (D) Both B & C

25. Charles Darwin's ideas concerning the causes of evolution were probably formulated in his mind:
(A) While he was still a student at Cambridge University
(B) Before he began his voyage of exploration around the world on H.M.S. Beagle
(C) During his voyage on H.M.S. Beagle, especially after he reached the Galapagos Islands
(D) During the late 1880's

26. Charles Darwin concluded that the 13 species of finches on the Galapagos Islands:
(A) Were identical to 13 finch species in northwestern South America 600 miles to the east
(B) Probably evolved from one ancestral South American species
(C) Had all adapted to the same food sources
(D) Both B and C

27. Which of the following statements is true about Charles Darwin?
(A) He believed that evolution was due to the inheritance of acquired characteristics.
(B) He supported Lamarck's explanation of how evolution occurred
(C) He understood that the variation that exists in natural populations of plants or animals is the result of repeated mutations.
(D) He was first to outline modern theory of evolution

28. The co-contributor of theory of evolution by natural selection is:
(A) Charles Lyell (B) Alfred Wallace
(C) Lamarck (D) James Hutton

29. Which of the following statements about Darwin is true?
(A) He failed to convince most biologists and other educated people in the late 19th century that life evolves.
(B) He thought that the biggest and strongest animals are always at an advantage in natural selection.
(C) His book On the Origin of Species did not sell well and the biologists in his time did not take much notice of it.
(D) Survival of fittest means the reproductive success of animal

30. Which of the following ideas was developed by Thomas Malthus?
(A) Peppered moths living near English industrial cities provide a good example of evolution
(B) The diversity of Galapagos finch species is the result of natural selection.
(C) Living things often produce far more offspring than are needed to maintain their numbers
(D) All of above

31. One of the following organs is vestigial:
(A) Nictating membrane in mammals
(B) Ear muscles in man
(C) vermiform Appendix in carnivores
(D) All of the above

32. Flower parts are considered to have evolved from:
(A) Flower (B) Leaves
(C) Stem (D) Root

33. Darwin believed in perceived unity in life which means:
(A) All organisms have common ancestor
(B) All types of lives are same
(C) Life is like a unit
(D) None of them

34. Similarity in structures resulting from common ancestry is known as:
(A) Heterology (B) Analogy
(C) Chronology (D) Homology

35. The Wallace's papers about the theory of natural selection were presented to Society of London:
(A) Lamarckian (B) Linnaean
(C) Darwinian (D) Evolutionary

36. Darwin's theory "The origin of species" was published in_____A.D:
(A) 1859 (B) 1830
(C) 1840 (D) 1858

37. Alfred Wallace was working in:
(A) East Indies (B) East India
(C) West India (D) West Indies

38. One of the following statements about Darwin is true:
(A) He believed in Descent with modification
(B) He believed in Natural selection
(C) He was naturalist
(D) All of these

39. One of the following statements is not the part

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based:
(A) Biogeography and fossil record
(B) Biogeography and comparative anatomy
(C) Molecular biology and fossil record
(D) Fossil record and comparative anatomy

58. **Darwin's theory of natural selection based on the following observations EXCEPT:**
(A) Genotypic frequencies of non-evolving populations
(B) Struggle for existence
(C) Over production
(D) Survival for fittest

59. **Darwin wrote a book named:**
(A) Origin of species by "Natural Selection"
(B) Special creation
(C) Natural selection
(D) Philosophic Zoologique

60. **The greatest weakness (demerit) in Darwinism was its failure to explain the cause of:**
(A) Variations
(B) Struggle for existence
(C) Over production
(D) Survival for fittest

61. **Who hypothesized that organism evolved through the inheritance of acquired characteristics:**
(A) Darwin (B) Lamarck
(C) Aristotle (D) Linnaeus

62. **The first comprehensive model that attempted to explain how life evolved was:**
(A) Theory of natural selection
(B) Theory of special creation
(C) Theory of inheritance of acquired characters
(D) Hardy-Weinberg theorem

63. **Point out the incorrect point of Lamarck's theory:**
(A) Those parts of body used extensively become larger and stronger
(B) Organs that are not used deteriorate
(C) Those parts of body use extensively become larger and stronger and Organs that are not used deteriorate
(D) Modification acquired in body can be passed to off springs

64. **According to concept of hereditary the modifications an organism acquires during its lifetime can be passed along to its offspring:**
(A) Lamarck (B) Darwin
(C) Linnaeus (D) Malthus

65. **Which of the following theories of evolution can best explain vestigial organs:**
(A) Lamarckism (B) Darwinism
(C) Natural selection (D) Special creation

66. **If a man were to obtain huge muscles from lifting weights in a gym on a regular basis, which scientist would say that the offspring of this man would be born with large muscles:**
(A) Lamarck (B) Darwin
(C) Sanger (D) Mendel

67. **Which one of the following is considered as strong evidence of evolution as it provides the visual record in complete series:**
(A) Embryology record
(B) Molecular record
(C) Biochemical record
(D) Fossil record

68. **Which of the following cause disturbance in the gene pool:**
(A) Emigration (B) Immigration
(C) Random mating (D) Both A & B

69. **A particular puzzling case of geographical distribution was _____ of Galapagos Island:**
(A) Fauna (B) Flora
(C) Fauna and flora (D) Population

70. **The birds, Darwin collected at Galapagos Island were of:**
(A) Twelve types (B) Thirteen types
(C) Fifteen types (D) Twenty types

71. **Over many generations, the two populations could become dissimilar enough to be considered on separate species. This is apparently what happened to be the:**
(A) Galapagos finches (B) Galapagos crows
(C) Galapagos Pisces (D) Galapagos whales

72. **Survival in the struggle for existence is not random but depends on the_____constitution of the surviving individuals:**
(A) Hereditary
(B) External environment
(C) Internal environment
(D) Both B & C

73. **The study of geographical distribution of organism is called:**
(A) Zoogeography (B) Biogeography
(C) Museography (D) Demography

74. **Similarity in origin resulting from common ancestors is known as:**

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(A) Homology (B) Heterology
(C) Monology (D) Metrology

75. **In human body coccyx, appendices, nictitating membrane, and ear muscles are some examples of:**
(A) Vestigial organs
(B) Evolutionary organs
(C) Common organs
(D) Historical organ

76. **Which statement best represents the meaning of the term evolution:**
(A) Changes in species toward greater complexity over time
(B) Changes in gene frequencies in a population over time
(C) The strongest individuals survive and produce the most offspring
(D) Changes in an individual over time

77. **Darwin's primary contribution to biological theory was the idea that:**
(A) An important mechanism of biological evolution is natural selection
(B) New alleles arise through mutation
(C) Evolution is the change in gene frequencies over time
(D) Genes are the units of inheritance

78. **Through careful observation, Charles Darwin came to understand that:**
(A) Populations of plants and animals in nature most often consist of individuals that are clones of each other
(B) Those individuals whose variation gives them an advantage is staying alive long enough to reproduce are more likely to pass their traits on to the next generation
(C) Populations of a species that become isolated from others by adapting to different environmental niches quickly become extinct
(D) All of the above

79. **The fossil record shows that:**
(A) Most species have not evolved
(B) Some species are evolutionary transitions between major groups of organisms
(C) All species are today just as they were when they were created
(D) All of these

80. **The present giraffe has a long neck as compared to its ancestors. Lamarck believed it could be due to:**
(A) Natural selection
(B) Isolation
(C) Inheritance of acquired characters
(D) Speciation

81. **For evolutionary success, mutations must occur in:**
(A) Somatic RNA (B) Somatic DNA
(C) Germplasm DNA (D) Germplasm RNA

82. **Which of the following concept is attributed to Charles Darwin?**
(A) Use and disuse of organs is of great importance in evolution
(B) Every cell must come from a pre-existing cell
(C) In the struggle for existence, the fittest would survive
(D) The gametes will carry only one of a pair of contrasting characters

83. **Key point of Lamarck's view about organic evolution is that every offspring:**
(A) Is similar to its parents
(B) Inherits characters acquired by the parental generation
(C) Shows struggle for existence
(D) Repeats phylogeny in its ontogeny

84. **The initial theory that environment can bring about changes in individuals was proposed by:**
(A) Mendel (B) Darwin
(C) Lamarck (D) Lyell

85. **Production of more individuals than the environment can lead to:**
(A) Struggle for existence (B) Natural selection
(C) Survival of the fittest (D) Evolution

86. **In humans the gill pouches develop into:**
(A) Middle ear (B) Eustachian tube
(C) Throat (D) Pharynx

87. **Gene pool consists of all alleles at all gene loci in all individuals of the:**
(A) Family (B) Clan
(C) Population (D) Community

88. **The change in frequency of alleles at a locus that occurs by chance is:**
(A) Gene pool (B) Mutation
(C) Genetic waft (D) Genetic drift

89. **In certain areas, such as Ecuador, forest coverage has been reduced by:**
(A) 50% (B) 67%
(C) 78% (D) 95%

90. **The most common form that does not alter allele frequency, but lessens the proportion of**

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heterozygote individuals is:
(A) Inbreeding (B) Crossbreeding
(C) Random breeding (D) Breeding

91. A group of inter-breeding individuals belonging to a particular species and sharing a common geographic area is:
(A) Population (B) Community
(C) Clan (D) Family

92. The total aggregate of genes in a population at any one time is called the population's gene:
(A) Puddle (B) Lake
(C) Pool (D) Pond

93. The most threatened areas on the earth, have been reduced to 44% of their original extent are:
(A) Tropical rain forests
(B) Temperate rain forests
(C) Carboniferous forests
(D) Deciduous rain forests

94. Hardy-Weinberg equilibrium explains:
(A) The introduction of new alleles into a population
(B) The formation of a new species
(C) The reasons for migration
(D) Constant allele frequencies in a population

95. In corn, kernel color is governed by a dominant allele for white color (W) and by a recessive allele (w). A random sample of 100 kernels from a population that is in Hardy-Weinberg equilibrium reveals that 9 kernels are yellow (ww) and 91 kernels are white. The frequency of the white allele in this population is:
(A) 0.3 (B) 0.7
(C) 0.91 (D) 0.09

96. Neo-Darwinism has integrated discoveries and ideas from:
(A) Taxonomy (B) Palaeontology
(C) Population genetics (D) All of these

97. What was the name of the ship that Charles Darwin sailed on during his famous voyage to the Galapagos Islands?
(A) The HMS Beagle
(B) The HMS Challenger
(C) The HMS Victory
(D) The HMS Bounty

98. What is the name of Charles Darwin's most famous book?
(A) On the Origin of Species
(B) The Descent of Man
(C) The Expression of the Emotions in Man and Animals
(D) The Voyage of the Beagle

99. What is the main mechanism of evolution proposed by Charles Darwin?
(A) Genetic drift (B) Gene flow
(C) Mutation (D) Natural selection

100. According to Darwin's theory of natural selection, which of the following is true?
(A) All individuals in a population are equally fit
(B) Individuals that are the strongest and fastest survive
(C) Individuals that are best adapted to their environment are more likely to survive and reproduce
(D) Evolution is a random process that occurs by chance

101. Who developed a theory of natural selection essentially identical to Darwin's:
(A) Hardy-Weinberg (B) Alfred Wallace
(C) Malthus (D) Lyell

102. Which of the following is an example of natural selection?
(A) A person lifting weights to build muscle
(B) A farmer selectively breeding cows for better milk production
(C) A bird with a longer beak being able to reach food more easily than birds with shorter beaks
(D) A dog learning to sit and stay when commanded

103. What is the name of the process by which humans have selectively bred plants and animals for desirable traits?
(A) Artificial selection (B) Natural selection
(C) Sexual selection (D) Genetic drift

104. The actual remains or traces of organisms that lived in ancient geological times:
(A) Vestigial remains
(B) Fossils
(C) Fossil fuel
(D) Rudimentary organs

105. Most fossils are found in the
(A) Sedimentary rock
(B) Metamorphic rocks
(C) Volcanic mountains
(D) Soil

106. What is the concept of "homology" in evolutionary biology?
(A) The idea that different species have similar physical structures because they share a common

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ancestor
(B) The idea that species evolve in parallel, with no common ancestor
(C) The idea that species evolve through a series of punctuated equilibria
(D) The idea that species are fixed and unchanging

107. What is the name of the scientist who independently proposed a similar theory of evolution around the same time as Charles Darwin?
(A) Gregor Mendel
(B) Jean-Baptiste Lamarck
(C) Alfred Russel Wallace
(D) Thomas Malthus

108. What is the name of the process by which two or more species evolve in response to each other?
(A) Convergent evolution
(B) Divergent evolution
(C) Coevolution
(D) Adaptive radiation

109. Which of the following is an example of a flaw in Lamarck's theory?
(A) The fact that acquired characteristics cannot be inherited
(B) The fact that environmental change is not the only factor driving evolution
(C) The fact that natural selection does not favour more complex organisms
(D) The fact that genetic mutations are not influenced by an organism's behaviour

110. Despite the flaws in Lamarck's theory, his work was important in the history of evolutionary thought because it:
(A) Laid the foundation for the theory of natural selection
(B) Introduced the concept of extinction
(C) Was the first scientific theory of evolution
(D) Highlighted the importance of genetic variation in evolution

111. Homologous Organs are:
(A) Modification to perform different functions as an adaptation to different environments
(B) Modification to perform differen: functions as an adaptation to similar environments
(C) Modification to perform similar functions as an adaptation to different environments
(D) Modification to similar different functions as an adaptation to similar environments

112. Which of the following is an example of homologous structures?
(A) The wings of birds and the wings of insects
(B) The arms of humans and the flippers of dolphins
(C) The eyes of insects and the eyes of mammals
(D) The legs of dogs and the legs of horses

113. When different animals live in the same habitat, they tend to show similarity in body form. This type of evolution is called:
(A) Organic Evolution
(B) Convergent Evolution
(C) Divergent Evolution
(D) Both B and C

114. Which statement is incorrect?
(A) Homologous organs are functionally different but structurally alike
(B) Analogous organs are functionally different but structurally alike
(C) Examples of homologous structures are arms of a man, forelimb of a cat, flipper of a whale
(D) Examples of analogous structures are wings of bats, birds and insects

115. Which of the following is an example of biogeographical evidence for evolution?
(A) The similarity of DNA sequences in different species
(B) The presence of similar physical features in different species
(C) The distribution of similar species in different parts of the world
(D) The similarity of the embryonic development of different species

116. What is the significance of the Modern Synthesis in the history of Neo-Darwinism?
(A) It integrated genetics with evolutionary theory
(B) It proposed that acquired characteristics could be inherited
(C) It rejected natural selection as the main mechanism of evolution
(D) It proposed that all organisms have an innate drive to evolve

117. Which of the following pieces of evidence supports Darwin's theory of evolution?
(A) The fossil record shows that species have changed over time.
(B) Homologous structures in different species

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suggest a common ancestry.
(C) Biogeography shows that species in different regions have evolved independently.
(D) All of the above.

118. What is meant by the term "fitness" in the context of natural selection?
(A) Physical fitness of an organism.
(B) Reproductive success of an organism.
(C) Ability to adapt to changing environmental conditions.
(D) All of the above.

119. Vestigial organs are evidence for which of the following ideas?
(A) Species are unchanging over time.
(B) Species are created independently of each other.
(C) Species share a common ancestry.
(D) Species are constantly evolving new organs and structures.

120. Which of the following is an example of a vestigial organ in humans?
(A) The appendix (B) The liver
(C) The lungs (D) The heart

121. Which of the following processes had resulted in the production of different breeds of domestic dogs and pigeons?
(A) Natural selection (B) Crossbreeding
(C) Artificial selection (D) Self-breeding

122. Natural selection can amplify or diminish variations that are:
(A) Non heritable
(B) Heritable
(C) Both heritable and non-heritable
(D) Acquired

123. Which of the following is not a function of the human coccyx (tailbone), which is considered a vestigial structure?
(A) Attachment site for muscles
(B) Balance and stability while sitting
(C) Support for the pelvis
(D) Digestive function

124. Which of the following is a potential explanation for why vestigial organs exist?
(A) They are remnants of structures that were once functional in ancestral species.
(B) They are the result of mutations that have rendered the structures non-functional.
(C) They are the result of adaptations to changing environmental conditions.
(D) They are not vestigial, but have a function that is not yet understood

125. Lamarck's theory of evolution was eventually replaced by the theory of natural selection proposed by:
(A) Charles Darwin
(B) Gregor Mendel
(C) Francis Crick
(D) Thomas Hunt Morgan

126. Lamarck believed that giraffes evolved longer necks through:
(A) Natural selection favouring individuals with longer necks
(B) Inheritance of acquired traits from stretching to reach higher leaves
(C) Hybridization with other long-necked species.
(D) Genetic drift causing random changes in neck length

127. In allopatric speciation, new species arise as a result of:
(A) Geographic isolation
(B) Genetic isolation
(C) Ecological isolation
(D) Reproductive isolation

128. The first living organisms on Earth were likely:
(A) Eukaryotes (B) Prokaryotes
(C) Multicellular organisms (D) Plants

129. The oldest known fossils are approximately how old?
(A) 3.5 billion years old
(B) 4.6 billion years old
(C) 6.3 billion years old
(D) 10 billion years old

130. The Wallace's papers about the theory of natural selection were presented to Society of_____London:
(A) Lamarckian (B) Darwinian
(C) Linnaean (D) Evolutionary

131. _____occurs through an interaction between the environment and the variability inherent in any population:
(A) Natural selection
(B) Mutation
(C) Genetic drift
(D) Non-random mating

132. Preference to desired characters by breeders is called:
(A) Natural selection (B) Plant breeding
(C) Artificial selection (D) Animal breeding

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33. **Evolution is:**
(A) Progressive development of a race
(B) History and development of race along with variations
(C) History of race
(D) Development of race.

34. **Which was absent in the atmosphere at the time of origin of life?**
(A) NH_3 (B) H_2
(C) O_2 (D) CH_4

35. **Correct order from ancient to advance era:**
(A) Paleozoic —> Proterozoic —> Cenozoic
(B) Archaeozoic —> Paleozoic —> Proterozoic
(C) Paleozoic —> Mesozoic —> Cenozoic
(D) Mesozoic —> Cenozoic —> Proterozoic

36. **Study of plants fossils is:**
(A) Palaeontology (B) Palaeobotany
(C) Paleozoology (D) Organic evolution

37. **The first organisms were:**
(A) Chemoautotrophs
(B) Chemoheterotrophs
(C) Autotrophs
(D) Eukaryotes

38. **Evolutionary convergence is development of:**
(A) Common set of characters in group of different ancestry
(B) Dissimilar characters in closely related groups
(C) Common set of characters in closely related groups
(D) All of above are correct

139. **Weisman cut off tails of mice generation after generation but tail neither disappeared nor shortened showing that the Darwin was correct:**
(A) Tail is an essential organ
(B) Mutation theory is wrong
(C) Lamarckism was wrong in inheritance of acquired characters.
(D) Theory of Natural Selection dwells on

140. **Which one of the following changes involved is irrelevant, in the evolution of man?**
(A) Perfection of hand for tool making
(B) Change of diet from hard nuts and hard roots to soft food
(C) Loss of tail
(D) Increase in the ability to communicate with others and develop community behaviour.

141. **Which of the following is a pair of homologous organs?**
(A) Fore limbs of cat & wings of bat
(B) Wings of grasshopper and wings of crow
(C) Lungs of rabbit and gills of Fish
(D) Wings of bat and wings of butterfly

142. **The homologous organs are those that show similarity in:**
(A) Appearance (B) Function
(C) Origin (D) Size

143. **Which period is dubbed as the age of prokaryotic microbes?**
(A) Precambrian (B) Cenozoic
(C) Mesozoic (D) Palaeozoic

144. **The presence of gill slits, in the embryos of all vertebrates, supports the theory of:**
(A) Metamorphosis (B) Biogenesis
(C) Organic evolution (D) Recapitulation

145. **Which of the following is the correct group of vestigial organs in man?**
(A) Nictitating membrane, ear muscles, eyelids and coccyx
(B) Appendix, coccyx, ear muscles and elbow joint
(C) Wisdom tooth, coccyx, body hair and ear muscles
(D) Wisdom tooth, Coccyx, nictitating membrane, and vermiform appendix

146. **Evolutionary convergence is characterized by:**
(A) Development of dissimilar characteristics in closely related groups
(B) Development of a common set of characteristics in groups of different ancestry
(C) Development of characteristics by random mating
(D) Replacement of common characteristics in different groups.

147. **Which evidence of evolution is related to Darwin's finches?**
(A) Evidence from biogeographically distribution
(B) Evidence from comparative anatomy
(C) Evidence from embryology
(D) Evidence from palaeontology.

148. **Which is the most important factor for continuity of a species from evolutionary point of view?**
(A) Replication of genetic material
(B) Formation of gametes
(C) Synthesis of proteins
(D) Spermatogenesis

149. **Sequence of which of the following is used to know the phylogeny?**
(A) m-RNA (B) r-RNA
(C) t-RNA (D) DNA

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150. A type of genetic drift in which the size of population is decreased due to some natural catastrophes such as volcano eruption, earthquake, flood, fire etc:
(A) Hardy Weinberg effect (B) Bottle neck effect
(C) Founder effect (D) Natural selection

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151. The comparative embryology of all vertebrates shows development of:(2012)
(A) Hairs (B) Scales
(C) Gill pouches (D) Fins

152. The structures which are reduced during the course of evolution and have no apparent functions are called: (2013)
(A) Regenerated organs (B) Vestigial organs
(C) Saltatory organs (D) Useless organs

153. For evolutionary point of view which respiratory protein is more common in many organisms: (2015)
(A) Cytochrome a (B) Cytochrome b
(C) Cytochrome c (D) Cytochrome d

154. Process by which unrelated species evolve to functionally resemble each other is called: (2017)
(A) Convergent evolution (B) Co-evolution
(C) Divergent evolution (D) Parallel evolution

155. Which one of the followings shows evidence of evolution from Molecular Biology? (2017)
(A) Development of bronchial arches in vertebrate embryo
(B) Distribution of species
(C) Comparison of genes and proteins in different species
(D) Study of vestigial organs

156. Large population size, random mating, no mutation and no emigration orimmigration are postulates of: (2017)
(A) Hardy-Weinberg equation
(B) Mendel's law of independent assortment
(C) Mendel's law of segregation
(D) Theory presented by Schleiden and Schwann

157. Acquired characteristics are inherited, that is the concept given by: (2017-Retake)
(A) Lamarck (B) Cuvier
(C) Malthus (D) Lyell

158. Functionally different and structurally alike organs are called: (2017-Retake)
(A) Vestigial organs
(B) Extinct organs
(C) Analogous organs
(D) Homologous organs

159. Change in frequency of alleles at a locus that occurs by chance is called: (2017-Retake)
(A) Mutation
(B) Non-random mating
(C) Migration
(D) Genetic drift

160. Which of the following factor causes change in gene frequency: (2017-Retake)
(A) Meiosis (B) Mutation
(C) Sexual recombination (D) Random mating

161. Organs specialized to perform specialized functions but structurally alike: (2018)
(A) Analogous (B) Autologous
(C) Homologous (D) All correct

162. Divergent evolution produces: (2018)
(A) Analogous (B) vital organs
(C) Homologous (D) vestigial organs

163. According to the theory of natural selection, organism produces: (2019)
(A) More offsprings than supported
(B) Less offsprings than supported
(C) Offsprings according to the resources available
(D) Offspring to create resources

164. This theory says that the mitochondria and chloroplast are, infect the ancient bacteria which now lived inside the large cells: (2020)
(A) Endosymbiont theory
(B) Darwin's theory of evolution
(C) Lamarckism
(D) Neo-Darwinism

165. The organs which are similar in functions but different in structures are called: (2020)
(A) Analogous
(B) Convergent Evolution
(C) Homologous
(D) Divergent Evolution

166. _____ occurs because natural selection gives some allele a better chance of survival than others: (2020)
(A) Fitness (B) Crossing over
(C) Evolution (D) Artificial selection

167. Adaptations that an organism acquires by its own action during its life span without modifying its genome are: (2022)
(A) Heritable
(B) Non-heritable
(C) Can be heritable through some modifications

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(D) Sometime heritable other times non heritable

168. For evolution to occur which of the following is not geological barrier: (2022)
(A) Mountain
(B) Ocean
(C) River
(D) Atmosphere

169. According to biogenetic law of Ernst Haeckel: (2022)
(A) There is survival of the fittest
(B) There is use and disuse of organs
(C) Phylogeny recapitulates ontogeny
(D) Ontogeny recapitulates phylogeny

170. Which of the following is the main point of Darwinism? (2023)
(A) Overproduction
(B) Variations
(C) Disuse of organs
(D) Perceived unity in life

171. Which of the following type of organs are functional in ancestral species rather than in present day species: (2023)
(A) Vestigial organs (B) Vital organs
(C) Homologous (D) Embryonic organs

172. According to evolutionary studies, prokaryotes may have arisen around: (2023)
(A) 2.5 billion years ago
(B) 3.5 billion years ago
(C) 4.5 billion years ago
(D) 5.5 billion years ago

173. Which of the following is not an example of disuse of organs: (2023)
(A) Snake's legs
(B) Shedding of milk teeth
(C) Muscle atrophy
(D) Movement of ear

174. The change in the frequency of alleles at locus that occurs by chance is known as: (UHS 2024)
(A) Mutation (B) Genetic drift
(C) Non-random mating (D) Speciation

175. Identify the correct pair of vestigial organs: (UHS 2024)
(A) Ear muscle and Vermiform appendix
(B) Heart and Liver
(C) Ear muscle and Liver
(D) Vermiform appendix and Heart

176. Which of the following increases variations within a gene pool: (UHS 2024)
(A) Chromosomal inversion
(B) Crossing over
(C) Gene mutation
(D) Random fusion of gametes

177. The formula calculating the frequency of genotype and alleles in a population gene pool is known as: (UHS 2024)
(A) Hardy-Weinberg equation
(B) Darwin equation
(C) Lamarck equation
(D) James Hutton equation

178. Which of the following about natural selection is not true: (UHS 2024)
(A) It affects variations that are heritable
(B) It is selected by breeder
(C) It can improve the adaptation of species
(D) It is regional in nature

179. The idea of inheritance of acquired characters was presented by: (UHS 2024)
(A) Jean Baptist Lamarck (B) Charles Darwin
(C) Thomas Malthus (D) Alfred Wallace

180. According to endosymbiont theory, flagella may have derived by the ingestion of prokaryotes similar to: (UHS 2024)
(A) Amoeboid prokaryotes (B) Spirochete
(C) Anaerobic bacterium (D) Spirillum

181. Wings of birds and that of flying lizards provide evidence of: (ETEA 2024)
(A) Convergent evolution
(B) Divergent evolution
(C) No evolution
(D) Same origin

182. The embryological stages of _____ show similarity in anatomical features: (ETEA 2024)
(A) All living things
(B) All non-vertebrates
(C) All vertebrates
(D) Human, Jelly fish and mouse

183. According to Lamarckism, the basis of evolution is: (ETEA 2024)
(A) Inheritance of acquired characteristics
(B) Mutation
(C) Natural selection
(D) Survival of the fittest

184. What best describes the hind leg bones seen in the whale: (ETEA 2024)
(A) Analogous to the fin of living fish
(B) Fossil structure from an extinct ancestor
(C) Homologous structure of the wings of a bat
(D) Vestigial structures that had a function in an ancestor

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Answer Key

1. D	2. A	3. A	4. A	5. A	6. A	7. D	8. B	9. C	10. A
11. D	12. A	13. C	14. C	15. B	16. C	17. C	18. D	19. C	20. A
21. A	22. D	23. A	24. A	25. C	26. B	27. D	28. B	29. D	30. C
31. D	32. B	33. A	34. D	35. D	36. A	37. A	38. D	39. D	40. A
41. C	42. C	43. B	44. B	45. B	46. B	47. D	48. C	49. C	50. C
51. D	52. B	53. C	54. B	55. D	56. D	57. A	58. A	59. A	60. A
61. B	62. C	63. D	64. A	65. A	66. A	67. D	68. D	69. C	70. B
71. A	72. A	73. B	74. A	75. A	76. D	77. A	78. B	79. B	80. C
81. C	82. C	83. B	84. C	85. A	86. B	87. C	88. D	89. D	90. A
91. A	92. C	93. A	94. D	95. B	96. D	97. A	98. A	99. D	100. C
101. B	102. C	103. A	104. B	105. A	106. A	107. C	108. C	109. A	110. A
111. A	112. B	113. B	114. B	115. C	116. A	117. D	118. B	119. C	120. A
121. C	122. B	123. D	124. A	125. A	126. B	127. A	128. B	129. A	130. C
131. A	132. C	133. A	134. C	135. C	136. B	137. B	138. A	139. C	140. A
141. A	142. C	143. A	144. D	145. C	146. B	147. A	148. A	149. B	150. B
151. C	152. B	153. C	154. A	155. C	156. A	157. A	158. D	159. D	160. B
161. C	162. C	163. A	164. A	165. A	166. C	167. B	168. D	169. D	170. D
171. A	172. B	173. B	174. B	175. A	176. C	177. A	178. B	179. A	180. B
181. A	182. C	183. A	184. D						

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UNIT # 09

LIFE PROCESSES
(NUTRITION)

High Yield Content:

- Digestion in stomach, Small intestine
- Enzymatic action (Amylase, pepsin, rennin, etc.)
- Absorption of Protein (Chylomicron)
- Large Intestine
- Nutritional Disorders (Food Poisoning, Anorexia nervosa)

SCAN QR CODE To Watch MDCAT Lectures, Test Discussions, and Past Papers Discussion on

"Nutrition"

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NUTRITION: KEY CONCEPTS

- Nutrition is the process by which living organisms obtain and utilize food to maintain life and carry ou physiological activities.

Mode of Nutrition

Feature	Autotrophic	Heterotrophic
Definition	Organisms prepare their own food using simple inorganic substances like CO_2 and H_2O.	Organisms depend on other organisms (plants or animals) for their food.
Source of Energy	Sunlight (photosynthesis) or chemical reactions (chemosynthesis).	Organic food obtained from plants or animals
Examples of Organisms	Green plants, Algae, Cyanobacteria.	Animals, Fungi, Most bacteria.
Types	**Photosynthesis** (light energy) **Chemosynthesis** (chemical energy).	**Holozoic** (e.g., humans). **Saprophytic** (e.g., fungi, bacteria). **Parasitic** (e.g., tapeworm).

CARNIVOROUS PLANTS / INSECTIVOROUS PLANTS

- Carnivorous plants are specialized plants that derive some or most of their nutrients by trapping and **digesting small animals**, primarily insects.
- All insectivorous plants are **true autotrophs**, but they capture prey to fulfill their **nitrogen requirem** for rapid growth or may grow in nitrogen poor soil.
- In some plants the trapped insects are **decomposed by bacteria**, in others may be digested by enzyme **secreted by the leaves.**

Types of Insectivorous Plants

Feature	Pitcher Plant	Venus Fly Trap	Sundew
Scientific Name	*Sarracenia pupurea*	*Dionaea muscipula*	*Drosera intermedia*
Leaf Modification	Sac or Pitcher like	Bilobed with midrib between them along with row of **long bristles.**	Tiny Leaves bear numerous hair-like **tentacles** with **glandular tips.**
Digestion	Bacteria or enzymes break down protein of insects	Digestion by enzymes secreted from the glands on leaf surface.	Protein of insects digested by enzymes.

HUMAN DIGESTIVE SYSTEM

- In humans there is only **extracellular digestion** (in gut cavity).
- Human digestive system **(Tube like gut)** can be divided into **alimentary canal/GIT (Gastrointestinal tract)** and **accessory digestive structures.**
- **GIT (9m/30ft)** consists of a continuous long coiled tube that extends from mouth to anus.
- **GIT includes** Oral cavity, Pharynx, Esophagus, Stomach, Small intestine and Large intestine.
- **Accessory digestive structures include** teeth, tongue, salivary glands, liver, gall bladder and pancreas
- The digestive tube consists of **four major layers**: an internal mucosa, sub-mucosa, muscularis and an external serosa.

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- **Direction of passage of food:** Buccal/Oral cavity → Esophagus → Stomach → Small intestine (Duodenum → Jejunum → Ileum) → Large intestine (Caecum → Ascending colon → Transverse colon → Descending colon → Sigmoid colon → Rectum) → Anus.
- **Goblet cells** are specialized epithelial cells found in the **stomach, small intestine,** and **large intestine** that secrete **mucus**, which acts as a protective barrier and lubricant

Sites of Digestion

Site	Chemical Digestion	Mechanical Digestion
Mouth Cavity	Salivary amylase (Ptyalin)	Mastication by teeth
Stomach	Gastric Juice	Churning by smooth muscles in muscularis
Small Intestine	Pancreatic and Intestinal juice	Emulsification of food by bile

DIGESTION IN ORAL CAVITY

- Mouth cavity is surrounded by cheeks, lips, tongue and palate.
- **Papillae:** small, raised projections on the surface of the tongue that contain taste buds or serve mechanical functions like gripping and manipulating food.
- **The palate** forms the roof of the oral cavity. It consists of a **hard palate** (anterior part) and **soft palate** (posterior part).

Teeth in oral Cavity

- **32 permanent teeth** (adult) and **20 deciduous teeth** (milk teeth in children).
- **Human dentition** can be described as **thecodont, heterodont** and **diphyodont.**
- **Dental Formula** for humans **2:1:2:3 / 2:1:2:3** (2 Incisors, 1 Canine, 2 Premolars, 3 Molars in each half of the jaw).

Type of Tooth	Shape	Number (in adults)	Function
Incisors	Chisel-shaped (flat and sharp edges)	8 (4 in upper jaw, 4 in lower jaw)	Cutting and biting relatively large piece of food
Canines	Pointed, sharp (conical shape)	4 (2 in upper jaw, 2 in lower jaw)	Tearing and piercing food, especially meat.
Premolars	Broad, flat surface with **two cusps**	8 (4 in upper jaw, 4 in lower jaw)	Crushing and grinding food.
Molars	Broad, flat surface with **multiple cusps**	12 (6 in upper jaw, 6 in lower jaw) including **4 wisdom teeth (last molar).**	Grinding, chewing, and crushing food into smaller particles.

Function of oral Cavity

- There are **four important functions:**
- **1**-Selection of food
- **2**-Grinding or mastication of food
- **3**-Lubrication of food and
- **4**-Enzymatic digestion of food.
- There are **three pairs of salivary glands** which secrete saliva.

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Types of Salivary Glands (Exocrine)			
Gland	**Location**	**Secretions**	**Opening of ducts**
Parotid Glands (Largest)	In front of ear	Saliva with amylase (Serous secretion)	Posterior part of the oral cavity
Submandibular/ Sub-maxillary Glands	Behind jaws	Saliva with amylase and mucus (Seromucous secretion)	Floor of the oral cavity
Sublingual Glands (Smallest)	Below tongue	Saliva with mucus only (Mucous secretion)	Floor of the oral cavity

Saliva

- Saliva is a watery fluid secreted by the salivary glands into the mouth, aiding in digestion, lubrication, and protection.
- **Fresh saliva is alkaline** with pH nearly 8, quickly loses carbon dioxide and **gets to pH 6.**

Composition of Saliva

- **Water and Mucus:** moisten and lubricate the food.
- **Sodium bicarbonates and other salts:** Stabilize pH and slightly antiseptics.
- **Salivary amylase (Ptyalin):** Covert starch or glycogen into maltose **(3%-5%).**
- Saliva also contains **lysozymes** and **antibodies (IgA)** which protect the mouth from bacterial infections.

Swallowing

- **Bolus:** As a result of mastication, softened, partly digested and slimy food mass is rolled into small oval lump. Bolus is pushed to the back of the mouth by the **action of tongue** and **muscles of pharynx.**
- **Pharynx** is a common passage for digestive system and respiratory system, it is also lined by mucus.
- Transfer of bolus from buccal cavity to pharynx and then to esophagus is called **Swallowing/Deglutition.**
- Beginning of swallowing is voluntary and then it became involuntary.
- Swallowing process is regulated by nerves in **medulla oblongata** and **pons.**

Event of swallowing

- **Tongue moves** upward and backward against the roof of mouth, forcing the bolus to the back of the mouth cavity.
- **Soft palate** is pushed up by tongue which closes nasal opening at the back.
- Tongue forces the epiglottis into more or less horizontal in position, thus closing the opening of windpipe (glottis). **Epiglottis diverts the bolus** towards esophagus.
- **The larynx** (Hyaline cartilage at the top of windpipe) moves upward under the back of the tongue.
- **The glottis** is partly closed by the contraction of ring of muscles.

Peristalsis

- **Characteristics movement** of digestive tract due to alternate contraction and relaxation of **smooth muscles** by which food is pushed along the digestive tract.
- It starts just behind the mass of food, from the buccal cavity, along the esophagus to stomach and then along the whole alimentary canal.
- **Anti-peristalsis** is the reverse peristaltic movement due to which food is passed from the intestine back into stomach and even into mouth. It may lead to vomiting.
- **Hunger pang** is the uncomfortable sensation due to peristaltic contraction caused by low glucose level. It usually begins **12-24 hours** after previous meal.

Esophagus

- It is about **25 cm long** tube extended between pharynx and stomach.
- It is present **dorsal to trachea.**

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- The primary function of the esophagus is to transport food, liquids, and saliva from the mouth to the stomach through a process called peristalsis.

DIGESTION IN STOMACH

- Stomach is elastic muscular bag located in left superior part of abdomen below the diaphragm.
- It is typically J-shaped storage organ and makes discontinuous feeding possible.
- Stomach shows both chemical and mechanical digestion.
- Stomach is involved in absorption of some chemicals like aspirin and ethanol.
- Chyme is the semisolid mass of food formed after digestion in stomach.

Parts of Stomach

Part	Location	Secretions
Cardia	Surrounds the opening of the esophagus into the stomach.	Allows food to enter the stomach; prevents backflow of stomach contents into the esophagus by Cardiac Sphincter (Lower Esophageal Sphincter/ LES).
Fundus	Dome-shaped region above the cardia.	Temporary storage of swallowed food and gases.
Body	Main central part of the stomach.	Secretes digestive enzymes (pepsinogen) and gastric acid (HCl) for digestion.
Pylorus	Lower portion near the duodenum.	Contains the pyloric sphincter that controls the passage of food into the small intestine.

Layers of Stomach Wall

Layers	Role
1. Serosa / Adventitia	Outermost protective layer of connective tissues, also called visceral peritoneum.
2. Muscularis	Three layers of smooth muscle (longitudinal, circular, and oblique). Responsible for churning and mixing food with gastric secretions.
3. Submucosa	Connective tissue contains blood vessels, lymphatics vessel, and nerves.
4. Mucosa	Innermost layer containing gastric glands and gastric pits.

Gastric glands

Cells	Secretions	Role
1. Mucous Cells	Mucus	Protects the stomach lining from acidic gastric juice and enzymes. Serve as first line of defense in immune system.
2. Parietal / Oxyntic Cells	Hydrochloric Acid (HCl) and Intrinsic Factor	- Maintain Acidic pH (2-3) for enzymatic action. - Kill microorganism and act as chemical barrier against germs. - Convert inactive pepsinogen into pepsin. - Inactivate salivary amylase. - Intrinsic factors help in the absorption of Vitamin B_{12} in the ileum.
3. Chief / Zymogen Cells	Pepsinogen (Inactive enzyme)	Converts to pepsin (active form) in the presence of HCl for protein digestion.
4. G-Cells / Endocrine cells	Gastrin (Hormone)	Stimulate gastric juice production, secretion and stomach motility.

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DIGESTION IN SMALL INTESTINE

- The length of small intestine is **6-7 meter** and consists of three parts i.e. **duodenum, jejunum and ileum**.

Duodenum

- First and shortest part and about **20-30 cm** long.
- Secretions of pancreas and liver are poured in it.
- Duodenum act as both as **exocrine** (produce **intestinal juice**) and **endocrine** glands (release of **Secretin** and **Cholecystokinin** hormones).
- **Chyle** is the food mass formed after neutralization of chyme by the secretions from liver, pancreas and duodenum.

Jejunum and Ileum

- Jejunum is the second portion and **2.5 meters** long comprising about **2/5th of small intestine**.
- Ileum is the third and **longest part** with length of **3.5 meters** comprising **3/5th of small intestine**.
- The food which escaped undigested from duodenum is completely digested in the jejunum and ileum by the group of enzymes contained in the intestinal juice.

Summary of Digestive Enzymes

Enzyme	Source	Substrate	Site of Action	End Products
Salivary Amylase (Ptyalin)	Salivary Glands	Starch or Glycogen	Mouth	Maltose
Lingual Lipase	Tongue (Ebner's Glands)	Lipids	Mouth and Stomach	Fatty acids and glycerol
Pepsin	Stomach (Chief Cells)	Proteins	Stomach	Polypeptides / Peptones
Rennin (Chymosin)	Infants Stomach	Casein (Milk protein)	Stomach	Paracasein (curd)
Pancreatic Amylase (Amylopsin)	Pancreas (Acinar Cells)	Starch or Glycogen	Small Intestine	Maltose
Pancreatic Lipase	Pancreas (Acinar Cells)	Lipids	Small Intestine	Fatty acids and glycerol
Trypsin	Pancreas (Acinar Cells)	Proteins (Basic amino acids lysine and arginine)	Small Intestine	Polypeptides / Peptones
Chymotrypsin	Pancreas (Acinar Cells)	Proteins (Aromatic amino acids phenylalanine, tryptophan, and tyrosine)	Small Intestine	Polypeptides / Peptones
Carboxypeptidase	Pancreas (Acinar Cells)	Polypeptides (Acts on C-terminus)	Small Intestine	Dipeptide
Aminopeptidase	Pancreas (Acinar Cells)	Polypeptides (Acts on N-terminus)	Small Intestine	Dipeptide
Deoxyribonuclease (DNAse)	Pancreas	DNA	Small Intestine	Nucleotides
Ribonuclease (RNAse)	Pancreas	RNA	Small Intestine	Nucleotides
Enterokinase	Duodenal mucosa	Trypsinogen	Small Intestine	Trypsin
Erypsin	Small Intestine (Brush Border)	Dipeptides	Small Intestine	Amino acids

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Maltase	Small Intestine (Brush Border)	Maltose	Small Intestine	Glucose
Lactase	Small Intestine (Brush Border)	Lactose	Small Intestine	Glucose and Galactose
Sucrase	Small Intestine (Brush Border)	Sucrose	Small Intestine	Glucose and Fructose

Summary of Digestive Hormones

Hormone	Source	Target Organ(s)	Stimulus for Release	Action/Effect
Gastrin	G-cells in the pyloric region of the stomach	Stomach (parietal cells, chief cells)	Presence of food (especially proteins) in the stomach.	Stimulates **HCl secretion** from parietal cells. Enhances **pepsinogen release** from chief cells. Increase stomach motility.
Secretin	S-cells in the duodenum	Pancreas, Stomach, Liver	Acidic chyme entering the duodenum (low pH).	Stimulates the release of **bicarbonate** secretion from **pancreas** to neutralize stomach acid. **Inhibits gastric** acid secretion. Increases **bile secretion** by the liver.
Cholecystokinin (CCK)	I-cells in the duodenum and jejunum	Gallbladder, Pancreas, Stomach	Presence of fats and partially digested proteins in the duodenum.	Stimulates **gallbladder contraction** to release bile. Stimulates secretion of **pancreatic enzymes.** Slows gastric emptying.
Somatostatin	D-cells in the stomach, duodenum, and pancreas	Stomach, Pancreas, Small Intestine	High levels of HCl in the stomach.	Inhibits secretion of **gastrin**, HCl, and pancreatic enzymes. **Reduces bile** and bicarbonate release. **Slows gastric emptying** and motility.

ABSORPTION OF FOOD

- Nearly all the absorption of products of digestion take place in the ileum.
- The internal surface of ileum has **many folds**, which exhibit **velvety appearance** due to presence of numerous finger-like projections called **villi (0.5-1.5 mm long).**
- Each villus is covered by **simple columnar epithelium, blood capillaries** and **lymph capillary, called Lacteals.**
- The **total surface area** of absorption becomes **incredibly large** due to infoldings, villi and microvilli.

Simple Sugars (Carbohydrates)

- The absorption of simple sugars occurs by combination of **simple diffusion** and **active transport.**
- The absorbed sugar molecules are transferred to the capillaries in intestinal villi and are carried to the **hepatic portal system** to the liver.
- Then, in liver **non-glucose** sugars are **converted to glucose.**

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Amino Acids

- Individual amino acids are absorbed in the **epithelial cells of villi** and enter hepatic portal system, which transport them to liver.
- The amino acids may be modified or released into the bloodstream and distributed throughout the body.

Fatty Acid and Glycerol

- Fatty acid and glycerol absorbed by the epithelial cells where they again **recombine into fats.**
- The **fats** are **mixed** with **cholesterol and proteins**, forming small globules called **Chylomicrons (Lipoproteins).**
- **Chylomicrons** are transported out of epithelial cells into the lacteal by **Exocytosis.** Then, these are passed in the **blood stream via thoracic lymph duct.**
- The **lipoproteins** are **hydrolyzed** by blood **plasma enzymes** and enter the body cells, where they may be **used by respiration** or **stored** as fats in the liver, muscles or under the skin.

ROLE OF LIVER IN DIGESTION

- Liver is the **largest** and **fragile** internal organ of the body.
- It has wide range of functions including **detoxification** and **production of bile** to help digestion.
- **Kupffer cells** are resident **macrophages (W.B.Cs)** found in **liver sinusoids** and role in immunity.
- **Bile** temporarily **stored in the gall bladder** and then **released into duodenum** through bile duct.

Composition of Bile

- Bile is a **yellow-green digestive fluid** contains **Water, Bile Salts (sodium glycocholate** and **taurocholate), cholesterol, Lecithin (Phospholipids), Mucus, Cellular debris** and **Bile pigments (Bilirubin and Biliverdin)** which are formed by the breakdown of haemoglobin in liver.
- **Biliverdin** is formed as the **initial product of hemoglobin** breakdown and **bilirubin** formed by the **reduction of biliverdin.**

Role of Bile

- Bile salts **Emulsify** large fat globules into smaller droplets **(micelles)** in the small intestine.
- This process **increases the surface area** for the enzyme pancreatic lipase, facilitating fat digestion.
- Bilirubin gives bile its **characteristic yellow color** and **is** responsible for the **yellow** and **brown** coloration of **urine** and **feces**, respectively.
- **Jaundice:** caused by the accumulation of bile pigment in blood.
- **Gall stone:** caused by precipitation of cholesterol in gall bladder which may block the release of bile
- The **gall blader** (8cm long & 4cm wide) has **sac-like structure** on the inferior surface of liver. It connects to the common bile duct by **cystic duct.**

Regulation of Bile Secretion

- **Secretin:** Stimulates the liver to produce bile with a higher concentration of **bicarbonate.**
- **Cholecystokinin (CCK):** Stimulates gallbladder contraction, relaxes the **sphincter of Oddi,** releasing bile into the duodenum.

ROLE OF PANCREAS IN DIGESTION

- The pancreas is a vital gland in the digestive system, functioning as both an **exocrine** and **endocrine** organ.
- The pancreas consists of **head,** located within the curvature of duodenum, a **body** and a **tail** which extend to the spleen.
- Its primary role in digestion is carried out by its **exocrine functions,** which involve the secretion of **pancreatic juice** into the small intestine.
- Pancreatic juice is **slightly alkaline (pH 8)** and consists of enzymes that digest all the principal components of food i.e., carbohydrates, lipids and proteins **(Complete summary of pancreatic enzymes are already discussed in table above).**

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Regulation of Pancreatic Secretion

- Pancreatic juice secretion is regulated by **Secretin** and **Cholecystokinin (CCK)** which is produced by the wall of duodenum upon **detection of acidic food, proteins, fats and vitamin.**
- Complete summary of digestive hormones is already discussed in table above.

LARGE INTESTINE

- The large intestine is the final part of the digestive system responsible for **water absorption, electrolyte balance,** and the **formation of feces.**
- It is divided into **caecum, colon** and **rectum**.
- The junction between ileum and large intestine is **ileocolic junction guarded by ileocolic sphincter**

Caecum (9-10 cm)

- It is the **blind sac** and proximal part of large intestine.
- Houses the **appendix** (blind finger like tube), a vestigial organ with **lymphatic tissue.**
- **Appendicitis**: Inflammation of appendix might be due to putrefaction of food.

Colon (1.5-1.8 m)

- Colon is the **longest part** of large intestine which further **divides** into **four parts.**
- **Ascending Colon**: Travels upward on the right side of the abdomen.
- **Transverse Colon**: Extends across the abdomen.
- **Descending Colon**: Travels downward on the left side.
- **Sigmoid Colon**: S shaped region leading to the rectum.

Rectum (Last part of large intestine)

- A short, straight tube that **temporarily stores** feces before defecation and rejected through anus at intervals.
- **Anus** is the **terminal portion** of digestive tract and surrounded by **two sphincters.**
- The **internal** anal sphincter is of **smooth muscles** (involuntary) and **external** anal sphincter is of **striped muscles** (Voluntary).

Functions of large intestine

- The proximal half of large intestine function to absorbs **water (~90%)** and **electrolytes**.
- Absorbs important ions like **sodium (Na^+)** and chloride **(Cl^-)**.
- Gut bacteria produce essential vitamins, such as **vitamin K** (by **E.coli**: anaerobic facultative bacteria) and some **B-complex vitamins** (Biotin).
- The mucosa of large intestine **secretes bicarbonates** to neutralize the increased acidity and also act as mucosal barrier and protect from microbial infection and invasion.
- **Composition of fecal material:** Bacteria, plant fibers, sloughed off mucosal cells, mucus, cholesterol, bile pigment and water.
- **Diarrhea:** Less absorption of water by large intestine leads to diarrhea and then **dehydration.**
- **Constipation:** This is due to excessive absorption of water by large intestine.

Defecation reflex

- **Defecation reflex** is involved in the emptying of rectum from feces. It is generated when rectum is filled with feces. It is consciously controlled in an individual other than infants.
- When appropriate, adults usually can initiate the defecation reflex by holding breath and contracting the abdominal muscles.
- The defecation reflex persists only for a **few minutes** and quickly dies.
- A person usually can **inhibit defecation** voluntarily by keeping the external anal sphincter contracting.

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Sphincters in the Human Gut

Sphincter	Location	Function
Upper Esophageal Sphincter (UES)	Between the **pharynx** and the **esophagus**	Controls the entry of food into the esophagus. Prevents air from entering the esophagus during breathing.
LES / Lower Esophageal Sphincter (Cardiac Sphincter)	Between the **esophagus** and the **stomach**	Prevents backflow (reflux) of stomach contents (acid and food) into the esophagus. Relaxes to allow food entry into the stomach.
Pyloric Sphincter	Between the **stomach** and the **duodenum** (small intestine)	Regulates the passage of partially digested food (chyme) from the stomach into the duodenum. Prevents backflow of chyme from the duodenum into the stomach.
Ileocecal Sphincter	Between the **ileum** (last part of the small intestine) and the **cecum** (first part of the large intestine)	Prevents the backflow of material from the large intestine into the small intestine. Controls the movement of undigested food into the large intestine.
Internal Anal Sphincter	Surrounding the anal canal **(involuntary control)**	Maintains continence by keeping the anal canal closed at rest.
External Anal Sphincter	Surrounding the anal canal **(voluntary control)**	Allows voluntary control over defecation.

SOME COMMON DISORDERS RELATED TO HUMAN DIGESTIVE SYSTEM

Common Nutritional Disorders

Disorder	Description	Causes	Symptoms	Treatment
Dyspepsia (Indigestion)	Incomplete or imperfect digestion of food.	Overeating, acidity in stomach, insufficient quantity and quality of bile. Helicobacter pylori infection.	Bloating, nausea, Vomiting, abdominal pain, flatulence, heartburn.	Dietary changes, antacids. Cimetidine Antibiotics
Food Poisoning **Botulism:** Severe form of food Poisoning.	Illness from indigestion of food contaminated with toxins. Occurs from **12-24 hours** after eating contaminated food.	Consumption of contaminated food, improperly canned or preserved foods. ***Clostridium botulinum***, ***Salmonella*** and ***Campylobacter.***	Abdominal pain, Muscle weakness, dry mouth, difficulty swallowing, blurred vision, headache, paralysis in severe cases.	Maintain good hygiene, proper hydration, use ORS. Antibiotics for wound botulism.
Obesity	Excessive accumulation of body fat, leading to health risks.	High-calorie diet, lack of exercise, genetics, hormonal imbalances, lifestyle factors.	Weight gain, fatigue, shortness of breath, increased risk of diabetes, heart disease, and arthritis.	Lifestyle modifications (diet, exercise), medications, bariatric surgery in severe cases.

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NUTRITION

Anorexia Nervosa	Loss of appetite due to fear of becoming obese. Common in females, age between 12-21 years.	Psychological factors, cultural pressure, genetics, stress, or trauma.	Extreme weight loss, fatigue, dry skin, hair thinning, irregular periods, distorted body image.	Psychotherapy, nutritional counseling, medical monitoring, medications (antidepressants if needed).
Bulimia Nervosa	An eating disorder in slightly older girls, involving bouts of over-eating followed by purging (vomiting or laxative use).	Psychological factors, body image concerns, stress, genetics.	Tooth decay, sore throat, dehydration, electrolyte imbalance, irregular heartbeats.	Cognitive behavioral therapy (CBT), nutritional counseling, medications.
Piles (Hemorrhoids)	Swollen blood vessels in the rectum or anus, causing discomfort or bleeding.	Chronic constipation, Unhygienic conditions, straining during bowel movements, obesity.	Rectal pain, itching, bleeding during defecation, swelling around the anus.	High-fiber (roughage) diet, use of laxatives, sitz baths, medications, surgery in severe cases.
Ulcers	Open sores in the stomach or duodenum caused by the breakdown of the mucosal lining.	H. pylori infection, excessive gastric HCl secretion, excessive alcohol, smoking, and stress.	Abdominal pain, nausea, bloating, vomiting, hole in gut cause spilling of food contents into abdominal cavity.	antibiotics for H. pylori, Antacids, NSAIDs (Nonsteroidal anti-inflammatory drugs).
Pyrosis (Heartburn)	A burning sensation in the chest caused by acid reflux into the esophagus.	Acid reflux, overeating, obesity, spicy foods, caffeine, smoking	Burning sensation in chest/throat, sour taste in mouth, difficulty swallowing.	Antacids, weight management, avoiding eating spicy foods.

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1. Correct dental formula of humans:
(A) [illegible] (B) 1023 / 1023
(C) 2123 / 2123 (D) 3212 / 3212

2. Saliva with only amylase is secreted by:
(A) Buccal glands
(B) Sub-mandibular glands
(C) Parotid glands
(D) Sub-lingual glands

3. Which of the following terms describe human dentition?
(A) Thecodont, Diphyodont, Homodont
(B) Thecodont, Diphyodont, Heterodont
(C) Pleurodont, Monophyodont, Homodont
(D) Pleurodont, Diphyodont, Heterodont

4. The esophagus is a thin, long tube which extends _____ to trachea:
(A) Ventrally (B) Anteriorly
(C) Horizontally (D) Dorsally

5. Which of the following electrolytes is/are present in the saliva of human?
(A) Na^+ (B) K^+
(C) Cl^- (D) above all

6. Carbohydrate digestion occurs first in which structure:
(A) Mouth (B) Intestine
(C) Stomach (D) Liver

7. Identify the false statement:
(A) Esophagus does not secrete any enzyme
(B) Gall bladder concentrates bile juice
(C) Human teeth are thecodont
(D) There are two pairs of salivary glands in humans

8. The initial step in the digestion of milk in humans is carried out by:
(A) Lipase (B) Trypsin
(C) Rennin (D) Pepsin

9. Gastric juice of infants contains:
(A) Nuclease, pepsinogen, lipase
(B) Pepsinogen, lipase, rennin
(C) Amylase, rennin, pepsinogen
(D) Maltase, pepsinogen, rennin

10. The main function of oral cavity accomplished by saliva are:
(A) Mastication and digestion
(B) Lubrication and digestion
(C) Selection and mastication
(D) Grinding and mastication

11. The oral cavity is bounded by:
(A) Palate
(B) Tongue
(C) Cheeks
(D) Palate, Tongue, and Cheeks

12. Saliva contains _____ important enzymes:
(A) Two (B) Three
(C) Four (D) Five

13. The starch is digested in oral cavity by:
(A) Ptyalin (B) Amylase
(C) Amylase (D) Lipase

14. The action which is voluntary in the beginning but later it becomes automatic is:
(A) Secretion of saliva
(B) Grinding in oral cavity
(C) Selection of food
(D) Swallowing of food

15. It starts just behind the mass of food from the buccal cavity along the esophagus to the stomach and then along the whole alimentary canal:
(A) Swallowing (B) Peristalsis
(C) Antiperistalsis (D) Ingestion

16. Hunger contractions are increased by:
(A) Low blood glucose levels
(B) High blood glucose levels
(C) Low level of sodium in blood
(D) High level of sodium in blood

17. Which one is wrong pair:
(A) Scurvy – Vitamin C
(B) Rickets – Vitamin D
(C) Night blindness – Vitamin A
(D) Beriberi – Vitamin K

18. Which one of the following is the correct matching of a vitamin, its nature and its deficiency disease?
(A) Vitamin K – Fat soluble – Beri-Beri
(B) Vitamin A – Fat soluble – Beri-Beri
(C) Vitamin K – Water soluble – Pellagra
(D) Vitamin A – Fat soluble – Night blindness

19. A painful burning sensation in the chest usually associated with the back flush of acid chyme into the esophagus is called:
(A) Pyrosis (B) Dyspepsia
(C) Indigestion (D) Nausea

20. Inner layer of stomach wall consists of:
(A) Connective tissues
(B) Epithelial tissues
(C) Smooth muscles
(D) Connective tissue with many glands

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21. **Stomach wall is composed of four principal layers, choose the correct sequence from outer to inner layer:**
(A) Serosa, Muscularis, Submucosa, Mucosa
(B) Muscularis, Submucosa, Mucosa, Serosa
(C) Serosa, Submucosa, Muscularis, Mucosa
(D) Submucosa, Mucosa, Serosa, Muscularis

22. **Arrangement of muscles in muscularis of stomach from outer to inner:**
(A) Longitudinal, Circular, Oblique
(B) Oblique, Longitudinal, Circular
(C) Circular, Longitudinal, Oblique
(D) Oblique, Circular, Longitudinal

23. **Nearly all absorption of the products of digestion takes place in the:**
(A) Duodenum (B) Stomach
(C) Jejunum (D) Ileum

24. **A large proportion of fatty acids and glycerol enter the epithelial cells of the villi where they are:**
(A) Further broken down
(B) Recombine into fats
(C) Converted into phospholipids
(D) Converted into sphingolipids

25. **It is a blind sac that projects form the large intestine between ileum and colon:**
(A) Caecum
(B) Colon
(C) Rectum
(D) Vermiform appendix

26. **The absorption of water and salts does not take place in large intestine due to:**
(A) Infection
(B) Drug action
(C) Emotional disturbance
(D) Infection, drug action and Emotional disturbance

27. **Anus is surrounded by two sphincters:**
(A) The internal of smooth and outer of striped muscles
(B) The internal and outer both of smooth muscles
(C) The internal of striped and outer of smooth muscles
(D) The internal and outer both of striped muscles

28. **In large intestine vitamin K is formed by the activity of:**
(A) Symbiotic bacteria
(B) Parasitic bacteria
(C) Obligate parasite
(D) Facultative bacteria

29. **Trypsinogen is converted into trypsin by the activity of:**
(A) Goblet cells (B) Enterokinase
(C) Absorptive cells (D) Peptidase

30. **Saliva is basically composed of water, mucus, amylase and:**
(A) Sodium hydroxide
(B) Sodium bicarbonate
(C) Hydrocarbons
(D) Sodium chloride

31. **The major components of our food are:**
(A) Carbohydrates (B) Proteins
(C) Fats (D) All

32. **The role of water in our body is to:**
(A) Act as medium for transport of substance
(B) Provide medium for all metabolic reactions
(C) Prevent dehydration of body
(D) All

33. **A part of large intestine which is a blind sac and harbor some symbiotic organism is:**
(A) Colon (B) Caecum
(C) Rectum (D) Ileum

34. **How many types of salivary glands are present in the human body?**
(A) 3 (B) 4
(C) 5 (D) 6

35. **Digestion of carbohydrates starts from:**
(A) Buccal cavity (B) Stomach
(C) Small intestine (D) Large intestine

36. **All of the following are nutrients obtained by our body from food except:**
(A) Carbohydrates (B) Nucleic acids
(C) Proteins (D) Lipids

37. **Oxyntic cells are located in:**
(A) Islets of Langerhans and secrete insulin
(B) Kidneys and secrete renin
(C) Gastric epithelium and secrete HCL
(D) Gastric epithelium and secrete pepsin

38. **Digestion involves:**
(A) Burning of food
(B) Oxidation of food
(C) Hydrolysis of food
(D) Synthesis of food

39. **Longest segment of alimentary canal is:**
(A) Duodenum (B) Ileum
(C) Jejunum (D) Colon

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40. **Liver and pancreas pour their secretions into gut at:**
(A) Stomach (B) Jejunum
(C) Duodenum (D) Ileum

41. **The products of liver and pancreas participate in which type of digestion:**
(A) Both mechanical
(B) Chemical and mechanical respectively
(C) Both chemical
(D) Mechanical and chemical respectively

42. **Salivary glands located beneath the tongue are:**
(A) Sublingual (B) Submaxillary
(C) Submandibular (D) Parotid

43. **Inner most layer in gut wall is:**
(A) Mucosa (B) Muscularis
(C) Sub-Mucosa (D) Serosa

44. **Organ mainly responsible for chemical digestion of lipids is:**
(A) Stomach (B) Small Intestine
(C) Pancreas (D) Liver

45. **Damage to which gland of the oral cavity would lead to an increase in the concentration of triglycerides in the esophagus:**
(A) Submandibular (B) Parotid
(C) Sublingual (D) Ebner's

46. **Digested food is mainly absorbed in:**
(A) Stomach (B) Large intestine
(C) Small intestine (D) Buccal cavity

47. **Surface area for absorption of food in ileum is increased by:**
(A) Intestinal folds (B) Microvilli
(C) Villi (D) All of above

48. **Starch is converted to maltose by the action of:**
(A) Sucrase (B) Lactase
(C) Maltase (D) Amylase

49. **Enzyme mainly responsible for digestion of proteins in stomach is:**
(A) Pepsinogen (B) Pepsin
(C) Trypsinogen (D) Trypsin

50. **All are protein digesting enzymes except:**
(A) Pepsin (B) Trypsin
(C) Peptidase (D) Amylase

51. **Chemical nature of mucus is:**
(A) Glycolipid (B) Nucleoprotein
(C) Lipoprotein (D) Glycoprotein

52. **Heartburn (Pyrosis) is due to incompetence of:**
(A) Cardiac sphincter
(B) Ileocolic sphincter
(C) Pyloric sphincter
(D) Anal sphincter

53. **Final products of protein digestion in ileum are:**
(A) Amino Acids (B) Tripeptides
(C) Dipeptides (D) Polypeptides

54. **Absorption of water and minerals mainly takes place in:**
(A) Stomach (B) Large intestine
(C) Small intestine (D) Esophagus

55. **Bile is responsible for:**
(A) Hydrolysis of fats
(B) Emulsification of fats
(C) Condensation of fats
(D) Chemical digestion of fats

56. **Chymotrypsin is an enzyme secreted by:**
(A) Stomach (B) Liver
(C) Small intestine (D) Pancreas

57. **Stimulation of parasympathetic nervous system increases:**
(A) Gastrointestinal activity
(B) Rate of blood flow
(C) Heart rate
(D) Breathing rate

58. **Part of digestive system that is not in contact with food is:**
(A) Buccal cavity (B) Stomach
(C) Pancreas (D) Duodenum

59. **Secretion that contains enzymes for digestion of carbohydrates, lipids and proteins is:**
(A) Saliva (B) Pancreatic juice
(C) Gastric juice (D) Bile

60. **Large amount of carbohydrates is stored in:**
(A) Liver (B) Adipose tissue
(C) Stomach (D) Portal vein

61. **All of the following are true about digestive system of humans except:**
(A) Tubelike
(B) Intracellular digestion
(C) Alimentary canal
(D) Mechanical digestion

62. **Erypsin acts on:**
(A) Carbohydrates (B) Lipids
(C) Proteins (D) Nucleic acids

63. **Chylomicrons are:**
(A) Glycoprotein (B) Glycolipids
(C) Lipoproteins (D) Nucleoprotein

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64. These are painful sensations caused due to decreased blood glucose level:
(A) Peristalsis (B) Antiperistalsis
(C) Continuous motility (D) Hunger pangs

65. It allows transfer of residues from small to large intestine:
(A) Cardiac sphincter
(B) Ileocolic sphincter
(C) Pyloric sphincter
(D) Anal sphincter

66. If undigested food passes too quickly through large intestine, resulting disorder would be:
(A) Food poisoning (B) Constipation
(C) Diarrhea (D) Piles

67. Branches of lymph capillaries within villi of intestine are called:
(A) Nodes (B) Ducts
(C) Lacteals (D) All

68. Which of the following enzyme is released in an inactive form?
(A) Amylase (B) Enterokinase
(C) Lipase (D) Pepsin

69. Which of the following is absorbed in the large intestine?
(A) Water and peptones
(B) Water and salts
(C) Amino acids and sugars
(D) Carbohydrates and lipids

70. The function of goblet cells is to secrete:
(A) Gastrin (B) Pepsinogen
(B) Hydrochloric acid (D) Mucus

71. All insectivorous plants are:
(A) Heterotrophs (B) Autotrophs
(C) Decomposers (D) Parasite

72. Carnivorous or insectivorous plants commonly grow in areas where _____ is deficient because of unfavorable atmosphere for bacteria:
(A) Phosphorus (B) Potassium
(C) Nitrogen (D) Carbon

73. End of leave is modified to form a hood:
(A) *Sarracenia pupurea*
(B) *Drosera intermedia*
(C) *Dionaea muscipula*
(D) All of the above

74. Which of the following gastric cells indirectly help in erythropoiesis?
(A) Chief cells (B) Mucous cells
(C) Goblet cells (D) Parietal cells

75. Which of the following hormone helps in secretion of HCl from stomach?
(A) Renin (B) Gastrin
(C) Secretin (D) Somatostatin

76. Which one of the following pairs of food components in humans reaches the stomach totally undigested?
(A) Starch and cellulose
(B) Protein and starch
(C) Starch and fat
(D) Fat and cellulose

77. Which of the following hormones stimulates the production of pancreatic juice and bicarbonate?
(A) Insulin and glucagon
(B) Cholecystokinin and secretin
(C) Gastrin and insulin
(D) Angiotensin and epinephrine

78. Some proteolytic enzymes are:
(A) Trypsin, Erypsin, Pepsin
(B) Amylase, Lipase, Zymase
(C) Amylopsin, Steapsin, Ptyalin
(D) Urease, Dehydrogenase, Zymase

79. Which hormones do stimulate the production of pancreatic juice and bicarbonate:
(A) Cholecystokinin and secretin
(B) Insulin and glucagon
(C) Angiotensin and epinephrine
(D) Gastrin and insulin

80. Bile secretion is proportional to the concentration of:
(A) Protein (B) Fat
(C) Carbohydrate (D) Vitamins

81. Maximum digestion of food takes place in:
(A) Stomach (B) Jejunum
(C) Colon (D) Duodenum

82. Identify the cells whose secretion protects the lining of gastro-intestinal tract from various enzymes:
(A) Chief Cells (B) Goblet Cells
(C) Oxyntic Cells (D) Duodenal Cells

83. The main digestive function of enterokinase is:
(A) Conversion of pepsinogen into pepsin
(B) Conversion of trypsinogen into trypsin
(C) Conversion of trypsin into trypsinogen
(D) Stimulation of the gastric glands to secrete gastric juice

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84. **The organ in human body where Brunner's glands are present:**
(A) Large intestine (B) Small intestine
(C) Liver (D) Kidney

85. **The hepatic portal vein drains blood to liver from:**
(A) Lungs (B) Kidneys
(C) Gastrointestinal tract (D) Heart

86. **Chymotrypsinogen is produced by:**
(A) Liver (B) Pancreas
(C) Stomach (D) Duodenum

87. **The longitudinal muscular folds of inner wall of stomach are called:**
(A) Papilla of vater (B) Rugae
(C) Villi (D) Fissure

88. **Which of the following options best represents the enzyme composition of pancreatic juice:**
(A) Amylase, pepsin, trypsinogen, maltase
(B) Peptidase, amylase, pepsin, rennin
(C) Lipase, amylase, trypsinogen, procarboxypeptidase
(D) Amylase, peptidase, trypsinogen, rennin

89. **All of the following is correct with respect to large intestine except:**
(A) No significant digestive activity.
(B) Absorption of some water
(C) Absorption of certain minerals.
(D) Absorption of remaining glucose and amino acid.

90. **Pancreatic juice contains bicarbonate which is secreted by:**
(A) Paneth cells (B) Goblet cells
(C) Kupffer's cells (D) Acinar cells

91. **Conversion of large fat globules into smaller globule is:**
(A) Emulsification (B) Digestion
(C) Assimilation (D) Specification

92. **Kwashiorkor disease is due to:**
(A) Simultaneous deficiency of proteins and fats
(B) Simultaneous deficiency of proteins and calories
(C) Deficiency of carbohydrates
(D) Protein deficiency not accompanied by calorie deficiency

93. **In which of the following disease liver is affected, skin and eyes turn yellow due to the deposition of bile pigments?**
(A) Vomiting (B) Jaundice
(C) Diarrhea (D) Dysentery

94. **Fatty acids and glycerol are first absorbed by:**
(A) Lymph vessels
(B) Blood
(C) Blood capillaries
(D) Hepatic portal Vein

95. **In adults the deficiency of vitamin D causes:**
(A) Rickets (B) Beri-Beri
(C) Scurvy (D) Osteomalacia

96. **Vitamin K is a required for:**
(A) Change of Prothrombin to thrombin
(B) Synthesis of Prothrombin
(C) Change of Fibrinogen to Fibrin
(D) Formation of thromboplastin

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97. **Which of the following enzyme is released in an inactive form? (2011)**
(A) Amylase (B) Enterokinase
(C) Lipase (D) Pepsin

98. **Which of the following hormone stimulates the secretion of pancreatic juices from pancreas and liver? (2011)**
(A) Secretin
(B) Gastrin
(C) Pepsinogen
(D) Both secretin and gastrin

99. **In large intestine vitamin K is formed by the activity of: (2011)**
(A) Symbiotic bacteria
(B) Parasitic bacteria
(C) Obligate parasite
(D) Facultative bacteria

100. **The muscles of the stomach walls thoroughly mix up the food with gastric juice and as a result semi-solid/ semi-liquid material is called: (2012)**
(A) Bolus (B) Mucus
(C) Chyle (D) Chyme

101. **Trypsinogen is converted into trypsin by the activity of: (2012)**
(A) Goblet cells (B) Enterokinase
(C) Absorptive cells (D) Peptidase

102. **In large intestine, vitamin K is formed by the activity of: (2012)**
(A) Symbiotic bacteria
(B) Parasitic bacteria
(C) Obligate parasite
(D) Facultative bacteria

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Goblet cells secrete: (2012)
(A) HCL (B) Enzymes
(C) Mucus (D) Amylase

Which one of the following vitamins is produced by microflora of large intestine? (2012)
(A) Vitamin D (B) Vitamin C
(C) Vitamin K (D) Vitamin A

_____ is activated to_____, by enterokinase / enteropeptidase enzyme secreted by the lining of duodenum: (2013)
(A) Trypsinogen, trypsin
(B) Pepsinogen, trypsin
(C) Pepsinogen, pepsin
(D) Chymotrypsinogen, chymotrypsin

Which of the following is absorbed in the large intestine? (2013)
(A) Water and peptones
(B) Water and salts
(C) Salts and glycerol
(D) Amino acids and sugars

Saliva is basically composed of water, mucus, amylase and: (2013)
(A) Sodium hydroxide
(B) Sodium bicarbonate
(C) Hydrocarbons
(D) Sodium chloride

In human, Escherichia coli is involved in the formation of: (2014)
(A) Calcium (B) Vitamin A
(C) Vitamin D (D) Vitamin K

The function of goblet cells is to secrete: (2014)
(A) Gastrin (B) Pepsinogen
(C) Hydrochloric acid (D) Mucus

Gastric glands are made up of_____type of cells: (2014)
(A) Two (B) Four
(C) Three (D) Five

HCL in gastric juice is secreted by which one of the following cells: (2014)
(A) Chief cells (B) Mucous cells
(C) Oxyntic cells (D) Kupffer cells

The lymph vessel of villi is called: (2015)
(A) Epithelium (B) Adenoids
(C) Afferent lymph vessel (D) Lacteal

Oxyntic cells in stomach produce: (2015)
(A) Pepsin (B) Gastrin
(C) Pepsinogen (D) HCl

114. The hormone which inhibits the secretion of gastric juice is: (2015)
(A) Secretin (B) Thyroxin
(C) Gastrin (D) Parathormone

115. Trypsinogen is activated to trypsin by: (2015)
(A) HCl (B) Mucus
(C) Enterokinase (D) Gastrin

116. The emulsification of fats is the role of: (2015)
(A) Saliva (B) Gastrin
(C) Pancreatic juice (D) Bile

117. Digestion of _____ starts in oral cavity due to the action of enzymes present in saliva: (2016)
(A) Starch (B) Fatty acids
(C) Cellulose (D) Polypeptides

118. Food enters from stomach into small intestine through: (2016)
(A) Pyloric sphincter (B) Semilunar valve
(C) Cardiac sphincter (D) Diaphragm

119. are the part of gastric gland which produces hydrochloric acid: (2016)
(A) Parietal cells (B) Chief cells
(C) Goblet cells (D) Zymogen cells

120. Protein components of food are digested by the enzymatic secretion of: (2016)
(A) Goblet cells (B) Zymogen cells
(C) Parietal cells (D) Oxyntic cells

121. Digestive system consists of different layers, the innermost is known as: (2016)
(A) Submucosa (B) Muscularis
(C) Mucosa (D) Serosa

122. Food is diverted into the esophagus by: (2017)
(A) Glottis (B) Cheeks
(C) Tongue (D) Epiglottis

123. Label 'a' in the following diagram: (2017)

(A) Cardiac sphincter
(B) Stomach valve
(C) Sinoatrial valve
(D) Pyloric sphincter

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124. Enzyme pepsin acts on: (2017)

Option	Substrate	Product
(A)	Proteins	Polypeptides
(B)	Polypeptide	Dipeptides
(C)	Fats	Fatty acids & glycerol
(D)	Proteins	Amino acids

125. Following is the structure of a gastric gland in stomach wall where 'X' is: (2017)

(A) Mucosa (B) Visceral fat cells
(C) Mucous cells (D) Oxyntic cells

126. Which of the following cells secrete HCl: (2017-Retake)
(A) Oxyntic cells (B) G-Cells
(C) Zymogen cells (D) Mucous cells

127. Appendix is finger like process arise from: (2017-Retake)
(A) Colon (B) Caecum
(C) Rectum (D) Small intestine

128. All kind of absorption take place in: (2017-Retake)
(A) Duodenum (B) Ileum
(C) Jejunum (D) Colon

129. The term loss of appetite refers to disease: (2018)
(A) Botulism
(B) Anorexia Nervosa
(C) Obesity
(D) Bulima Nervosa

130. Salivary amylase begins to digest starch into shorter polypeptide chain and then to: (2018)
(A) Glucose (B) Sucrose
(C) Maltose (D) Lactose

131. Number of salivary glands found in the oral cavity: (2018)
(A) 3 (B) 2
(C) 6 (D) 8

132. The first part of large intestine is: (2018)
(A) Colon (B) Cecum
(C) Appendix (D) Rectum

133. Digested food from intestine is carried to the liver by: (2022)
(A) Hepatic artery
(B) Hepatic portal artery
(C) Hepatic vein
(D) Hepatic portal vein

134. Feeding by living in or on the other organism (Host) belonging to different species is called: (2023)
(A) Mineral nutrition
(B) Parasitic nutrition
(C) Saprophytic nutrition
(D) Symbiotic nutrition

135. Autotrophic mode of nutrition in organisms depends upon: (UHS 2024)
(A) Saprotrophic mode
(B) Photosynthetic mode
(C) Parasitic mode
(D) Obligate mode

136. Which hormone stimulates the secretion of gastric juice: (ETEA 2024)
(A) Cholecystokinin (B) Gastrin
(C) Insulin (D) Secretin

137. Carnivorous plants have evolved mechanisms for tapping and digesting small animals. The product of this digestion is used to supplement the plant's supply of: (ETEA 2024)
(A) Carbohydrates (B) Lipids
(C) Nitrites (D) Water

138. Which is true about the cells found in gastric glands lining the stomach wall: (ETEA 2024)
(A) Chief cells secrete gastrin
(B) Hormone cells secrete intrinsic factor
(C) Mucus cells secrete mucin
(D) Parietal cells secrete pepsinogen

139. A person with a removed gall bladder experiences difficulty in fat digestion due to: (NUMS 2024)
(A) Absence of Bile
(B) Uncontrolled release of Bile
(C) Reduced alkalinity of bile
(D) Absence of bile pigments

140. At the end of ileum, there is a / an _____ sphincter that opens and closes time to time to allow a small amount of residue to enter the large intestine: (SZABMU 2024)
(A) Hepatic (B) Cardiac
(C) Ileocolic (D) Pyloric

141. Gall stones are mostly made up of: (SZABMU 2024)
(A) Calcium (B) Cholesterol
(C) Calcium Phosphate (D) Proteins

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Answer Key

1. A	2. C	3. B	4. D	5. D	6. A	7. D	8. C	9. B	10. B
11. D	12. B	13. A	14. D	15. B	16. A	17. D	18. D	19. A	20. D
21. A	22. A	23. D	24. B	25. A	26. D	27. A	28. A	29. B	30. B
31. D	32. D	33. B	34. A	35. A	36. B	37. C	38. C	39. B	40. C
41. D	42. A	43. A	44. C	45. D	46. C	47. D	48. D	49. B	50. D
51. D	52. A	53. A	54. C	55. B	56. D	57. A	58. C	59. B	60. A
61. B	62. C	63. C	64. D	65. B	66. C	67. C	68. D	69. B	70. D
71. B	72. C	73. A	74. D	75. B	76. D	77. B	78. A	79. A	80. B
81. D	82. B	83. B	84. B	85. C	86. B	87. B	88. C	89. D	90. D
91. A	92. D	93. B	94. A	95. D	96. B	97. D	98. A	99. A	100. D
101. B	102. A	103. C	104. C	105. A	106. B	107. B	108. D	109. D	110. C
111. C	112. D	113. D	114. A	115. C	116. D	117. A	118. A	119. A	120. B
121. C	122. D	123. D	124. A	125. D	126. A	127. B	128. B	129. B	130. C
131. C	132. B	133. D	134. B	135. B	136. B	137. C	138. C	139. B	140. C
141. B									

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UNIT # 09

LIFE PROCESSES
(GAS EXCHANGE)

High Yield Content:

- Structure of Human respiratory system
- Transport of gases (O_2 and CO_2)
- Respiratory disorders
- Mechanism of breathing
- Lung's capacity (Vital capacity, Tidal volume etc.)

SCAN QR CODE To Watch MDCAT Lectures, Test Discussions, and Past Papers Discussion on

"Gas Exchange"

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GASEOUS EXCHANGE: KEY CONCEPTS

Feature	External Respiration	Internal Respiration	Cellular Respiration
Definition	The exchange of gases (O_2 & CO_2) between the external environment and the bloodstream.	The exchange of gases (O_2 & CO_2) between blood and body tissues.	The biochemical breakdown of glucose inside cells to release energy (ATP).
Location	Occurs in the lungs (alveoli & capillaries).	Occurs at the capillary level in tissues.	It takes place inside the mitochondria of cells.
Oxygen Role	Oxygen diffuses from alveoli into the blood.	Oxygen diffuses from blood into body cells.	Oxygen is used to produce ATP in mitochondria.

Properties of Respiratory Surface

- The area where gaseous exchange with the environment actually takes place is called **respiratory surface**. It must have the following properties so hat diffusion can occur effectively:

i. Must be moist.
ii. Must be permeable so that gases can pass through
iii. It must be thin, because diffusion if only efficient over distance of **1mm or less.**
iv. It should possess a large surface area.
v. Should possess a good blood supply.
vi. There should be a good ventilation mechanism to maintain steep diffusion gradient across respiratory surface.

HUMAN RESPIRATORY SYSTEM

- The human respiratory system can be divided into two regions e.g., upper Respiratory tract and lower respiratory tract.
- **Upper Respiratory tract** includes nostrils, nasal cavity and pharynx
- **Lower respiratory tract** includes the larynx, trachea, bronchi, and lungs.

Air passageway

Nostrils → Nasal Cavity → Pharynx → Larynx → Trachea → Bronchi → Terminal Bronchioles → Respiratory Bronchioles → Alveolar ducts → Alveolar sacs

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Component	Anatomy	
Nostrils (2)	➢ Bone and cartilage ➢ Hairs ➢ Mucous membrane	➢ Filtration of larger particles ➢ Moistening ➢ Warming (about 30°C)
Nasal Cavities (2)	➢ Each cavity is subdivided into 3 passageways. ➢ Ciliated Columnar epithelium ➢ Mucous membrane	➢ Filtration ➢ Moistening ➢ Warming (about 30°C)
Pharynx / Throat	➢ Cone-shaped muscular passage ➢ Divided into nasopharynx oropharynx, and laryngopharynx ➢ Stratified Squamous Epithelium ➢ Mucous membrane	➢ Common part of digestive system and respiratory system ➢ Channelize air to larynx
Larynx / voice box	➢ Composed of cartilage (hyaline) and muscles ➢ Stratified Squamous Epithelium ➢ Glottis (Opening of trachea) ➢ Epiglottis (Hinge like elastic cartilage) ➢ Vocal card (2)	➢ Air passageway ➢ Filtration ➢ Moistening
Trachea/ windpipe (1) Ventral to esophagus)	➢ 15-20 C-Shaped cartilage (hyaline) rings ➢ Ciliated Columnar epithelium ➢ Mucous cells / Goblet cells	➢ Air passageway ➢ Filtration ➢ Moistening
Primary Bronchi (2)	➢ C-shaped cartilage rings ➢ Ciliated Columnar epithelium ➢ Mucous cells	➢ Air passage away ➢ Filtration ➢ Moistening
Secondary & Tertiary Bronchi	➢ Irregular Cartilage plates ➢ Ciliated Cuboidal epithelium ➢ Mucous cells	➢ Air passage away ➢ Filtration ➢ Moistening
Terminal bronchioles	➢ Diameter of 1 mm or less ➢ No cartage ➢ Simple Cuboidal epithelium ➢ Mucous cells	➢ Air passage away ➢ Filtration Moistening
Respiratory Bronchioles	➢ No cartage ➢ Simple Cuboidal epithelium ➢ Mucous cells	➢ Deliver air to the alveoli
Alveolar Ducts & Alveolar Sacs	➢ Alveolar ducts are tiny passageways that branch off from the respiratory bronchioles. ➢ Alveoli are tiny air sacs surrounded by capillaries. ➢ Simple Squamous Epithelium	➢ Gaseous exchange with blood

➢ Epiglottis is cartilaginous lid having a muscularly controlled, hinge-like action

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- Vocal cords are two thin edged stretched fibrous bands. These are **larger in male** so male have **low pitched** voice.
- Air sac (Clusters of alveoli) is a functional unit of lungs.

Component	Cartilage	Goblet Cells	Smooth Muscles	Cilia	Exchange of gases
Trachea	✓	✓	✓	✓	X
Bronchi	✓	✓	✓	✓	X
Terminal Bronchiole	X	X	✓	✓	X
Respiratory Bronchiole	X	X	X	A Few	X
Alveolar Duct	X	X	X	X	✓
Alveoli	X	X	X	X	✓

Lungs

- The lungs are principal organ for respiration situated in the **thoracic cavity**, on either side of the heart.
- Each lung is **conical in shape**, with its **base** resting on the diaphragm and its **apex** extends to point just about clavicle.
- They are closed sacs that are **connected** to the **outside** by the way of trachea and nostrils or mouth.
- The **right** and **left lungs** are slightly **unequal in size**. The right lung has **three lobes** (superior, middle, inferior) while the left lung has **two lobes** (superior, inferior) to accommodate the heart.
- **Hilum** is a triangular shaped depression of both lungs where the blood vessels and airways pass into the lungs.
- The right and left lungs are separated medially by the heart and **mediastinum**, which is the area between the lungs.
- Lungs are covered by a **double layered** thin membranes sac called **pleura. Visceral pleura** is the inner layer that directly covers the lungs while the **Parietal pleura** is the outer layer that lines the chest wall.
- **Pleural Cavity:** The space between the visceral and parietal pleura, filled with pleural fluid. The fluid reduces friction and allows the lungs to expand smoothly during breathing.

Surfactant

- It is a **mixture** of lipoproteins secreted by **type-II alveolar cells** which form a layer over the surface of the fluid within the alveoli to **reduce surface tension.**
- It speeds up the transport of respiratory gases and helps to kill bacteria, which reach the alveoli.
- In **premature infants**, **respiratory distress syndrome** is common due to its deficiency. It is more common in infants with a **gestation age** of less than **7 months.**

MECHANISM OF BREATHING

- Breathing is a process by which fresh air containing oxygen is pumped into the lungs and air with more carbon dioxide is pumped out of lungs.
- During rest, breathing occurs rhythmically at the frequency of **15-20 times/min** in humans and it can increase to **30 times/min** during exercise.
- **Lungs** are **spongy** in nature. They themselves neither draw in air nor push it out (Passive expansion and contraction).
- The floor of the chest cavity is **diaphragm** which is a sheet of **skeletal muscle**. It separates the thoracic cavity from abdominal cavity.
- Walls of the chest cavity are composed of ribs and intercostals muscles.
- There are two sets of **intercostals muscle** between each pair of ribs: The **external intercostal** and **internal intercostals** muscles. The muscle fibers run diagonally but in opposite direction.

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Phases of Breathing

Features	Inspiration	Expiration
Definition	➢ It is the process of taking in of the air (rich in O_2 and poor in CO_2)	➢ It is the process of taking out of the air (rich in CO_2 and poor in O_2)
Another Name	➢ Inhalation (Active process)	➢ Exhalation (Passive process)
Status of lungs	➢ Passive expansion of lungs	➢ Passive recoiling of lungs
Status of diaphragm	➢ Contracts ➢ Moves down ➢ Becomes less dome shaped	➢ Relaxes ➢ Moves up ➢ Becomes less dome shaped
Intercostal/Rib Muscles	➢ External intercostal Contract ➢ Internal intercostals Relax	➢ External intercostal Relax ➢ Internal intercostals Contract
Rib cage	Moves ➢ Upward ➢ Forward ➢ Outward	Moves ➢ Downward ➢ Inward ➢ Backward
Volume of thoracic Cavity	Increases	Decreases
Change in pressure in the thorax	Decreases	Increases
Air moves	Into lungs	Out of lungs

Control of breathing

- Normally, breathing is controlled **involuntarily** but within limits the rate and depth of the breathing are also under voluntary control as shown by the ability to hold the breath.
- Involuntary control of breathing is carried out by a **breathing centre** located in **medulla oblongata** of the brain.
- The **ventral (lower) portion** of the breathing centre acts to increase the rate and depth of inspiration and is called **inspiratory centre.**
- The **dorsal (top) and lateral (side)** inhibit inspiration and stimulate expiration called **expiratory centre.**
- The breathing centre communication with the intercostal muscles by way of the **intercostal nerves** and with the diaphragm by way of the **phrenic nerve**. Rhythmic nerve impulses to the diaphragm and intercostal muscles bring about ventilation movements.
- **Voluntary control** is also used during **forced breathing, speech, singing, sneezing** and **coughing**. Impulses originating in the **cerebral hemisphere** pass to the breathing centre which then carries out the appropriate action.

TRANSPORT OF GASES

- Intake of oxygen and release of carbon dioxide by blood passing through capillaries of alveoli is brought about **diffusion** because of the **difference** in **partial pressures** of these gases.
- Blood is distributed in extremely thin layers and therefore, exposed to large alveolar surface.
- Blood in lungs is separated from alveolar air by **extremely thin membranes** of the capillaries and alveoli.

Transport of Oxygen

- Approximately **97%** of the oxygen is carried by RBCs as **oxyhaemoglobin**.
- 3% of the oxygen is transported as **dissolved oxygen** in blood plasma.

At the Level of Lungs

- Haemoglobin (purple red) is readily combined with oxygen to form **bright red oxyhaemoglobin** (Hb + O_2 → $Hb4O_2$).

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- The ability of hemoglobin to bind with oxygen is called oxygen carrying capacity of blood. It is directly proportional to the pO_2.
- Maximum capacity of haemoglobin to carry oxygen is about **20ml/100ml** of blood at sea level. At this, blood will be 100% saturated and is achieved at **100 mm Hg** PO_2.
- Under normal conditions, blood of alveoli of lungs is not completely oxygenated. **At 115 mm Hg** oxygen tension, there is **19.6ml of O_2/100ml** of blood, where **hemoglobin is 98% saturated**.

At the Level of Aerobic Tissue

- Oxyhaemoglobin is **unstable** and splits into the **normal purple red haemoglobin** and oxygen in the condition of low oxygen concentration and low pressure. **Carbonic anhydrase** present in RBCs facilitates this activity.

$$Hb4O_2 \rightarrow Hb + 4O_2$$

- When oxygen pressure falls **below 60 mmHg**, as in many cells and tissues. The oxygen saturation of hemoglobin decreases very sharply, which results in the liberation of large quantities of oxygen from hemoglobin.
- In this way in the aerobic tissues where the oxygen tension is low, oxyhemoglobin dissociated rapidly.
- Under normal conditions **every 100ml** of blood gives **5ml O_2** to aerobic tissue.

Factors Affecting O_2 Holding Capacity of Hemoglobin

Carbon Dioxide

- When carbon dioxide pressure increases the oxygen tension decreases and the capacity to hold oxygen becomes less.
- Increased carbon dioxide tension favors the greater liberation of oxygen from the blood to the tissue.

Temperature

- Rise in temperature causes a decrease in oxygen carrying capacity of blood/Hb.
- For example, in increased muscular activity.

pH

- With decrease in pH of blood amount of oxygen bound to haemoglobin also declines.
- Decreased pH results from **increase in hydrogen ions**. Hydrogen ions combine with the protein part of hemoglobin molecules causing a decrease in its ability to bind oxygen.

Transport of Carbon Dioxide

- Carbon dioxide is **more soluble** than oxygen and dissolved freely in the tissue surrounding the cells.
- CO_2 that produced by the **aerobic cell** are dissolved in tissue fluid and the passes to blood.
- CO_2 Which is much more **important than oxygen** as a regulator of normal alveoli ventilation/breathing. Under certain circumstances, however, a reduced PO_2 in the arterial blood does play an important **stimulatory role**, especially during the conditions of shock.

Ways of Transport of CO_2

Sr. No	Percentage	Transported As
1.	70%	Bicarbonate ions
2.	23%	Carboxyhemoglobin/Carbaminohemoglobin
3.	7%	Dissolved in blood plasma

As Bicarbonate Ions

- About 70% of CO_2 is carried in the blood as HCO_3^-.
- CO_2 Diffuses into the blood, enters the RBCs and combines with water to form **carbonic acid** in the presence of **carbonic anhydrase**.

$$CO_2 + H_2O \longrightarrow H_2CO_3$$

- H_2CO_3 is an unstable compound and dissociates to form H^+ and $H_2CO_3^-$ **(Bicarbonate)**

$$H_2CO_3 \longrightarrow H^+ + H_2CO_3^-$$

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- Accumulation of H^+ increases acidity in the blood, hence pH decreases. The H^+ readily associates with the $Hb4O_2$ to form hemoglobinic acid and O_2 is releases to the tissue as shown below:

$$Hb4O_2 + H^+ \rightarrow HHB + 4O_2$$

- From inside of the RBCs, negatively charged $H_2CO_3^-$ diffuse to the blood plasma. This is balanced by the diffusion of Cl^- in the opposite direction.
- The movement of both of the negatively charged species is achieved by special $H_2CO_3^-$ Cl^- carrier protein that exists in the membrane of RBCs and moves the ions in opposite direction, maintaining the balance of ions on either side. This is called **chloride shift/Hamburger's phenomenon.**
- The Cl^- that enters the RBCs combines with K^+ to form KCl, whereas $H_2CO_3^-$ in the blood plasma combines with Na^+ to form $NaHCO_3$. The blood pH is thus maintained at approximately 7.4 by the buffer mechanism that exists in the blood.
- In lungs, process reverses and $H_2CO_3^-$ combine with H^+ to release CO_2 & H_2O.

As Carboxyhaemoglobin /Carbaminohaemoglobin

- About 23% of CO_2 is carried as Carboxyhaemoglobin /Carbaminohaemoglobin. It is formed when CO_2 combines with **amino group** of globin part of haemoglobin.
- When PCO_2 is **higher** in the **tissues** than blood formation of Carboxyhaemoglobin /Carbaminohaemoglobin occurs.
- When the PCO_2 is **higher** in the **blood** than tissues as in case of lungs Carboxyhaemoglobin /Carbaminohaemoglobin releases its CO_2.

As Dissolved CO_2 in Plasma

- Only 7% of CO_2 is carried this way. This is rather inefficient way to carry CO_2, but it does occur.

Capacity of Blood for CO_2

- Arterial Blood contains about **50 ml of CO_2 / 100ml of blood**, whereas venous blood contains **54 ml of CO_2/100ml** of blood. In this way, each 100ml of blood takes **4ml of CO_2** as it passes through the tissues and gives 4 ml of CO_2 as it passes through lungs.

Effects in Gases Transport

Effect	Definition	Location	Mechanism	Significance
Hamburger Effect (Chloride Shift)	Exchange of HCO_3^- (bicarbonate) out and Cl^- (chloride) in RBCs to maintain electrical neutrality.	Occurs in systemic capillaries (tissues) and pulmonary capillaries (lungs).	In tissues: HCO_3^- leaves RBCs and Cl^- enters. In lungs: HCO_3^- enters RBCs, binds with H^+ to form CO_2, and Cl^- exits.	Maintains CO_2 transport and blood pH balance.
Bohr Effect	Increase in CO_2 or H^+ (low pH) reduces hemoglobin's O_2 affinity, enhancing oxygen unloading in tissues.	Occurs in tissues and lungs.	High CO_2/low pH in tissues → Hb releases more O_2. Low CO_2/high pH in lungs → Hb binds more O_2.	Ensures more O_2 delivery to active tissues where metabolism is high.
Haldane Effect	Deoxygenated hemoglobin carries more CO_2 than oxygenated hemoglobin.	Occurs in lungs and tissues.	Low O_2 in tissues → Hb binds more CO_2 and H^+. High O_2 in lungs → Hb releases CO_2 for exhalation.	Enhances CO_2 transport from tissues to lungs.

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ROLE OF RESPIRATORY PIGMENTS

- Respiratory pigments are colored molecules, which act as oxygen carries by binding reversibly to oxygen. The most important respiratory pigments in humans are **haemoglobin** and **myoglobin**.

Features	Haemoglobin	Myoglobin
Found in	RBCs/Blood	Muscles
Structure	➢ It consists of **four polypeptide** chains ➢ Each molecule possesses four irons containing haem groups ➢ It exhibits **quaternary structure**	➢ It consists of **one polypeptide** chain ➢ Each molecule possesses one iron containing haem group ➢ It exhibits **tertiary structure.**
Capacity for oxygen	More	Less
Affinity with oxygen	Less	More
Loses oxygen	At 60 mm Hg PO_2	At 20 mm Hg PO_2
O_2 molecules Bound	4	1
Main Function	It transports oxygen (**75 times** increases due to haemoglobin)	It stores oxygen

RESPIRATORY VOLUMES

- Breathing occurs in cyclic manner due to the movements of the chest wall and the lungs. The resulting changes in pressure, causes changes in lung volumes i.e. the amount of air, the lungs are capable of occupying
- Respiratory volume is the **amount of air inhaled, exhaled** and **stored** within the lungs at any given time.
- **Total Lungs Capacity (TLC):** In an adult human being, when the lungs are fully inflated the total inside capacity of lungs is about **5-6 liters.**
- **Tidal Volume (TV):** The amount of air inhaled or exhaled during a normal breath at rest. Its average value is about **500ml.**
- **Inspiratory Reserve Volume (IRV):** The additional amount of air that can be inhaled after a normal inspiration. This is **forced inspiration.** Its average value is about **3100ml.**
- **Expiratory Reserve Volume (ERV):** The extra amount of air that can be **exhaled forcefully** after a normal expiration. Its average value is about **1200ml.**
- **Residual Volume (RV):** The amount of air that remains in the lungs after a person has exhaled as much as possible (forced expiration). Its average value is about **1200ml.**
- **Vital Capacity (VC):** Tidal Volume (TV) + Inspiratory Reserve Volume (IRV) + Expiratory Reserve Volume (ERV)

Changes in composition of breath air		
Gas	Inhaled Air (%)	Exhaled Air (%)
Oxygen (O_2)	21%	16%
Carbon Dioxide (CO_2)	0.04%	4%
Nitrogen (N_2)	79%	79%
Water Vapor (H_2O)	Varies (depending on humidity)	Saturated (6%)

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Respiratory Disorders			
Features	**Tuberculosis**	**Emphysema**	**Cancer**
Disease	**Infectious disorder** of respiratory systems	Breakdown of alveoli	**Malignant tumor** in lungs and show potentially unlimited growth.
Cause	**Mycobacterium tuberculosis** (air- born droplets) Malnutrition Poor living conditions	Smoking	Smoking (90%) Other Pollutants
Pathogenesis	**Contagious disease** lung damage Cough & fever	Smoking chemicals **weaken the walls of alveoli** eventually cause bursting which reduces the surface area for oxygenation of blood	Malignant tumor Local expansion by invasion and systemic by **metastasis** Occlusion of respiratory passage
Treatment	Medicine/ Antibiotics	Quitting Smoking Bronchodilator, Antibiotics	Pneumonectomy Chemotherapy & radiotherapy

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GAS EXCHANGE

1. Each nasal cavity is sub-divided into:
(A) Two passageways
(B) Three passageways
(C) Four passageways
(D) Five passageways

2. Large dust particles are trapped by the hair and mucus in the:
(A) Nostrils (B) Nasal cavities
(C) Pharynx (D) Nose

3. It is a complete cartilaginous structure surrounding the upper end of the trachea:
(A) Trachea (B) Glottis
(C) Larynx (D) Windpipe

4. The opening of larynx is called:
(A) Nostril (B) Glottis
(C) Nares (D) Epiglottis

5. What helps in voice production, when vibrated by air:
(A) Larynx (B) Voice box
(C) Vocal cords (D) Pharynx

6. What determine the degree of closure of glottis during swallowing:
(A) Forward movement of tongue
(B) Downward movement of tongue
(C) Upward movement of the larynx
(D) Downward movement of the larynx

7. Food does not enter the partly open larynx because:
(A) Epiglottis closes the glottis
(B) Esophageal sphincter closes the glottis
(C) Epiglottis diverts the food mass to one side of glottis
(D) Epiglottis stops the food to move further down

8. Which is a common passage for food and air:
(A) Trachea (B) Esophagus
(C) Pharynx (D) Glottis

9. Mucus secreting goblet cells are present in:
(A) Larynx (B) Glottis
(C) Epiglottis (D) Trachea

10. All of the following are lined with mucous membrane of ciliated epithelium except:
(A) Nasal cavity (B) Trachea
(C) Bronchi (D) Bronchioles

11. Bronchioles are made up of mainly:
(A) Connective tissues
(B) Goblet cells
(C) Circular smooth muscles
(D) Endothelial cells

12. Each air sac consists of several microscopic alveoli which are:
(A) Double layered structure
(B) Single layered structure
(C) Triple layered structure
(D) Multi layered structure

13. The epithelium of alveoli is:
(A) Ciliated epithelium
(B) Squamous epithelium
(C) Cuboidal epithelium
(D) Columnar epithelium

14. Opening from nose to throat is closed by:
(A) Epiglottis
(B) Soft palate
(C) Esophageal sphincter
(D) Respiratory valves

15. At which level of vertebrae of the vertebral column, trachea divides and forms bronchus:
(A) 4th thoracic vertebrae
(B) 5th thoracic vertebrae
(C) 7th thoracic vertebrae
(D) 3rd thoracic vertebrae

16. Lungs are covered by:
(A) Perichondrium (B) Pleural sac
(C) Pericardium (D) Peristomium

17. "Epiglottis" is made up by:
(A) Elastic cartilage (B) Fibrous cartilage
(C) Hyaline cartilage (D) Bony structure

18. Which of the following prevents collapsing of Trachea:
(A) Muscles (B) Diaphragm
(C) Ribs (D) Cartilaginous rings

19. Which of the following factor can affect the rate of diffusion of gases:
(A) Thickness of the membranes involved in diffusion
(B) Solubility of the gases
(C) Pressure of the gases
(D) All of these

20. Mark the true statement among the following with reference to normal breathing:
(A) Inspiration is a passive process whereas expiration is active
(B) Inspiration is an active process whereas expiration is passive
(C) Inspiration and expiration are active processes
(D) Inspiration and expiration are passive processes

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21. By the contraction in diaphragm volume of thoracic chamber increases in the:
(A) Dorso-ventral axis
(B) Antero-posterior axis
(C) Dorso-posterior axis
(D) Antero-ventral axis

22. Binding of oxygen with haemoglobin is primarily related to:
(A) Partial pressure of O_2
(B) Partial pressure of CO_2
(C) H^+ ion concentration
(D) Temperature

23. About 97% of oxygen is transported by RBC remaining 3% is:
(A) Dissolved in plasma & transported
(B) Retained in lungs
(C) Attached to cell membranes
(D) Found inside mitochondria

24. Carbon monoxide has greater affinity for Haemoglobin as compared to oxygen:
(A) 1000 Times (B) 200 Times
(C) 20 Times (D) 2 Times

25. Effect of CO_2 concentration on dissociation of oxyhaemoglobin is called:
(A) Bohr's effect (B) Haldane effect
(C) Hamburger effect (D) Root effect

26. Under normal condition 100 ml blood deliver _____ to tissue:
(A) 1 ml O_2 (B) 10 ml O_2
(C) 5 ml O_2 (D) 25 ml O_2

27. Exchange of gases in lung alveoli occurs through:
(A) Active transport (B) Osmosis
(C) Simple diffusion (D) Endocytosis

28. Partial pressure of oxygen in alveoli, atmospheric air and tissue will be:
(A) 40, 159, 45 (B) 40, 0.3, 45
(C) 104, 159, 40 (D) 104, 0.3, 45

29. Almost same PO_2 in humans is found in:
(A) Alveoli and tissues
(B) Oxygenated blood and deoxygenated blood
(C) Alveoli and oxygenated blood
(D) Alveoli and deoxygenated blood

30. Chronic disorder in which alveolar wall are damaged due to which respiratory surface is decreased. One of the major causes of this is cigarette smoking:
(A) Asthma (B) Emphysema
(C) Bronchitis (D) Fibrosis

31. Which of following is an infectious respiratory disorder:
(A) Asthma (B) Emphysema
(C) Lung's cancer (D) Tuberculosis

32. The chemical nature of surfactants is:
(A) Glycoprotein (B) Nucleoprotein
(C) Glycolipids (D) Lipoprotein

33. A person breathes in some volume of air by forced inspiration after having a forced expiration. This quantity of air taken in is:
(A) Total lung capacity
(B) Tidal volume
(C) Vital capacity
(D) Inspiratory capacity

34. Volume of air remains in the lungs after normal expiration is:
(A) ERV + RV (B) IRV + RV
(C) RV + IRV + ERV (D) TV

35. Ciliated epithelial cells are located in:
(A) Esophagus (B) Villi
(C) Trachea (D) Aorta

36. Part of haemoglobin involved in transport of carbon dioxide is:
(A) Haem portion (B) Carboxyl group
(C) Amino group (D) R group

37. The breathing rate is increased by an increase of_____ in the blood:
(A) Oxygen (B) Carbon monoxide
(C) Nitrogen (D) Carbon dioxide

38. The mode of respiration in mammals is:
(A) Mucosal (B) Cutaneous
(C) Tracheal (D) Pulmonary

39. Human pharynx is conventionally divided into _____ segments:
(A) 1 (B) 2
(C) 3 (D) 4

40. In human the respiratory center is:
(A) Cerebrum (B) Pons
(C) Medulla oblongata (D) Midbrain

41. The trachea or windpipe extends to the:
(A) Lungs
(B) Pleural cavity
(C) Chest cavity and thorax
(D) Abdominal cavity

42. In the wall of trachea there are a series of:
(A) C-Shaped cartilaginous rings
(B) U-shaped cartilaginous rings
(C) C-shaped muscular rings

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(D) U-shaped muscular rings

43. Voice box of human being is called:
(A) Larynx (B) Pharynx
(C) Bronchus (D) Syrinx

44. It is the functional unit of lungs:
(A) Air sacs (B) Alveoli
(C) Bronchioles (D) Bronchi

45. Overlying the alveoli there is a rich network of:
(A) Blood capillaries (B) Bronchioles
(C) Bronchi (D) Smooth muscles

46. The part of the thoracic cavity containing the lungs is lined by:
(A) Ribs (B) Diaphragm
(C) Pleural membranes (D) Pleural fluid

47. The closed sac type organs that are connected to the outside by way of the trachea and the nostrils or mouth are:
(A) Air Sacs (B) Alveoli
(C) Thorax (D) Lungs

48. The anterior part of nasal cavity near the nostrils is called:
(A) Vestibules (B) Glottis
(C) Hilum (D) Diaphragm

49. Respiration occurs at:
(A) Organismic level
(B) Cellular level
(C) Organismic and cellular level
(D) Organismic and tissue level

50. Organismic respiration is also known as:
(A) Breathing
(B) Ventilation
(C) Breathing or ventilation
(D) Internal respiration

51. Carbonic anhydrase enzyme is present in:
(A) W.B.C (B) R.B.C
(C) Platelets (D) Leukocytes

52. When an oxygen tension is 115mm of mercury, haemoglobin is _____ percent saturated:
(A) 96 (B) 97
(C) 98 (D) 99

53. The capacity of haemoglobin to combine with oxygen is affected by the following EXCEPT:
(A) Carbon dioxide pressure
(B) Temperature of the blood
(C) pH of the blood
(D) Nitrogen pressure

54. Following actions are carried out by the air while passing through the nasal cavities of human being EXCEPT:
(A) Desiccation (B) Warming
(C) Moistening (D) Filtration

55. The CO_2 carried as bicarbonate ion is_____ of the total CO_2 carried by human blood:
(A) 5% (B) 70%
(C) 20% (D) 6%

56. $HCO_3 + H^+ \longrightarrow H_2CO_3 \longrightarrow CO_2 + H_2O$. It occurs when blood circulates through:
(A) Alveolar capillaries
(B) Capillary bed of body
(C) Arterial system
(D) Venous system

57. During expiration:
(A) Diaphragm contracts, intercostal muscles relax, and rib cage is elevated
(B) Diaphragm contracts, intercostal muscles relax, and rib cage is lowered
(C) Diaphragm contracts, intercostal muscles contract and rib cage is elevated
(D) Diaphragm relaxes, intercostal muscles relax, and rib cage is lowered

58. Amount of which gas is always in excess in expired air as compared to inspired air?
(A) Oxygen (B) Nitrogen
(C) Carbon dioxide (D) CO

59. The trachea or windpipe extends to the:
(A) Lungs
(B) Pleural cavity
(C) Chest cavity and thorax
(D) Abdominal cavity

60. In Patient with---------- alveolar walls degenerate, and small alveoli combine to form larger alveoli with decreased surface area:
(A) Tuberculosis
(B) Emphysema
(C) Asthma
(D) Respiratory Distress

61. The part of the thoracic cavity containing the lungs is lined by:
(A) Ribs (B) Diaphragm
(C) Pleural membranes (D) Pleural fluid

62. Following reaction given below is catalyzed by an enzyme known as:
$CO_2 + H_2O$ .....H_2CO_3
(A) Lyase
(B) Carbonic Anhydrase

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(C) Hydrolase
(D) Catalase

63. When an oxygen tension is 115mm of mercury, haemoglobin is _____ percent saturated:
(A) 96 (B) 97
(C) 98 (D) 99

64. Diaphragm is a sheet of:
(A) Smooth muscles (B) Skeletal muscles
(C) Circular muscles (D) Cardiac muscles

65. The total inside capacity of the adult human lungs is:
(A) 3 liters (B) 3.5 liters
(C) 4 liters (D) 5 liters

66. Pressure inside the chest cavity is reduced by:
(A) Downward movement of diaphragm
(B) Upward movement of diaphragm
(C) Upward movement of the ribs
(D) Downward movement of the diaphragm and upward movement of ribs

67. A physiologically dead air space is increased in lungs as a result of:
(A) Asthma (B) Emphysema
(C) Cancer (D) Tuberculosis

68. During swallowing opening of larynx is cover automatically by one of the cartilages called:
(A) Glottis
(B) Vocal cords
(C) Epiglottis
(D) Mucous membrane

69. Vocal cords are thin edged fibrous band stretched across in the mucous membrane of the:
(A) Epiglottis (B) Lungs
(C) Glottis (D) Trachea

70. Bronchioles are made up of mainly by:
(A) Longitudinal striped muscles
(B) Oblique circular muscles
(C) Circular cardiac muscles
(D) Circular smooth muscles

71. Respiration by lungs is called:
(A) Pulmonary respiration
(B) Buccal cavity
(C) Cutaneous respiration
(D) Gill respiration

72. During rest time in human breathing occurs rhythmically at the frequency of:
(A) 15-30 times/minute
(B) 15-20 Times/minute
(C) 30-40 times/minute
(D) 30-35 times/minute

73. What helps in gaseous exchange between blood and lungs in man:
(A) Difference in partial pressure of O_2 and CO_2
(B) Distribution of blood in thin layer within alveolar capillaries
(C) Due to thin membranes of capillaries and alveoli
(D) All of these

74. Human lungs are spongy due to the presence of millions of:
(A) Bronchi (B) Nucleoli
(C) Alveoli (D) Parabronchi

75. In man when the smaller bronchi attain a diameter of 1mm they are called:
(A) Bronchi (B) Parabronchi
(C) Bronchioles (D) Alveoli

76. Functional units of lungs are called:
(A) Alveoli (B) Parabronchi
(C) Air sacs (D) Villus

77. Lungs are covered with double layered thin membranous are called:
(A) Diaphragm (B) Pericardium
(C) Pleura (D) Rib cage

78. In mammals' ventilation movements of lungs are governed by:
(A) Muscular wall of lungs
(B) Diaphragm
(C) Intercostal muscles
(D) Diaphragm & intercostal muscles

79. Air enters into the lungs through:
(A) Trachea → lungs → larynx → pharynx → alveoli
(B) Nose → larynx → pharynx → bronchus → alveoli → bronchioles
(C) Nostrils → pharynx → larynx → trachea → bronchi → bronchioles → alveoli
(D) Nose → mouth → lungs → bronchi → bronchioles → alveoli

80. Air is warmed as it passes through:
(A) Nasal cavities (B) Bronchi
(C) Trachea (D) Alveoli

81. Structural units of lungs are:
(A) Alveoli (B) Air sacs
(C) Air chamber (D) Parabronchi

82. A structure that does not contain cartilage:

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(A) Alveolar duct (B) Alveolar sacs
(C) Alveoli (D) All a, b, c

83. Smooth muscles present in all except:
(A) Trachea (B) Bronchi
(C) Bronchioles (D) Alveoli

84. Each nasal cavity is divided into _____ passageways:
(A) 2 (B) 4
(C) 3 (D) 1

85. Nasal cavity is lined with:
(A) Columnar epithelium
(B) Squamous epithelium
(C) Ciliated epithelium
(D) Cuboidal epithelium

86. How many pairs of vocal cords are present in humans:
(A) 1 (B) 3
(C) 2 (D) 4

87. Trachea lies _____ to the esophagus:
(A) Dorsal (B) Medial
(C) Ventral (D) Lateral

88. Which is not lined by mucous membrane?
(A) Glottis (B) Nasal cavity
(C) Pharynx (D) None of these

89. Which of the following plays an important role in swallowing and breathing?
(A) Pharynx (B) Epiglottis
(C) Larynx (D) All of these

90. The narrowest and most numerous tubes of lungs are termed as:
(A) Bronchus (B) Bronchioles
(C) Alveoli (D) Hilum

91. The exchange of gases in a mammal takes place at:
(A) Trachea (B) Bronchi
(C) Bronchioles (D) Alveoli

92. During inspiration, as a result of contraction of muscle attached to it, the diaphragm:
(A) Becomes dome-shaped
(B) Flattens
(C) Rotates
(D) Flattens & rotates

93. What is the role of surfactant?
(A) It decreases alveolar surface tension
(B) It keeps airway wet
(C) It increases size of alveoli
(D) All of them

94. Which of the following is a function of the lungs?
(A) Transport of gases within the body
(B) Serves as a reservoir of blood for the left ventricle
(C) It is a filter to protect the systemic vasculature
(D) Facilitate the exchange of O_2 and CO_2 between air and blood

95. Which one of the following statement is not correct regarding trachea?
(A) It usually lies posterior to the muscular esophagus
(B) It splits into the right and left bronchi to supply air to the lungs
(C) Opening to the trachea is covered by epiglottis
(D) Tracheal rings are C-shaped

96. The treatment given to T.B Patient?
(A) ART (B) DOTS
(C) Enema (D) None

97. Respiratory pigment present in muscles is called:
(A) Myoglobin (B) Haemoglobin
(C) Globin (D) Hemocyanin

98. Blood contains_____oxygen per 100ml of blood when haemoglobin is 98% saturated:
(A) 19.6ml (B) 17.6ml
(C) 18.6ml (D) 16.6ml

99. How much air can lungs hold when they are fully inflated?
(A) 5 liters (B) 4.5 liters
(C) 4 liters (D) 3.5 liters

100. Haemoglobin carries how many times more oxygen than plasma?
(A) 20 (B) 70
(C) 50 (D) 100

101. The right and left lungs are separated by:
(A) Hilum (B) Mediastinum
(C) Diaphragm (D) Rib cage

102. A decrease in the pH of human blood caused by exercise would:
(A) Decrease breathing rate
(B) Increase heart rate
(C) Decrease cardiac output
(D) Decrease CO_2 binding to haemoglobin

103. Haemoglobin has great affinity for oxygen due to the presence of:
(A) Iron (B) Potassium
(C) Sodium (D) Calcium

104. Carbon dioxide is transported in the form of carbaminohemoglobin after binding with

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haemoglobin. Which part of haemoglobin is involved in its transport:
(A) Haem portion
(B) Fe in haemoglobin
(C) Carbonyl group of amino acid
(D) Amino group of amino acids

105. % of CO_2 carried as carboxyhemoglobin is:
(A) 5% (B) 20%
(C) 70% (D) 10%

106. Carcinoma is basically a:
(A) Benign tumor
(B) Localized tumor
(C) Tumor showing metastasis
(D) Muscle cancer

107. A person suffering from _____ can't oxygenate his blood properly:
(A) Asthma
(B) Pulmonary tuberculosis
(C) Emphysema
(D) Lung cancer

108. Histamine causes severe contraction of:
(A) Bronchi (B) Alveoli
(C) Air sacs (D) Bronchioles

109. Mycobacterium causes:
(A) Asthma (B) Emphysema
(C) TB (D) Lung cancer

110. No. of polypeptides in myoglobin:
(A) 2 (B) 8
(C) 6 (D) 1

111. Carbonic anhydrase is present in:
(A) Blood plasma (B) Lymphocytes
(C) R.B.C (D) W.B.C

112. Oxygen absorbed & transported in human at sea level is (100% saturation):
(A) 120ml/15ml (B) 50ml/100ml
(C) 100ml/100ml (D) 20ml/100ml

113. How much CO_2 is present in 100ml of arterial blood?
(A) 30ml (B) 50ml
(C) 40ml (D) 54ml

114. Which of the following is the correct pathway of CO_2 from tissues to the atmosphere:
(A) Reaction with H_2O to make H_2CO_3, dissociation to H^+ and HCO_3^-, H^+ combines with imidazole side chain of haemoglobin, carried back to lungs as HHB^+ and HCO_3^-, reverse reaction forms CO_2
(B) O_2 is metabolized to CO_2, reaction with H_2O to make H_2CO_3, $H2CO_3$ combines with imidazole side chain of haemoglobin, $H_2CO_3HB^+$ is carried back to the lungs, reverse reaction forms CO2
(C) Reaction with H_2O to make H_2CO_3, dissociation to H^+ and HCO_3^-, HCO_3^-, combines with imidazole side chain of haemoglobin, carried back to the lungs as HCO_3^-, HB^+ and H^+, reverse reaction forms CO_2
(D) O_2 is metabolized to CO_2, reaction with H_2O to make H_2CO_3, dissociation to H^+ and HCO_3^-, carried back to lungs in this form, reverse reaction form CO_2

PAST PAPER MCQS

115. During swallowing of food which structure closes nasal opening? (2011)
(A) Hard palate (B) Epiglottis
(B) Soft palate (D) Larynx

116. The right atrium of the heart usually receives the: (2011)
(A) Deoxygenated blood
(B) Filtered blood
(C) Oxygenated blood
(D) Non-filtered blood

117. What is the residual volume of air which always remains inside the lungs of humans? (2012)
(A) 3.5 liters (B) 5.0 liters
(C) 0.5 liters (D) 1.5 liters

118. Mature mammalian red blood cells do not have: (2012)
(A) Nucleus (B) Fluids
(C) Red color (D) Haemoglobin

119. In a normal person plasma constitutes about _____by volume of blood: (2012)
(A) 50% (B) 45
(C) 60% (D) 55%

120. The total inside capacity of the lung is_for men: (2013)
(A) 7 liters (B) 6-7 liters
(C) 5 liters (D) 2.5 liters

121. The average life span of red blood cell is about: (2013)
(A) Two month (B) One month
(C) Five months (D) Four months

122. About 70-85 % CO_2 in blood is carried: (2015)
(A) As carboxyhaemoglobin
(B) Freely as CO_2
(C) With proteins in plasma
(D) As bicarbonate

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123. Carboxyhaemoglobin (10-20%) is formed when CO_2 combines with: (2016)
(A) Amino group of haemoglobin
(B) Haem portion of haemoglobin
(C) Iron part of haemoglobin
(D) Plasma proteins

124. Breathing consists of: (2016)
(A) Four phases (B) One phase
(C) Three phases (D) Two phases

125. Low partial pressure of oxygen in tissues favors the_____of oxyhaemoglobin: (2017)
(A) Dissociation (B) Stability
(C) Formation (D) Transformation

126. Respiratory tubules are known as bronchioles when they attain the diameter of ___or lesser: (2017)
(A) 1.2 cm (B) 1.0 mm
(C) 1.0 cm (D) 1.2 mm

127. The double membrane sac around lungs is called (2017)
(A) Pleura (B) Chest cavity
(C) Diaphragm (D) Hilum

128. Which one of the following is a respiratory disorder that is related to malnutrition? (2017)
(A) Cancer (B) Emphysema
(C) Asthma (D) Tuberculosis

129. Breakdown of thin wall of alveoli occurs in: (2017-Retake)
(A) Emphysema (B) T.B
(C) Cancer (D) Asthma

130. Site of gaseous exchange in humans is: (2017-Retake)
(A) Trachea (B) Bronchus
(C) Alveoli (D) Nose

131. Exhaled air contains how much percentage of CO_2: (2017-Retake)
(A) 4 (B) 21
(C) 0.04 (D) 16

132. Gaseous exchange in animals takes place with the help of process called as: (2017-Retake)
(A) Active transport (B) Cyclosis
(C) Phagocytosis (D) Diffusion

133. During breathing air from pharynx enters to: (2018)
(A) Trachea (B) Bronchi
(C) Alveoli (D) Bronchioles

134. Gradual breakdown of alveoli wall leads to which type of disease in smokers: (2018)
(A) Coronary heart disease
(B) Bronchitis
(C) Emphysema
(D) Asthma

135. A disease cause by gradual breakdown of thin alveoli is _____: (2019)
(A) Tuberculosis (B) Bronchitis
(C) Emphysema (D) Asthma

136. During inspiration the space inside the chest cavity is increased due to: (2019)
(A) Increased pressure
(B) Relaxation of the muscles of diaphragm
(C) Relaxation of external intercostal muscles
(D) The contraction of the muscles of diaphragm

137. The respiratory surfaces exhibits following characteristics: (2022)
(A) It must be permeable
(B) It must be thick for low diffusion
(C) It should be non-vascularized
(D) It should be low ventilation mechanism

138. Smooth muscles are found in all mentioned below except: (2023)
(A) Trachea (B) Bronchi
(C) Bronchioles (D) Alveoli

139. The method of bringing oxygenated air into contact with gas exchange surface is called: (2023)
(A) Photorespiration (B) Ventilation
(C) Respiration (D) Gas transport

140. About 70 % of the carbon dioxide is carried in blood as: (UHS 2024)
(A) Carbonate (B) Bicarbonate
(C) Carbonic anhydrase (D) Tricarbonate

141. Range of normal total lungs capacity in humans is: (UHS 2024)
(A) 5-6 liter (B) 10-11 liter
(C) 8-9 liter (D) 12-13 liter

142. Most of the carbon dioxide in blood is transported as bicarbonate ions. Choose the event which is not taking place during gaseous exchange at tissue level: (NUMS 2024)
(A) Formation of HHb
(B) Formation of sodium bicarbonate
(C) Formation of oxyhaemoglobin
(D) Chloride shift

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Answer Key

1. B	2. A	3. C	4. B	5. C	6. C	7. C	8. C	9. D	10. D
11. C	12. B	13. B	14. B	15. B	16. B	17. A	18. D	19. D	20. B
21. B	22. A	23. A	24. B	25. A	26. C	27. C	28. C	29. C	30. B
31. D	32. D	33. C	34. A	35. C	36. C	37. D	38. D	39. C	40. C
41. C	42. A	43. A	44. A	45. A	46. C	47. D	48. A	49. C	50. C
51. B	52. C	53. D	54. A	55. B	56. A	57. D	58. C	59. C	60. B
61. C	62. B	63. C	64. B	65. D	66. D	67. B	68. C	69. C	70. D
71. A	72. B	73. D	74. C	75. C	76. C	77. C	78. D	79. C	80. A
81. A	82. D	83. D	84. C	85. A	86. C	87. C	88. D	89. D	90. B
91. D	92. B	93. D	94. D	95. A	96. B	97. A	98. A	99. A	100. B
101. B	102. B	103. A	104. D	105. B	106. C	107. C	108. D	109. C	110. D
111. C	112. D	113. B	114. A	115. B	116. A	117. D	118. A	119. D	120. C
121. D	122. D	123. A	124. D	125. A	126. B	127. A	128. D	129. A	130. C
131. A	132. D	133. A	134. C	135. C	136. D	137. A	138. D	139. B	140. B
141. A	142. C								

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UNIT # 09

LIFE PROCESSES
(TRANSPORT)

High Yield Content:

- Apoplast, Symplast and Vacuolar pathways for water
- Cohesion tension theory
- Pressure flow theory
- Human heart, Function of Blood, Blood vessels, Blood cells
- Cardiac cycle, ECG, Blood pressure, Mechanism of heart excitation
- Lymphatic system
- Immune system, Type of immunity, Types of antibodies

SCAN QR CODE To Watch MDCAT Lectures, Test Discussions, and Past Papers Discussion on

"Transport"

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TRANSPORT: KEY CONCEPTS

- The transport system is essential for the survival of all living organisms, as it ensures the movement of vital substances such as nutrients, gases, water, and waste products within the body.
- Both plants and animals have specialized transport systems that support their structure, metabolism, and growth.

TRANSPORT IN PLANTS

UPTAKE AND TRANSPORT OF MINERALS

- The roots of a plant not only anchor the plant body in the soil but also absorb minerals and water from the soil.
- The nutrients are first absorbed by roots epidermal cells from where these are moved the xylem these materials are ultimately reached to the leaves.
- There are three types of nutrients needed by the plants, carbon dioxide, water and minerals besides light to carry out photosynthesis.
- The rate of absorption of individual mineral which is independent of rate of absorption of water molecules is determined by:
  - I. Concentration both inside and outside of the root cells.
  - II. The ease with which it can passively penetrate cell membrane.
  - III. Extent to which carrier molecules and active absorption are involved.
- Root hairs are epidermal extensions which provide large surface area for absorption of water and minerals.
- It has been estimated that out of the (total surface area provided by roots, 67% is provided by the root hair. A rye plant less than 1 meter tall has some 14 million root hairs (Combined length 600km).
- Plants are able to synthesize all their required compounds, with the help of minerals and H_2O from soil CO_2 from air, and light energy.
- Most of the minerals enter the root hairs or epidermal cells of roots along with water in bulk flow, but some are taken in by diffusion, facilitated diffusion, or active transport.

Mineral Absorption by Roots

- The minerals available to plants for absorption are dissolved in the soil water. Their concentration varies according to the fertility and the acidity of the soil, besides other factors.
- When the soil minerals are not in solution but are bound by ionic bonds to soil particles, they are not available to plants.

Processes Involved in Absorption by Roots

- The uptake of minerals by root cells is a combination of passive uptake and active uptake, involving the use of energy in the form of ATP.
- The minerals also move down their concentration gradient through plasmodesmata to cells of cortex, endodermis, pericycle and then to sap in xylem cells. From here they are pulled up by transpiration pull to different parts of plant.
- The diffusion of ions along with water also takes place by mass flow along the apoplast pathway. Ions moving in the apoplast can only reach the endodermis, where casparian strips (made of suberin and lignin) prevent further progress.
- To cross the endodermis, ions must pass by diffusion or active transport into endodermis cells, entering their cytoplasm, and possibly their vacuoles. The ions then reach the xylem cells.
- Diffusion of ions can also take the vacuolar pathway where the ions move along their concentration gradient through the cell membranes, cytoplasm (Symplast pathway), and tonoplast (the membrane of vacuoles), and reach the dead xylem cells.
- Most of ions are taken up by the roots by the process of active transport.

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TRANSPORT

- In this process molecules and ions move from their low concentration to their higher concentration (i.e. against the concentration gradient), through cell membrane, by the use of energy in the form of ATP.
- Some nutrients are carried from the soil to the epidermal cells of roots through their cell membrane by **facilitated diffusion.**
- In this type of diffusion, **carrier molecules** within the cell membrane transport nutrients across the membrane.
- These carrier molecules are **proteins** which are present within cell membrane of epidermal and other root cells.

UPTAKE OF WATER BY ROOTS

- The cell wall of epidermal cells of roots is **freely permeable** to water and other minerals, while cell membrane is partially permeable. From root hairs, water molecules enter the epidermal cells by osmosis.

Root Hair Cell → Epidermal Cell → Cortex Cell → Endodermal Cell → Pericycle → Xylem Vessel

Pathways Taken by Water to Reach Root Xylem

Feature	Symplast Pathway	Apoplast Pathway	Vacuolar Pathway
Definition	Movement of water through the cytoplasm of cells via plasmodesmata.	Movement of water through cell walls and intercellular spaces without crossing cell membranes. **Blocked** at endodermis due to **casparian strips.**	Movement of water from vacuole to vacuole through the tonoplast (vacuolar membrane).
Pathway	Cytoplasm → Plasmodesmata → Cytoplasm	Cell wall → Intercellular spaces	Vacuole → Cytoplasm → Vacuole
Speed of Movement	Moderate	**Fastest**	**Slowest**
Importance	Regulates water movement and allows selective ion transport.	Major route for bulk water transport in roots.	Less common occurs under specific physiological conditions.

WATER POTENTIAL

- **Water molecules** possess **kinetic energy** which means that in liquid or gaseous form, they move about rapidly and randomly from one place to another. So, greater the concentration of the water molecules in a system, the greater is the total kinetic energy of water molecules. This is called **water potential** and is represented by **Ψw.**
- Ψw of a medium is directly proportional to the concentration of water in that medium therefore, pure water has highest value of **Ψw** which is designated a value of **zero.**
- Ψw of all the solutions or the cells must be less than zero i.e., in negative range.

Factory affecting ψw:

- The Ψw in plant solutions is mainly influenced by the solute concentration (**osmotic or Solute potential** = ΨS) and the **pressure potential** (Ψp). The pressure potential is generated when water enters and inflates plant cells.

Osmotic (Solute) Potential = Ψs

- Solutes reduce Ψw by consuming some of the potential energy available in the water. This measure of decrease in Ψw of a medium due to the addition of solutes is called **solute/osmotic potential.**
- It can also be defined as 'the measure of the change in water potential of a system due to the presence of solute molecules.

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- ΨS is negative in a plant cell and zero in distilled water. More solute molecules present lower (more negative) is the ΨS.

Pressure Potential (ΨP)

- The measure **increases in water potential** of a medium due to the addition of water or due to the pressure greater than the atmospheric pressure is pressure potential.
- If pressure is greater than atmospheric pressure is applied to pure water or a solution, its water potential increases. It is equivalent to **pumping water** from one place to another such a situation may arise in living systems.
- When water enters plant cells by osmosis, pressure may be built up inside the cell making the **cell turgid** and increasing the water potential.
- Thus, the total water potential is **sum of ΨS and ΨP.**
- If we use the term water potential, the tendency for water to move between any two systems can be measured, not just from cell to cell in a plant but also from soil to root from leaf to air or from soil to air. The **steeper the potential gradient** the faster the flow of water is along it.
- As the individual component change, the raise or lower the total ΨW of a system. When this happens, water moves to equilibrate.
- Therefore, for water to move through the plant from the soil to the air (transpiration) the conditions must exist as:

Ψw of soil > Ψw of the roots> Ψw of the stem > Ψw of the leaf > Ψw of the atmosphere

ASCENT OF SAP

- Water and minerals are absorbed by the root's epidermal cells from where these substances are first move to the root xylem and then to the leaves.
- This **upward movement** of water and dissolved minerals towards the leaves through the xylem tissue is called ascent of sap.
- Since this movement occurs against gravity therefore, a considerable force is required to conduct water and minerals in tall heighted plants.
- It is explained through **TACT theory, Root pressure** and **Imbibition.**

TACT Theory (Transpiration Adhesion Cohesion & Tension)

- This theory was proposed by **Dixon and Joly** in 1894 and is widely accepted to explain the mechanism of the **ascent of sap** in the xylem.
- According to this theory, **four factors** such as Transpiration pull, Adhesion, Cohesion and Tension are combined to form a collective force that is mainly responsible for ascent of sap.

I. Transpiration

- The **evaporation of water** from aerial parts of plant especially through stomata of leaves is called transpiration.
- As a leaf transpires the **water potential** of its mesophyll cells **drop.** This drop causes water to move by osmosis from the xylem cells into dehydrating mesophyll cells.
- The water molecules leaving the xylem are attached to other water molecules in the same xylem tube by **hydrogen bonds**. Therefore, when a water molecule moves up the xylem, the process continues all the way till the root, where water is pulled from the xylem cells.
- This pull causes water to move down its concentration gradient transversely from the root epidermis to the cortex by endosmosis and to pericycle. This pulling force is called **transpiration pull** and is so strong that it also reduces the water potential of root epidermal cells.
- Thus, water in the soil moves from its higher potential to lower water potential of epidermis of root by osmosis.

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Types of Transpiration

Feature	Stomatal	Lenticular	Cuticular
Definition	Loss of water vapor through **stomata** (pores) on leaf surfaces.	Loss of water vapor through **lenticels** (small openings) on stems and fruits.	Loss of water vapor through the **cuticle** (waxy layer) covering leaves and stems.
Rate of Transpiration	90%	1-2%	5-7%
Occurrence	Mainly in **leaves**, especially on the lower epidermis.	Found **woody stems, and bark**. externally scars or protrusions	Occurs on the **epidermal surface** of leaves and impermeable to water

II. **Adhesion**
- Adhesion develops **between water molecules** and **cell wall of xylem cells**. The **composition of cell wall** provides necessary adhesion to water molecules that helps water creep up.
- The **cellulosic component** of cell wall especially has great **affinity** for water.
- Adhesion also helps to hold water in xylem when transpiration is not occurring.

III. **Cohesion**
- It is the strong **attraction between water molecules** due to hydrogen bonding.
- This creates a continuous, **unbroken column** of water from roots to leaves.

IV. **Tension**
- It is provided when **water chain is pulled up** in the xylem. **Transpiration** provides the necessary energy or force. This xylem tension is strong enough to pull **200 meters in plants**.
- It is essential that the xylem walls should have high tensile strength. The **lignin** and **cellulose** provide strength to cell wall of xylem vessels.
- Large quantity of water is carried at relatively up to **8m/hr.**, being recorded in tall trees, and commonly in other plants at **1m/hr.**
- The **total water** pulled up in the leaves is transpired, except **about 1 %** which is used by plants in various activities including photosynthesis.

Root Pressure
- A pressure created by **active secretion of salts** and other solutes from root cells into xylem sap, which **lowers the water potential** of the xylem sap is called root pressure.
- A pressure of **100 — 200 KPa** (exceptionally 800 KPa) is generated by root pressure.
- **Guttation or exudation** is a loss of liquid water through water secreting glands or **hydathodes.**
- It is caused by root pressure in small plants like grasses. It is more notable when transpiration is suppressed, and the relative humidity is high at night.

Imbibition
- It was first proposed by **Sacks in 1874.**
- The cell walls components, especially **cellulose, pectin** and **lignin** can take up water and as a result increase in volume, but the components do not dissolve in water, this is called imbibition.
- The root cell walls imbibe water from the soil, and this water moves by apoplast pathway. It is a **reversible process.**

TRANSLOCATION OF ORGANIC SOLUTES
- The movement of prepared **organic solutes** to different parts of the plant body **through phloem tissue** is called **translocation.**

Main Components of Phloem
- **Sieve elements:** The cells of phloem that transport sugars and organic material throughout the plant are called. They **Lack a nucleus** at maturity but retain a thin layer of cytoplasm.

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- **Companion Cells:** Small, **nucleated cells** closely associated with sieve tube elements, connected via plasmodesmata. Companion cells **supply ATP** and proteins to the sieve tube.
- **Phloem Parenchyma:** Living cells with thin walls, found around sieve tubes and companion cells. Involved in **storage** of organic materials (like starch, fats, and proteins) and lateral transport of nutrients.

Direction of Translocation

- Like ascent of sap, translocation cannot be characterized as upward or downward movement, because prepared organic food is to move in different directions. Therefore, in order to define the direction of translocation, it is usually said that it always occurs from a **source towards a sink.**
- The term **source** is applied to the **area of supply** of food such as **food preparation** or **storage structures.** The term **sink** is used for the **area of utilization of food** like metabolizing or storage organ.
- Leaf is purely a source while fruit is particularly a sink. On the other hand, roots and stem act as both source and sink.

Composition of Phloem Sap

- Phloem sap is composed of **10-25% dry matter. 90%** of this dry matter is **sucrose/cane sugar,** while remaining are other **organic compounds** including hormones.

Mechanism of Translocation / Pressure Flow Hypothesis

- The **Pressure Flow Hypothesis**, also known as the **Mass Flow Hypothesis,** explains the mechanism of **translocation of organic nutrients (mainly sucrose)** through the **phloem from source** (e.g., leaves) to sink (e.g., roots, fruits, growing tissues). A hypothesis was first proposed by **Ernst Munch in 1930.**
- It is states that the flow of solution in the sieve elements is driven by an **osmotically generated pressure** gradient between source and sink.
- **Source:** Area of **high pressure** (due to sugar loading).
- **Sink:** Area of **low pressure** (due to sugar unloading).
- According to this theory, the **sugars** are **loaded into the phloem's sieve tube** elements by the **companion cells. Active transport** increases the concentration of sugars in the phloem, thus **water potential decreases.**
- As a result, water moves to phloem by osmosis from nearby xylem cells and increases **hydrostatic pressure** in the phloem, which pushes forcibly the sap away from the source.
- The pressure gradient from source to sink causes translocation from the area of **higher hydrostatic pressure** (at the source) to the area of **lower hydrostatic pressure** (at the sink).
- When this solution reached to the sink, the sink cells actively absorb the organic solutes from the sap.
- The Loss of solutes in phloem sap causes an **increase** in **water potential** so the water moves from phloem back to the xylem tube.
- In biennials e.g. roof of beet is a sink in first growing season but becomes source in the next growing season, when sugars are utilized in growth of new shoots.
- The movement in phloem is from source to sink in most of the plant during active photosynthesis

Overview

Source (Leaves): Photosynthesis → Glucose → Sucrose → Loaded into Phloem by active transport → Water Enters from Xylem (High Pressure) → Mass Flow Through Phloem (Sieve Tube) → Sucrose Unloaded by active transport → Water Returns to Xylem (Low Pressure)

TRANSPORT IN MAN / CARDIOVASCULAR SYSTEM

- The cardiovascular System consists of **three basic components.**
  I. Circulatory Fluid: The Blood
  II. Pumping organ: The Heart
  III. Blood Vessels : Blood Tubes

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BLOOD

- Blood is the form of **fluid connective tissue** in which dissolved nutrients, respiratory gases, hormones, and wastes are transported through the body.
- The weight of blood in our body is about **1/12th** of our body.
- The normal **pH** of blood is **7.4.**
- It is made up of two main components i.e. **plasma** and **cells** or **cell-like bodies.**

Composition of Plasma

- **Water** constitutes about **90%** of the blood plasma, and **10% dissolved substances**. The substances dissolved in plasma vary in their concentration and can be divided into **six categories:**
- **Inorganic ions** and salts make up **0.9%** of the plasma by weight. More than **2/3** of this amount is **NaCl.**
- **Plasma Proteins** constitute **7-9%** by weight of the plasma. Most of these proteins are synthesized in the liver. Some of the **globulins (immunoglobulins)** are produced by lymphocytes and released in plasma or lymph in response to antigen. **Thrombin** acts as a catalyst in blood clotting process. **Fibrinogen** takes part in blood clotting process. Immunoglobulins play important role in bod's defense against disease
- **Organic nutrients** include glucose, fats, phospholipids, amino acids and lactic acid. Some of them enter blood from intestine (during absorption). **Lactic acid** is produced in muscles as a result of glycolysis and is transported by blood to liver. **Cholesterol** is either metabolized or used as precursor of steroid hormones.
- **Nitrogenous wastes** are produced as a result of cellular metabolism. These products are carried from the liver where they are produced, to the organs from where they are removed i.e. kidneys. **Urea** and small amounts of **uric acid** are present in plasma.
- **Hormones** and **gases** are also found in plasma.

BLOOD CELLS

- **Hematopoietic stem cells (HSCs)** are immature cells that can develop into all types of blood cells. They are found in the **bone marrow** and **peripheral blood.**
- Complete summary of various types of Blood cells are as follows.

Types of Blood Cells

Feature	RBCs	WBCs	Platelets
Name	Erythrocytes	Leucocytes	Thrombocytes
Colour	Red	Colorless	Colorless
Formation	Liver & spleen (embryonic life) Red bone marrow of bones	Red bone marrow & lymphatic tissue	Red bone marrow
Size	8 µm	Larger than RBC	Smaller than RBC
Shape	Biconcave disc	Variable (round, amoeboid)	Small, irregular fragments
Number per mm^3 of blood	5-5.5 million/mm^3 (male) 4-4.5 million/ mm^3 (female)	7000-8000/mm^3	250,000/mm^3
Structure	Elastic cell membrane, **no nucleus**, 95% Hb, 5% enzymes, salts, proteins	Have **nucleus** and capable of motility	Cytoplasmic fragments of **megakaryocytes** and **anucleated**
Life span	4 months (120 days)	Variable	7-10 days
Function	Transport of gases	Immunity	Blood clotting (Covert soluble fibrinogen into insoluble fibrin)

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Main Categories of WBCs

Feature	Granulocytes	Agranulocytes
Formation	Red Bone Marrow	Bone Marrow Lymphoid tissue (Lymph nodes, spleen, tonsils, adenoids, thymus)
Nucleus	Incompletely divided/spherical	Spherical to lobed
Cytoplasm	Granular	Agranular
Examples	Neutrophils, Eosinophils, Basophils	Monocytes, Lymphocytes (B & T)

Subcategories of WCBs

There are five different types of WBCs which can be distinguished on the basis of the shape of the nucleus and density of granules in the cytoplasm

Feature	Neutrophils	Eosinophils	Basophils	Monocytes	Lymphocytes
Size in relation	Twice	Twice	Twice	Twice to Thrice	Slightly larger
Nucleus	2-5 Lobes	Bilobed	Bilobed	Round to lobed	Round nearly Filling cell
%age	62%	2%	<1%	3%	32%
Function	Destruction of **small particles** by phagocytosis. **Die in Process** and contribute to **Pus formation.**	**Inactivate inflammation** producing substances & **attack parasites**	Release **heparin** to prevent blood clots & **histamine** to cause inflammation	Destroy large particles by phagocytosis. Stay in blood for **10-20 hours** then enter tissues and become tissue **macrophages.** Contribute to **Pus formation.**	Immune response by producing **antibodies.** Life spans of months or even years

FUNCTIONS OF BLOOD

Maintenance of Osmotic Balance

- Plasma proteins maintain **colloid osmotic pressure** (also known as **oncotic pressure**, is the force that keeps water in blood vessels).
- **75%** of the role is played **by albumins**, 25% by globulins and almost none by fibrinogen.

Transportation

- Blood helps to transport **nutrients, water, salts** and **waste products.**
- **Hormones** are transported by blood from the endocrine tissues to the target cells.
- **Gases** (O_2 and CO_2) are transported by blood.

Homeostasis

- Blood acts as a buffer to maintain the **acid-base balance** i.e. concentration of H^+ and OH^- ions in the body
- Blood helps in **maintaining the body temperature**, concentration of water and salts, thus helps in homeostasis.
- Blood helps the body in maintaining the internal environment, by producing **heparin, histamine** and also by maintaining the amounts of chemicals.

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Neutrophils and monocytes engulf and destroy invading

Granular
Neutrophil

between blood and body tissues through blood capillaries

HUMAN HEART

between lungs, slightly to the left

Thoracic cavity under the control of the autonomic nervous

Adult heart has shape of cone

space and apex of heart is in fifth intercostal space

62%

Destruction of small particles by phagocytosis and contribute to Pus

consists of two parts, outer and inner part

tissue called Fibrous Pericardium

parts of Parietal layer which lines the inner surface of the

pericardium) that directly covers the heart's surface

parietal and visceral layers filled with pericardial fluid

layers Epicardium, Myocardium and Endocardium

comprising of smooth outer surface of heart

type of muscles, the cardiac muscles. They are

same as skeletal muscles except that they are branched cells

called intercalated discs.

epithelium over a layer of connective tissue

human heart. They are separated from each other

intraventricular groove (septa) separates ventricles

canal and is composed of cusps or flaps

between right atrium and ventricle

between left atrium and ventricle

oxygenated blood is maintained by formation of

called papillary muscles

attached to cusps of atrioventricular valves

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- Aorta and pulmonary trunks have **aortic** and **pulmonary valves**. Each valve consists of **three pockets**, free inner borders of which meet in center of artery to block blood flow.
- **Semilunar valves** are present at base of aorta and pulmonary trunk. Each valve consists of three pockets like semilunar cusps.

Passage Of Blood Through Heart

- The **superior vena cava** and **inferior vena cava**, both carrying **deoxygenated blood**, enter the **right atrium**.
- The right atrium sends blood through the **tricuspid valve** to the right ventricle. The right ventricle sends blood through pulmonary **semilunar valve** into the pulmonary trunk and two pulmonary arteries to lungs.
- **Four pulmonary veins**, carrying oxygenated blood from the lungs, enter the left atrium.
- The left atrium sends blood through **bicuspid valve** to the left ventricle. The **left ventricle** sends blood through aortic semilunar valve into the **aorta** to the body.
- The Heart is a **double pump** because the right ventricle sends **deoxygenated blood** to the lungs and left ventricle sends **oxygenated blood** throughout the body.

Systemic Circulation	Pulmonary Circulation
Heart (Left Ventricle) → Aorta → Arteries → Arterioles → Capillaries (in organs and tissues) → Venules → Veins → Superior/Inferior Vena Cava → Heart (Right Atrium)	Heart (Right Ventricle) → Pulmonary Artery → Lungs (Capillaries) → Pulmonary Veins → Heart (Left Atrium)

Major Arteries Arising from the Aorta

Region of Aorta	Arteries Arising	Supplied Areas
Ascending Aorta	Right Coronary Artery Left Coronary Artery	Heart muscle (myocardium)
Aortic Arch	**Brachiocephalic Artery (Trunk)** divided into Right Subclavian Artery and Right Common Carotid Artery.	Right Subclavian Artery supplies the right upper limb. Right Common Carotid Artery supplies the right side of the head and neck.
	Left Common Carotid Artery	Left side of the head and neck.
	Left Subclavian Artery	Left upper limb.
Descending Aorta	Thoracic trunk gives off arteries to the chest wall and organs in the thoracic cavity.	Intercostal arteries, bronchial arteries
Abdominal Aorta	**Celiac Trunk** divides into **Hepatic, Gastric** and **Splenic Arteries**	Liver, stomach, spleen
	Superior Mesenteric Artery	Intestines
	Renal Arteries	Kidneys
	Inferior Mesenteric Artery	Lower intestines
	Gonadal Arteries	Testes or Ovaries
	Common Iliac Arteries	Pelvis and Lower limbs

CARDIAC CYCLE

- It is the **sequence of events** which take place during the completion of **one heartbeat**.
- Heartbeat involves **three distinct stages** i.e. atrial systole, ventricular systole and diastole.
- Relaxed period of heart chambers is called **diastole** and contraction is called **systole**.
- One complete heartbeat consists of one systole and one diastole and lasts for about **0.8 seconds**.
- In one life, heat contacts about **2.5 billion times**, without stopping.

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Phases of Heartbeat

Phase	Valves	Events in Artia	Events in Ventricles	Duration
Diastole (Relaxation)	AV valves open SL valves closed	Atria relaxed Deoxygenated blood enters right atrium by vena cava Oxygenated blood enters left atrium by pulmonary veins	Ventricles relaxed Deoxygenated blood enters right ventricle through right atrium Oxygenated blood enters left ventricle through left atrium	0.4 sec
Atrial Systole	AV valves open SL valves closed	Muscles of atria contact	Ventricles are relaxed and receive blood from atria	0.1 sec
Ventricular Systole	AV valves close (LUBB sound) SL valves open at the beginning SL valves close at the end of systole (DUBB sound)	Atria are relaxed during this phase	Both ventricles contact Left ventricle pumps oxygenated blood via aorta to all parts of body Right ventricle pumps deoxygenated blood to lungs via pulmonary arteries	0.3 sec approximately

MECHANISM OF HEART EXCITATION AND CONTRACTION

- Cardiac muscles are **myogenic** i.e. its rhythmic contraction arises from within the muscle itself.
- Cardiac muscle has an **intrinsic rhythmicity** that allows the heartbeat to originate and be conducted through the heart without extrinsic stimulation.
- Specialized strands of interconnecting cardiac muscles tissue that coordinate cardiac contraction constitute the **conduction system.**
- Heartbeat starts when the **sinoatrial node (pacemaker)** sends out electrical impulses to the atrial muscles, thus causing both atria to contact. It is located at the **upper end of right atrium.**
- Approximately **0.04 seconds** required for action potentials to travel from SV node to AV node and **0.11 second** delay from AV node to AV bundles.

Conduction Pathway

SA Node → AV Node → Bundle of His → Right & Left Bundle Branches → Purkinje Fibers

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Conducting System of Heart

Components	Structure
Sinoatrial Node	➢ It consists of specialized plexus of cardiac muscles in upper wall of right atrium. ➢ It consists of diffusely oriented cardiac fibers, few myofibrils and few nerve endings from autonomic nervous system. ➢ It is close to where Vena Cava enters the atrium. ➢ SA node is developed from the sinus venosus and has become a part of the atrium, so it is called sinoatrial node
Atrioventricular Node	➢ AV node is present near the junction of right atrium and right ventricle. ➢ Acts as a "gatekeeper" that slows down the electrical impulses coming from the Sinoatrial (SA) Node.
Atrioventricular Bundle / Bundle of His	➢ AV node is connected to a strand of specialized muscles (in the ventricular septum) known as atrioventricular bundle or bundle of His. ➢ This bundle passes through a small opening in the fibrous skeleton to reach the interventricular septum. ➢ Then, they divide to form right and left bundle branches which extend beneath the endocardium on either side of the interventricular septum to the apices of the right and left ventricles respectively.
Purkinje Fibres	➢ The inferior terminal branches of the bundle branches are called Purkinje fibres, which are large diameter cardiac muscle fibres. ➢ They have fewer myofibrils than most cardiac muscle cells. ➢ Intercalated disks are well developed between the Purkinje fibres and contain numerous gap junctions. ➢ As a result of these structural modifications, action potentials travel along the Purkinje fibres much more rapid than through other cardiac muscle tissue.

ELECTROCARDIOGRAM

- An Electrocardiogram (ECG) is a diagnostic test that records the electrical activity of the heart over a period of time.
- It helps detect heart abnormalities such as arrhythmias, heart attacks, and other cardiac conditions such as size and position of heart chambers, damage to the heart muscle, impaired blood flow to heart muscle and function of artificial pacemaker etc.

Components of ECG

Component	Indicates
P Wave	➢ Atrial depolarization (atrial contraction). ➢ The ventricles of the heart are in diastole during the expression of the P wave.
P-R Interval	➢ Period of time from the start of the P wave to the beginning of the QRS complex. ➢ This interval indicates Time for impulse conduction from atria to ventricles.
QRS Complex	➢ The QRS complex begins with a short downward deflection (Q), continues as a sharp upward spike (R), and ends as a downward deflection (S). ➢ The QRS complex indicates the depolarization of the ventricles.
S-T Segment	➢ During this interval, the ventricles are in systole, blood is ejected from the heart. ➢ The time duration known as the S-T segment represents the period between the completion of ventricular depolarization and initiation of repolarization.
T Wave	➢ The T wave is produced by ventricular repolarization.

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BLOOD VESSELS

- Blood vessels are **tubular structures** that transport blood throughout the body. They are part of the **circulatory system**, which ensures the delivery of oxygen, nutrients, and the removal of waste products.

Types Of Blood Vessels

Feature	Arteries	Veins	Capillaries
Direction of Blood Flow	They transport **blood away from heart** to various parts of body	They **collect blood** from various parts of body and transport it towards heart	They **link** arteries with veins
Type of Blood	All carry **oxygenated blood** except pulmonary and umbilical arteries	All carry **deoxygenated blood** except pulmonary and umbilical veins	They have **mixed blood**
Structure	Three layers: **Tunica Adventitia:** Connective tissue + Elastic fibers **Tunica Media:** Circular smooth muscles + Elastic fibers **Tunica Intima:** Simple squamous epithelium and elastic fibers composed of elastin	Three layers: **Tunica Adventitia:** Collagenous Connective Tissue **Tunica Media:** Circular smooth muscles + Thin elastic membrane + Collagen fibers **Tunica Intima:** Endothelium + Elastic fibers + Smooth Muscle	Only one cell thick endothelium
Location	Found **deep** within the body	Found **superficially** and deep.	Present in almost **all tissues** forming networks (capillary beds)
Elasticity	Elastic	Less elastic	Inelastic
Pulsatile Nature	Pulsatile	Non-pulsatile	Non-pulsatile
Valves	**No valves** except at the base of aorta & pulmonary trunk	**Semilunar Valves** are present to prevent the backflow of blood	No valves The **pre-capillary sphincters** also regulate the amount of blood flowing in capillaries.
Blood Pressure	High blood pressure	Low blood pressure	Falling pressure in these
Rate of Blood Flow	Rapid blood flow **400-500 mm/sec** in aorta and decreasing in arteries and arterioles	Increases from smaller to larger veins	Blood flow is slowest, less than **1 mm/sec**
Exchange of Material	No	No	Yes
Bore and Thickness	Have smaller bore and thick walls	Have larger bore and thin walls	Larger bore; wall one cell in thickness

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Portal System

- A portal system is a part of the circulatory system where blood passes through **two capillary beds** before returning to the heart.

Types of Portal System

Portal System	Location	Function	Capillary Beds Involved
Hepatic Portal System	Liver	Transports nutrient-rich blood from the **digestive organs** to the liver for **metabolism, detoxification**, and storage.	1. Capillaries in **digestive organs** → 2. Capillaries in the **liver** (hepatic sinusoids)
Hypophyseal (Pituitary) Portal System	Between **hypothalamus** and anterior **pituitary**	Carries **hormones** (releasing/inhibiting factors) from the hypothalamus to the anterior pituitary to regulate hormone secretion.	1. Capillaries in the **hypothalamus** → 2. Capillaries in the **anterior pituitary**
Renal Portal System	Kidneys	Carries blood from the glomerulus to a secondary capillary network.	1. Glomerular capillaries → 2. Peritubular capillaries.

Veins of Hepatic Portal System

- **Hepatic Portal vein**, the **largest vein** of the system, is formed by the union of **superior mesenteric veins, Splenic Vein & Inferior Mesenteric Vein.**
- **Superior Mesenteric Vein (SMV):** Drains blood from the small intestine, pancreas, and part of the large intestine.
- **Splenic Vein:** Drains blood from the spleen, pancreas, and stomach.
- **Inferior Mesenteric Vein:** Often joins the splenic vein, draining the distal part of the large intestine.
- Within the liver blood flows through dilated capillaries called **Sinusoids.**
- Blood from the liver sinusoids is collected into **central vein** which empty into **hepatic vein.**
- **Blood** from the **gall bladder** collected by **cystic vein** also enters the **hepatic veins.**
- Hepatic vein joins the **inferior vena cava.**

BLOOD PRESSURE & RATE OF FLOW OF BLOOD

Blood Pressure

- It is the **measure of force** with which blood pushes up per unit area **against** the **walls** of blood vessels.
- It is measured in **mm Hg.**
- Blood pressure is detected by mechanoreceptors called **baroreceptors.**
- **systolic pressure:** blood pressure is generated by the **contraction of ventricles.**
- **diastolic pressure.** Lowest atrial pressure when the **ventricles relax.**
- The **normal systolic blood pressure** is **120 mm Hg** which is during ventricular systole.
- The **normal diastolic blood pressure** is **75-85 mm Hg** which is during diastole of the heart.
- Arteries → High Pressure → Arterioles → Moderate Pressure → Capillaries → Low Pressure → Venules → Low Pressure → Veins → Very Low Pressure → Heart

Rate of Blood Flow

- Rate of flow of blood is **inversely proportional** to **cross sectional area** of blood vessels
- The rate of blood flow **tends to fall** as the blood moves through the branching arteries and arterioles, the rate is **lowest** in the **capillaries**; and **increases again** in the venules and veins.
- These changes in rate of blood flow result from changes in the total cross-sectional area.
- The flow of blood in veins is **maintained by the contraction of surrounding muscles, the action of semilunar valves** which prevent back flow of blood, Muscular activity including breathing movements helps normal flow of blood in the blood vessel.

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LYMPHATIC SYSTEM

- This is **accessory blood circulatory system** which is responsible for the transport and returning of material from the tissues of the body to the blood as well as **vital part** of the **immune system**.
- It comprises of lymph capillaries, lymph vessels, lymphoid masses, lymph nodes, lymph and lymphocytes.

Components of Lymphatic System

Component	Description
Lymph	➢ Lymph is the fluid which flows in the lymphatic system. ➢ Approximately **30 liters** of fluid pass from the blood capillaries into the interstitial space each day. Whereas **27 liters** pass from the interstitial space back into blood capillaries. The remaining **3 liters** of fluid enters the lymphatic capillaries, where the fluid is called lymph, and passes through the lymphatic vessels back to the blood. ➢ **Lymph** is a fluid in **transit** between **interstitial fluid** and **blood.** ➢ In addition to water, lymph contains solutes such as ions, nutrients, gases and some proteins, hormones, enzymes and waste products. ➢ After a fatty meal, the **fat globules** may make up **1%** of the lymph.
Lymph Capillaries	➢ Lymph capillaries **differ** from **blood capillaries** as they **lack a basement membrane** and **large intercellular spaces** in the walls of lymph vessels. ➢ The lymph capillaries are far **more permeable** than blood capillaries and nothing in the interstitial fluid is excluded from the lymph capillaries. ➢ The lymph capillary epithelium functions as a series of **one-way valve** (blind ended).
Lymph Vessels	➢ Lymph capillaries join to form larger lymph vessels that **resemble small veins.** ➢ Small lymphatic vessels have a **beaded appearance** because of the presence of one-way valves along their lengths that are similar to the valves of veins. ➢ **Lacteals** are the branches of lymph capillaries inside villi of intestine. ➢ **Largest lymph vessel** is thoracic duct. ➢ Lymph vessels which carry lymph towards lymph nodes are called **afferent lymph vessels** while the vessels that carry lymph away from lymph nodes are called **efferent lymph vessels.**
Lymph Nodes	➢ These are masses of **connective tissue** and round, oval, or bean-shaped structures distributed along the various lymphatic vessels. ➢ These are equipped with **lymphocytes.** ➢ In the human body, the lymph nodes are present in various body parts such as **neck region, axilla and groin.** ➢ Several afferent lymph vessels enter a lymph node, which is drained by single efferent lymph vessel. ➢ Lymph nodes act as **filter for lymph** as do spleen for blood.
Lymphoid masses	**Tonsils (Throat region):** first line of defense against inhaled or ingested pathogens
	Thymus (Behind the sternum): Maturation of T-lymphocytes
	Spleen (Upper left abdomen): Filters blood to remove old and damaged RBCs.
	Peyer's Patches (Small intestine): Monitor intestinal bacteria populations and defend against pathogens in the digestive system by stimulating immune responses.
	Bone Marrow (Inside bones): Produces all blood cells, including **lymphocytes,** which are crucial for immunity.

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Flow of Lymph

- The **thoracic duct** drains the lower limbs, abdomen, the left thorax, the left upper extremity, and the left side of the head and neck. The duct ends by entering the **left subclavian vein.**
- The **flow of lymph is maintained by:** Activity of skeletal muscles, Movement of Viscera, Breathing movements, Semilunar valves that prevent backward flow.

Functions of Lymphatic System

- Return of excess extracellular fluid and proteins to the blood.
- Absorption of large fat globules by **lacteals of villi.**
- Play important role in the **defense system** of the body. Lymphocytes and macrophages present inside lymph nodes kill bacteria and viruses.

IMMUNE SYSTEM

Immunity

- The capacity to **recognize the intrusion** of any foreign material to the body and to **mobilize cells and cell products** to help remove the particular sort of foreign material with greater speed and effectiveness is called immunity.

Lines of Defense

- The human body has **three lines of defense** against microbial attack.
- **First and second defense lines are non-specific** while **3rd defense line is specific.**
- **Physical barriers:** Skin, mucous membrane and blood clot.
- **Chemical barriers:** HCL, Lysozyme and Sebum.
- **Cellular/ biological barriers:** Phagocytes and lymphocytes.

First Line of Defense

Components	Description
Skin	- **Impenetrable barrier** against microbial invasion and is made up of two layers i.e. epidermis and dermis. - **Epidermis** is superficial multicellular keratinized consisting of dry dead cells so, most microbes that land on the skin cannot obtain the water and nutrients they need. Epidermis also contains **dendritic cells that phagocytize pathogens.** - Demis of skin contains sebaceous and sweat glands. Their Secretions contain natural antibiotic such as **lactic acid** that inhabit the growth of bacteria and fungi.
Mucous Membrane	- The **gastrointestinal tract** and inner surface of **nasal cavities** are covered by mucous membrane.
Role of Acid	- Acids such as gastric **HCl** kills the bacteria present in food.

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Second Line of Defense

Components	Description
Phagocytes	➢ A cell that destroys other abnormal body cells/cancerous cells. Two types of blood cells are phagocytes i.e., **macrophages** and **neutrophils.** ➢ **Macrophages** are derived from monocytes and generally found in lungs, liver, spleen, kidney and lymph nodes, rather than remaining in the blood. In these organs, they provide protection by trapping and destroying microorganisms entering the tissue. ➢ **Macrophages** also act as **antigen presenting cells (APCs)** and display some parts of microbes on their surface so that other body cells may also be informed. ➢ **Macrophages** also secrete many different proteins one of them is **interleukin-I** that signals the brain to raise the body temperature (fever). **Kupffer cells** are resident macrophages found in **liver.** ➢ **Neutrophils** are short lived. They are **highly mobile** and move **like amoeba.** Neutrophils also release **lysosomal enzymes** and certain chemicals that kill microorganisms and cause inflammation.
Natural Killer cells	➢ These cells **strike** at the **cancerous cells** or body cells that have been invaded by viruses. ➢ These cells kill their target by releasing **perforins,** which punch holes through the membranes of the infected cells so certain apoptotic proteases, known as the **granzymes,** diffuses into the target cell which carried out **apoptosis.**
Complement System	➢ **Small proteins (about 30)** found in the blood, synthesized by the liver which activated on the entry of foreign particles and **stimulate phagocytes.**
Interferons (cytokines)	➢ Large class of proteins released by host cells in **response to viruses** and limit cell-to-cell spread of viruses in the body. IFNs also **activate** immune cells, such as **natural killer cells** and **macrophages** that in turn **destroy virally infected cells.**
Inflammatory Response	➢ Heat, pain, redness and swelling are the sign of inflammation ➢ Damaged cells release chemical signals such as **histamine** that mediated **vasodilatation** and blood vessels start leaking and **allow phagocytes** to reach infected area. ➢ Phagocytes **engulf bacteria** and cell debris and result in **tissue healing.**
Role of Fever	➢ **Fever/pyrexia** is due to **pyrogens** that are chemicals released by invading organisms and WBCs (endogenous pyrogens). ➢ These pyrogens **increase temperature set point** of hypothalamus because higher body temperature than normal **increases** the activity of **phagocytic WBCs.** ➢ The **endogenous pyrogens** also reduce the concentration of **iron** in blood which slows down their rate of bacterial reproduction. ➢ Fever also increases the production of **interferons.** ➢ **Higher body temperature** may directly **inactivate** the virus particles; particularly **envelop viruses,** which are more heat-sensitive than non-enveloped viruses.

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Third Line of Defense

Components	Description
Specific defense	➢ The third line of defense is **highly specific defense/resistance** which relies on **antigens/immunogens** that serve as the stimulus to produce an immune response. ➢ It is derived from **mesoderm.** ➢ This immune response can be of **two types:** humoral/antibody mediated immune and cell-mediated immune response. ➢ The **activation of 3rd line** depends upon the participation of **monocytes/macrophages.**
Role of Monocytes	➢ Macrophages digest and display microbial antigens on their surfaces and also begin to secrete about 100 different compounds including various **enzymes, interferons** and a protein called **interleukin-1.** ➢ The **interleukin-1** secreted by macrophages **activates the T cells.** That in turn begins to secrete **interleukin-2,** which then **activates the B cells.** ➢ **Interleukin-1** also promotes a **general response to injury,** causing **fever** and activating other mechanisms that defend the body against invasion.
Cell Mediated Immune Response	➢ This type of immune response depends upon the **T-cells (Thymus).** ➢ **Helper T-lymphocytes (CD4):** These cells secrete **interleukin- 2,** which stimulates cell division of T-cells and B-cells. ➢ **Suppressor T-lymphocytes (CD8):** When infection is successfully removed, they shut down the immune response. ➢ **Cytotoxic T-lymphocytes (CD8):** Involved in direct killing or destroying of antigens. ➢ **Memory T-lymphocytes:** These cells **remain dormant** after the initial exposure and again activated upon **re-exposure** to the same pathogen.
Humoral Immune Response	➢ This immune response is shown by **B-lymphocytes.** ➢ B-lymphocytes have been given name due to their **1st discovery** from **Bursa of Fabricius,** which is a **lymphoid tissue in birds** around cloaca. ➢ In humans, these are produced and released in mature form from bone marrow. After stimulation by antigen, they are activated and start dividing and form: **Plasma cells clone** which synthesize and **secrete antibodies** in plasma and other body fluids. ➢ **Memory B-cells** which keep information/ memory of antigen encountered. ➢ B-cells express specific receptors on their cell membrane, the **B-cell receptors (BCRs).** ➢ **BCRs allow** the B-cell to bind a specific antigen, against which it will initiate an antibody response.

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Transport in Plants

1. **Root hairs are extensions of:**
   (A) Pericycle (B) Pith
   (C) Epidermis (D) Parenchyma
2. **Xylems translocate:**
   (A) Water only
   (B) Water and mineral salts only
   (C) Water, mineral salts and some organic nitrogen only
   (D) Water, mineral salts, some organic nitrogen and hormones
3. **A rye plant less than one meter tall has some:**
   (A) 14 million branch roots
   (B) 14 thousand branch roots
   (C) 14 hundred branch roots
   (D) 14 branch roots
4. **The water and minerals following the apoplast pathway move cell wall to cell wall:**
   (A) From epidermis to cortex
   (B) From epidermis to pericycle
   (C) From epidermis to xylem
   (D) From epidermis to endodermis
5. **Plasmolysis does not involve:**
   (A) Shrinkage of protoplast
   (B) loss of water
   (C) Exosmosis
   (D) Endosmosis
6. **Xylem translocates:**
   (A) Water only
   (B) Water and mineral salts only
   (C) Water, mineral salts and some organic nitrogen only
   (D) Water, mineral salts, some organic nitrogen and hormones
7. **Living elements of xylem is:**
   (A) Tracheid (B) Vessel
   (C) Xylem parenchyma (D) Xylem fibre
8. **Transport of food material in higher plants takes place through:**
   (A) Parenchyma tissues (B) Tracheids
   (C) Sieve elements (D) Companion cells
9. **The chief water conducting elements of xylem in gymnosperms are:**
   (A) Tracheids (B) Vessels
   (C) Fibres (D) Transfusion tissue
10. **Function of companion cells is:**
    (A) Loading of sucrose into sieve elements
    (B) Providing energy to sieve elements for active transport
    (C) Providing water to phloem
    (D) Loading of sucrose into sieve elements by passive transport
11. **What is the direction of movement of sugars in phloem:**
    (A) Non-multidirectional
    (B) Upward
    (C) Downward
    (D) Bi-directional
12. **Casparian strips occur in:**
    (A) Epidermis (B) Pericycle
    (C) Cortex (D) Endodermis
13. **Common features between lenticels and hydathodes are:**
    (A) Both allow exchange of gases
    (B) Always remain closed
    (C) There is no regulation of their opening & closing
    (D) They occur on the same organ of plant
14. **When the solute has been added to the solution, it water potential will:**
    (A) Increases
    (B) Decreases
    (C) Remain unchanged
    (D) First increases then decreases
15. **The immediate cause of the opening and closing of stomata is:**
    (A) Change in turgidity of guard cells
    (B) Flaccidity of guard cell
    (C) Orientation of microfibrils
    (D) Turgidity of subsidiary cells
16. **The hormones that signals the closure of stomata:**
    (A) Auxins (B) Cytokinin
    (C) Gibberellin (D) Abscisic acid
17. **Symplast includes all the following except:**
    (A) Cytoplasm (B) Cell wall
    (C) Cell membrane (D) Plasmodesmata
18. **Transpiration in plants will be lowest when:**
    (A) There is high humidity in the atmosphere
    (B) High wind velocity
    (C) There is excess of water in the soil
    (D) Environmental conditions are very dry
19. **With decrease in atmospheric pressure the rate of transpiration will:**
    (A) Remain unaffected (B) Increased
    (C) Decrease slowly (D) Decrease rapidly

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Types of Immunity

Features	Innate or Inborn Immunity	Adaptive or Acquired Immunity
Definition	A generalized (Non-specific) built in defense system providing a rapid response to pathogens.	A specific and learned immune response that develops after exposure to a pathogen.
Line of defense	Includes first line of defense (skin, mucous membranes), phagocytes (2nd line of defense).	Includes third line of defense (T-cells, B-cells, antibodies, memory cells).
Response Time	Hours	Days
Specificity	Limited and Fixed	Highly diverse, improves during the course of immune response
Response to Repeated infection	Identical to primary response	Much more rapid than primary response
Memory	No memory of past infections	Has memory, remembers previous infections for faster response in the future
Components	Physical barriers (skin, mucous membranes), phagocytes (macrophages, neutrophils), natural killer cells, complement system	T-cells, B-cells, antibodies, memory cells

Types of Acquired Immunity

Features	Active Immunity	Passive Immunity
Definition	Immunity develops when the body produces its own antibodies in response to an antigen (Vaccines etc.).	Immunity is acquired when ready-made antibodies are transferred from another source (Antisera etc.)
Source of Antibodies	Produced by the body's immune system after stimulation by antigen.	Received from an external source.
Time to Develop	Take time to develop (days to weeks).	Provides immediate immunity.
Duration of Immunity	Long-lasting, often lifelong due to memory cells.	Short-term, lasts weeks to months.
Types	1. Natural: Immunity developed after natural exposure to a pathogen (Infection-based immunity). 2. Artificial: Vaccine-induced immunity.	1. Natural: Maternal antibodies (placenta/breast milk/colostrum). 2. Artificial: Injection of antibodies (e.g. antitoxins, immunoglobulins).
Examples	Immunity after chickenpox infection. Immunity after Hepatitis B vaccine.	Maternal antibodies protecting a newborn. Anti-rabies serum is given after a dog bite.

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(D) Environmental conditions are very dry
19. **With decrease in atmospheric pressure the rate of transpiration will:**
(A) Remain unaffected (B) Increased
(C) Decrease slowly (D) Decrease rapidly

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20. **The water potential of pure water is:**
(A) Less than zero
(B) More than zero but less than one
(C) More than one
(D) Zero

21. **The metal ion involved in the stomatal regulation is:**
(A) Iron (B) Magnesium
(C) Zinc (D) Potassium

22. **Ascent of sap in woody stem occurs mainly due to:**
(A) Transpiration pull (B) Root pressure
(C) Imbibition (D) Photosynthesis

23. **Attractive forces of cell walls for water molecules are termed as:**
(A) Adhesion (B) Cohesion
(C) Osmosis (D) Plasmolysis

24. **The process of the escape of liquid from the tip of uninjured leaf is called:**
(A) Evaporation (B) Transpiration
(C) Guttation (D) Exudation

25. **Root pressure develops due to:**
(A) Increase in transpiration
(B) Active absorption
(C) Low osmotic potential in soil
(D) Passive absorption

26. **How much of water reaching the leaves is used in photosynthesis and plant growth:**
(A) Less than 5 percent
(B) Less than 1 percent
(C) Less than 10 percent
(D) Less than 4 percent

27. **Which of the following is correct regarding apoplast pathway of water:**
(A) Movement of water occurs through the intercellular spaces and the walls of the cells
(B) Movement of water is dependent on the gradient
(C) Water movement is through mass flow
(D) All of the above

Transport in MAN

28. **It protects the heart and prevents it from over extension:**
(A) Pericardial fluid (B) Ribcage
(C) Pericardium (D) Thorax

29. **The right atrioventricular valve is:**
(A) Tricuspid valve (B) Bicuspid valve
(C) Semilunar valve (D) Sphincter valve

30. **Chordae tendineae are attached to the:**
(A) Papillary muscles
(B) Flaps of tricuspid valve
(C) Papillary muscles and flaps of tricuspid valve
(D) Walls of the right ventricle

31. **Human heart is responsible for:**
(A) Pulmonary circulation
(B) Pulmonary and systematic circulation
(C) Systemic circulation
(D) Lymphatic circulation

32. **The cardiac and skeletal muscles are similar to each other with respect to:**
(A) Arrangement of myofibrils and myofilaments
(B) Number of nuclei per cell
(C) Occurrence of branching
(D) Nature of control

33. **The hormonal regulation of cardiac output is:**
(A) Mediated by adrenal medulla
(B) Mediated by adrenal cortex
(C) Mediated by pituitary gland
(D) Mediated by pineal gland

34. **Bundle of his is a network of:**
(A) Muscle fibres present only in the ventricle wall
(B) Nerve fibres distributed in ventricles
(C) Muscle fibres distributed throughout the heart walls
(D) Nerve fibres found throughout the heart

35. **Origin of heartbeat and its conduction is represented by:**
(A) SA Node-AV Node-Bundle of His-Purkinje Fibres
(B) Purkinje Fibres-AV Node-SA Node-Bundle of His
(C) SA Node-Purkinje Fibres-AV Node-Bundle of His
(D) AV Node-Bundle of His-SA Node-Purkinje Fibres

36. **The heartbeat cycle starts when the sino-atrial node at the upper end of right atrium sends out electrical impulses to the:**
(A) Ventricular muscles
(B) Atrial muscles
(C) Atrioventricular muscles
(D) Pericardial muscles

37. **With which of the following structure the flaps of AV valves are connected directly?**
(A) Walls of atria (B) Walls of ventricles

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(C) Chordae tendinae (D) Papillary muscles

38. **The pacemaker in human is made of:**
(A) Battery operated device
(B) Cardiac muscles & nerve endings
(C) Neurons
(D) Cardiac cell & smooth muscles

39. **Choose the correct one:**

Phase	ECG presentation	Time
(A) Atrial systole	QRS complex	0.4 sec
(B) Ventricular systole	P wave	0.2 sec
(C) Atrial diastole	T wave	0.8 sec
(D) Ventricular systole	QRS complex	0.3 sec

40. **Which one of the following statements best describes the function of Sino atrial node?**
(A) It sends out electrical impulses to atrial muscles causing both atria to contract
(B) It consists of small number of diffusely oriented cardiac fibers
(C) It sends out electrical impulses to ventricular muscles causing both ventricles to contract
(D) It is present at upper end of left atrium

41. **The heartbeat cycle starts when electrical impulses are generated from:**
(A) AV node (B) SA node
(C) SV node (D) PQ node

42. **The flaps of tricuspid valves are attached to muscular extensions of the right ventricle known as?**
(A) Smooth muscles
(B) Inter costal muscles
(C) Papillary muscles
(D) Skeletal muscles

43. **Mitral valve present in _____ of heart**
(A) Left side of heart
(B) Between ventricles
(C) Between Atrium
(D) Right side of heart

44. **Apex of human heart is of:**
(A) Left Atrium (B) Left ventricle
(C) Right atrium (D) Right ventricle

45. **The cardiac pacemaker in a patient fails to function normally. The doctors found that an artificial pacemaker is to be grafted in him. It is likely that it will be grafted at the site of:**
(A) Atrioventricular bundle
(B) Purkinje system
(C) Sinoatrial node
(D) Atrioventricular node

46. **Large molecules form interstitial fluid can also enter the:**
(A) Blood capillaries (B) Lymph capillaries
(C) Arteries (D) Veins

47. **The flow of lymph is maintained by the following, EXCEPT:**
(A) Activity of skeletal muscles
(B) Movement of viscera
(C) Breathing movements
(D) Blood pressure

48. **An immunity obtained by the inoculation of attenuated germs of that disease is called:**
(A) Artificial active immunity
(B) Natural active immunity
(C) Artificial passive immunity
(D) Natural passive immunity

49. **The survivor of an infection mostly develops:**
(A) Artificial active immunity
(B) Natural active immunity
(C) Artificial passive immunity
(D) Natural passive immunity

50. **In active immunity ____ is introduced into the body:**
(A) Antigens (B) Antibodies
(C) Immunoglobulins (D) Antibiotics

51. **Passive immune response is:**
(A) Long lasting (B) Delayed
(C) Immediate (D) Persistent

52. **Pick up the one that is active infection:**
(A) Polio (B) Mumps
(C) Rabies (D) Smallpox

53. **Its victim often succumbs to a bacterial disease or cancer, that under normal circumstances, the immune system can overcome:**
(A) Polio (B) AIDS
(C) Rabies (D) Tetanus

54. **An infant getting immunity through mother's feed is an example of:**
(A) Artificial active immunity
(B) Artificial passive immunity
(C) Natural active immunity
(D) Natural passive immunity

55. **The lymph vessels empty in:**
(A) Arteries (B) Capillaries
(C) Veins (D) Interstitial spaces

56. **It is fluid in transit between interstitial fluid and the blood:**
(A) Body fluid (B) Lymph
(C) Amniotic fluid (D) Pleural fluid

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(A) Body fluid (B) Lymph
(C) Amniotic fluid (D) Pleural fluid

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57. **In the intestine, the branches of lymph capillaries within villi are called:**
(A) Lymph vessels (B) Lymphatic ducts
(C) Microvilli (D) Lacteals

58. **Lymph node is drained by:**
(A) Many efferent lymph vessels
(B) Many afferent lymph vessels
(C) Single efferent lymph vessels
(D) Single afferent lymph vessels

59. **After oxygenation in lungs the blood is brought by _____ to the left atrium:**
(A) Pulmonary arteries (B) Pulmonary veins
(C) Pulmonary trunk (D) Aortic arch

60. **Necrosis of damage to portion of heart muscles is technically called as:**
(A) Heart attack
(B) Myocardial infarction
(C) Arrythmia
(D) Thromboembolism

61. **Worn out red blood cells breakdown and disintegrate in:**
(A) Liver
(B) Spleen
(C) Liver and spleen both
(D) Bone marrow

62. **Bacterial invaders and other foreign cells inducing cancer cells are fed by:**
(A) Macrophages and neutrophils
(B) Phagocytes and lymphocytes
(C) Monocytes and neutrophils
(D) Macrophages and monocytes

63. **Fibrinogen is converted into fibrin with the help of:**
(A) RBCs (B) Enzymes
(C) Platelets (D) Leukocytes

64. **Maintenance of colloid osmotic pressure of the blood is mainly carried out by a plasma protein called:**
(A) Albumin (B) Globulin
(C) Fibrin (D) Fibrinogen

65. **The most numerous of the cells in blood are:**
(A) Leukocytes (B) White blood cells
(C) Platelets (D) Erythrocytes

66. **Red blood cells are formed Principally in the red bone marrow of following bones EXCEPT:**
(A) Sternum (B) Ribs
(C) Vertebral (D) Femur

67. **The coexistence of atheroma and arteriosclerosis is called:**
(A) Thrombosis
(B) Atherosclerosis
(C) Embolism
(D) Thromboembolism

68. **Degenerative arterial changes associated with advancing age is called:**
(A) Arteriosclerosis (B) Atherosclerosis
(C) Thromboembolism (D) Thrombosis

69. **Thrombus formation may be fatal if occurs in:**
(A) Brain (B) Heart
(C) Brain and /or heart (D) Leg

70. **The blood vessels with walls are only one cell thick are:**
(A) Arteries (B) Arterioles
(C) Capillaries (D) Venules

71. **Compared to veins in mammals, an artery?**
(A) Has thinner wall
(B) Is located more superficially
(C) Has no internal valves
(D) Carries blood away from an organ

72. **The sites where materials are exchanged between the blood and body tissue are:**
(A) Alveoli (B) Venules
(C) Arterioles (D) Capillaries

73. **Middle layer of the wall of veins is:**
(A) Only slightly muscular
(B) Highly muscular
(C) Non-muscular
(D) Epithelial

74. **Which one of the following blood vessels have maximum cross-sectional area:**
(A) Artery (B) Vein
(C) Capillary (D) Aorta

75. **Blood plasma proteins perform variety of functions, however maintenance of osmotic pressure of blood is the role of:**
(A) Fibrin (B) Actin
(C) Albumin (D) Myosin

76. **When SA node sends out electrical impulses:**
(A) Both ventricles contracts
(B) Atria and ventricles contracts
(C) Both atria contract
(D) Both atria relax

77. **The blood pressure reaches the highest point during:**
(A) Systole
(B) Diastole
(C) Relaxation of ventricles

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(D) Contraction of atria

78. The rate of flow of blood is lowest in:
(A) Veins (B) Venae Cava
(C) Capillaries (D) Arterioles

79. They end blindly in the body tissue:
(A) Blood capillaries (B) Lymph capillaries
(C) Lymph vessels (D) Blood vessels

80. The risk of thrombosis increases by:
(A) Atherosclerosis
(B) Arteriosclerosis
(C) Embolism
(D) Myocardial infarction

81. Diameter of a capillaries is increased by a chemical called:
(A) Heparin (B) Nor-adrenaline
(C) Histamine (D) Nor-epinephrine

82. The valves present at the base of aorta are called:
(A) Sphincters (B) Semilunar
(C) Bicuspid (D) Tricuspid

83. Pick up the correct sequence of tissues found in the wall of artery:
(A) Connective tissue → circular smooth muscles → elastic layer → endothelium
(B) Connective tissue → elastic layer → endothelium → circular smooth muscles
(C) Connective tissue → endothelium→ elastic layer→ circular smooth muscles
(D) Circular smooth muscles → connective tissue → endothelium → elastic layer

84. The highest blood pressure in human being is found in:
(A) Venae cava (B) Aorta
(C) Pulmonary trunk (D) Arterioles

85. Pressure in the arteries fall during:
(A) Systole
(B) Diastole
(C) Relaxation of atria
(D) Contraction of ventricles

86. Diastolic pressure of normal individuals ranges from:
(A) 115-120mm Hg (B) 110-120mm Hg
(C) 75-85mm Hg (D) 70-80mm Hg

87. The structure/s which acts as physical barriers in animal is/are:
(A) Skin
(B) Mucous membranes
(C) Skin and mucous membranes
(D) Phagocytes

88. The third mechanism which defend the animal bodies against the foreign invaders is:
(A) Antisepsis (B) Immunization
(C) Phagocytosis (D) Leukocytes

89. Among the components of immune system there are two types of:
(A) Phagocytes (B) Monocytes
(C) Lymphocytes (D) Leukocytes

90. Pick up the one which is not included in the functions of antibodies:
(A) Immobilization of antigens
(B) Setting in motion events that ultimately cause the destruction of antigen
(C) Production of antitoxins
(D) Production of toxins

91. A lymphoid structure present in the wall of cloaca of young birds is called:
(A) Thymus gland (B) Bursa of fabricus
(C) Adenoid (D) Spleen

92. B-lymphocytes originate from:
(A) Lymphoid stem cells of bone marrow
(B) Bursa of fabricus
(C) Lymphoid stem cells of thymus
(D) Phagocyte stem cells

93. An antibody molecule consists of:
(A) Four polypeptide chains
(B) Three polypeptide chains
(C) Two polypeptide chains
(D) One polypeptides chain

94. Each antigen binding site of antibody consists of:
(A) V-Sequences of heavy chains
(B) V-Sequences of light chains
(C) V-Sequences of heavy chains and a light chain
(D) C-Sequences of both heavy chains

95. In case of tissue/organ transplant, the main threat of rejection is posed by:
(A) B-Cells (B) T-Cells
(C) Antibodies (D) Immunoglobulins

96. Pick up the disease which requires one time vaccination for protection in rest of the life:
(A) Measles and mumps
(B) Rabies and tetanus
(C) Snake bite and tetanus
(D) Snake bite and Rabies

97. An immunity obtained by the inoculation of attenuated germs of that disoase is called:
(A) Artificial active immunity

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(C) Immunoglobulin (D) Globulin

120. **Which of the following is not granulocyte:**
(A) Neutrophil (B) Monocyte
(C) Eosinophil (D) Basophil

121. **Lymph is without:**
(A) Leucocytes (B) Erythrocytes
(C) Plasma (D) Proteins

122. **Carotid artery carries?**
(A) Deoxygenated blood to brain
(B) Oxygenated blood to heart
(C) Oxygenated blood to brain
(D) Deoxygenated blood to heart

123. **How long is the delay at A-V node:**
(A) 0.15 millisecond (B) 0.15 nano sec
(C) 0.15 sec (D) 0.15 min.

124. **Speed of contraction of heart muscles is:**
(A) Rapid (B) Slow
(C) Intermediate (D) Constant

125. **Plates help in conversion of:**
(A) Active fibrinogen to inactive fibrin
(B) Inactive fibrinogen to active fibrin
(C) Fibrin to fibrinogen
(D) Active fibrinogen to active fibrin

126. **Where the lymph nodes are present in more concentration:**
(A) Groin & abdomen (B) Forearm
(C) Groin & axilla (D) Only abdomen

127. **The nodules of lymphoid tissues found in the wall of intestinal tract is known as:**
(A) Hashimoto's nodes (B) Grave's region
(C) DiGeorge's nodes (D) Peyer's patches

128. **In the human's thymus is located:**
(A) Along the femoral artery
(B) In the medulla oblongata
(C) In the mediastinum of the upper thorax
(D) Between the 19th and 20th vertebrae

129. **Fat globules are absorbed by lacteals and after a fatty meal these fat globules make up lymph in percentage:**
(A) 20% (B) 10%
(C) 1% (D) 5%

130. **To filter the lymph of lymphatic system, which structure is involved:**
(A) Spleen (B) Lacteal
(C) Liver (D) Lymph Nodes

131. **Blood is:**
(A) Organ
(B) Epithelial tissue
(C) Connective tissue
(D) Cellular component

132. **Granulocytes are formed in:**
(A) Lymphoid mass (B) Adenoid
(C) Liver (D) Red bone marrow

133. **Agranulocytes are formed in:**
(A) Lymph nodes (B) Thymus
(C) Spleen (D) All of above

134. **Volume of blood that comes out from left ventricle into the body per minute:**
(A) Cardiac output (B) Heart cycle
(C) Heart Rate (D) Pulse

135. **Which of the following chamber of heart is thickest?**
(A) Right atrium (B) Left atrium
(C) Right ventricle (D) Left ventricle

136. **Lymph closely resembles with:**
(A) Blood (B) Interstitial fluid
(C) Plasma (D) Urine

137. **Opening in inter-atrial septum is called:**
(A) Atrial foramen
(B) Ventricular foramen
(C) Foramen magnum
(D) Inter-atrial foramen

138. **Distinct stages of heartbeat are:**
(A) 3 (B) 5
(C) 4 (D) 6

139. **How many times heart contract in one's life:**
(A) 2.5 billion times (B) 3.5 billion times
(C) 2.5 million times (D) 5.2 billion times

140. **The successive cells of the cardiac muscle fiber are separated by junctions called:**
(A) Interatrial septum
(B) Chordeae tendinae
(C) Interventricular septum
(D) Intercalated discs

141. **Hepatic portal vein is produced by coming together of veins:**
(A) Gastric, sciatic and subclavian
(B) Gastric, intestinal and splenic
(C) Gastric, femoral and anterior abdominal
(D) Gastric, hepatic and renal

142. **Arteries are:**
(A) Thin walled and blood flows under diminished pressure
(B) Thick walled and blood flows under high pressure
(C) Thin walled and blood flows under high pressure

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(C) Immunoglobulin (D) Globulin

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143. R.B.C in mammals have no nucleus because:
(A) It has degenerated during development
(B) They do not have nucleus since their formation
(C) Nucleus is harmful for R.B.C
(D) To accommodate more haemoglobin

144. Match Column –I with Column –II and select the correct option from the codes given below:

Column –I (Plasma protein)	Column –II (Functions)
A. Fibrinogen	(i) Defense mechanism
B. Globulins	(ii) Osmotic balance
C. Albumins	(iii) Coagulation of blood

(A) A-(iii), B-(i), C-(ii)
(B) A-(i), B-(iii), C-(ii)
(C) A-(ii), B-(i), C-(iii)
(D) A-(iii), B-(ii), C-(i)

145. Which of the following statements is incorrect?
(A) Erythrocytes / RBC are the least abundant of all the cells in blood.
(B) The number of RBCs in adult man per mm^3 of blood is 5 million to 5.5. million.
(C) RBCs are formed in the red bone marrow in the adults
(D) RBCs are enucleated in most of the mammals.

146. Which of the following statements is/are incorrect about lymph?
(i) Lymph is colorful as it has haemoglobin but no RBC.
(ii) It contains specialized lymphocytes which are responsible for immunity of the body.
(iii) Lymph is a carrier for nutrients and hormones.
(iv) Fats are absorbed through lymph in the lacteals present in the intestinal villi.
(A) (i) only (B) (iii) and (iv)
(B) (ii) and (iii) (D) (iv) only

147. An adult human with average health has systolic and diastolic pressures as:
(A) 120 mm Hg and 80 mm Hg
(B) 50 mm Hg and 80 mm Hg
(C) 80 mm Hg and 80 mm Hg
(D) 60 mm Hg and 120 mm Hg

148. Rate of heartbeat is determined by:
(A) Purkinje fibres
(B) Papillary muscles
(C) AV-node
(D) SA -none

149. In healthy adult man the smallest type of leucocytes:
(A) Basophils
(B) Monocytes
(C) Eosinophils
(D) Lymphocytes

150. The volume of blood each ventricle pumps out during a cardiac cycle is about:
(A) 70 ml (B) 5000 ml
(C) 7 L (D) 1200 ml

151. Which vitamin helps in blood coagulation:
(A) Vitamin K (B) Vitamin C
(C) Vitamin A (D) Vitamin D

152. Heart pumps blood more forcefully in older persons than younger ones due to:
(A) Decrease in oxygen content of blood
(B) Decrease in elasticity of arteries
(C) Fall in nutrient of blood
(D) Increase in elasticity of arteries

153. Which one of the following mammalian cells is not capable of metabolizing glucose to carbon-dioxide aerobically:
(A) Red blood cells
(B) White blood cells
(C) Unstriated muscle cells
(D) Liver cells

154. Blood colloidal osmotic pressure mainly maintained by which plasma protein:
(A) Globulin (B) Albumin
(C) Fibrinogen (D) Prothrombin

155. Portal system is not associated with which of the following organs/tissues:
(A) Nephrons (B) Pituitary
(C) Liver (D) Alveoli

156. Serum differs from blood in:
(A) Lacking clotting factors
(B) Lacking antibodies
(C) Lacking globulins
(D) Lacking albumins

157. The following are needed for blood clotting:
(A) Ca^{++} and Vitamin E
(B) Ca^{++} and Vitamin K
(C) Ca^{++} and Vitamin A
(D) K^{+} and Vitamin K

158. Mammalian RBC are:
(A) Biconcave, circular, non-nucleated
(B) Biconcave, nucleated

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(C) Oval nucleated
(D) None

159. **The most active phagocytic white blood cells are:**
(A) Eosinophils and lymphocytes
(B) Neutrophils and monocytes
(C) Neutrophils and eosinophils
(D) Lymphocytes and macrophages

160. **Which type of white blood cells are concerned with the release of histamine and the natural anticoagulant heparin:**
(A) Eosinophils (B) Monocytes
(C) Neutrophils (D) Basophils

161. **Which one of the following is agranulocyte:**
(A) Neutrophil (B) Eosinophil
(C) Basophil (D) Monocyte

162. **Which of the following is incorrect match of W.B.Cs with its functions:**
(A) Neutrophils: Destroy small particles by phagocytosis
(B) Lymphocytes: Function in immune response by producing antibodies
(B) Eosinophils: Give rise to macrophages which destroy large particles by phagocytosis
(D) Basophils: Release heparin and histamine

163. **Compared to blood our lymph has:**
(A) More RBCs and less WBCs
(B) No plasma
(C) Plasma without proteins
(D) More WBCs and no RBCs

164. **Name the blood cells, whose reduction in number can cause clotting disorder, leading to excessive loss of blood from the body:**
(A) Neutrophils (B) Thrombocytes
(C) Erythrocytes (D) Leucocytes

165. **Platelets are cells fragments produced from:**
(A) Thrombocytes (B) Megakaryocytes
(C) Monocytes (D) Mast cell

166. **Characteristics of cardiac muscles are that they:**
(A) Contract quickly and get fatigued
B) Contract rhythmically and do not get fatigued
(C) Contract slowly and get fatigued
(D) Contract slowly and do not get fatigued

167. **Blood pressure in the mammalian aorta is maximum during:**
(A) Diastole of the right ventricle
(B) Systole of the left ventricle
(C) Diastole of the right atrium
(D) Systole of the left atrium

168. **The opening between the right atrium and the right ventricle is guarded by:**
(A) Tricuspid valve (B) Bicuspid value
(C) Semilunar valve (D) Eustachian valve

169. **The first heart sound is associated with:**
(A) Closure of the semilunar valves
(B) Closure of the tricuspid and Bicuspid valves
(C) Opening of the semilunar valves
(D) Opening of the Eustachian valve

170. **Which is responsible for initiating and maintaining the rhythmic contractile activity of the heart:**
(A) Sino-atrial node (SAN)
(B) Atrio-ventricular node (AVN)
(C) Purkinje fibres
(D) Bundle of his

171. **Bundle of His originates from:**
(A) Sinu-auricular node
(B) Auriculo-ventricular node
(C) Pulmonary aorta
(D) Systemic aorta

172. **Which among the following is correct during each cardiac cycle:**
(A) The volume of blood pumped out by the right and left ventricles is same
(B) The volume of blood pumped out by the Rt and Lt ventricles is different
(C) The volume of blood received by each atrium is different
(D) The volume of blood received by the aorta and pulmonary artery is different

173. **Which of the following is first to receive lymphatic duct from legs:**
(A) Left subclavian vein
(B) Right subclavian vein
(C) Right lymphatic duct
(D) Thoracic lymphatic duct

174. **Which of the following statement is true for Lymph:**
(A) WBC and serum
(B) All components of blood except RBCs, Platelets and some proteins
(C) RBCs, WBCs and Plasma
(D) RBCs, Proteins and Platelets

175. **Largest lymphoid organ of body is:**
(A) Liver (B) Kidney
(C) Spleen (D) Pancreas

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176. The structure of which of the following consists of a layer of single cell thickness:
(A) Blood capillary (B) Artery
(C) Venule (D) Arteriole

177. All veins have deoxygenated blood except:
(A) Renal vein (B) Hepatic vein
(C) Hepatic portal vein (D) Pulmonary veins

178. A vein differs from an artery in having:
(A) Strong muscular walls
(B) Narrow lumen
(C) Valves control direction of blood flow opposite to heart
(D) Valves control direction of blood flow towards heart

179. The connection between pulmonary & Aortic arches in Fetus is:
(A) Ligamentum arteriosus
(B) Ductus arteriosus
(C) Foramen ovale
(D) All of the above

180. Blood supply to heart musculature is via:
(A) Cardiac artery (B) Coronary artery
(C) Aorta (D) Pulmonary vein

181. In mammals the role of spleen is:
(A) Graveyard of RBC (B) Reservoir of blood
(C) Haemopoietic organ (D) All

182. Blood pressure is measured by:
(A) Sphygmomanometer
(B) Phonocardiogram
(C) Electrocardiogram
(D) Stethoscope

183. Which one indicates the hypertension:
(A) 90/60 (B) 120/85
(C) 110/70 (D) 140/100

184. Systolic pressure is higher than diastolic pressure due to:
(A) Volume of blood in the heart is greater during systole
(B) Arteries contract during systole
(C) Blood vessels offer resistance to flowing blood during systole
(D) Blood is forced into arteries during systole.

185. Common feature of cell humoral response and cell mediated response:
(A) Recognition of antigen
(B) Tissue rejection
(C) Production of antibodies
(D) Plasma clone formation

186. Antibodies are examples of _____ proteins:
(A) Fibrous (B) Catalytic
(C) Globular (D) Regulatory

187. Vaccination against specific disease like tetanus is an example of:
(A) Artificial active immunity
(B) Natural active immunity
(C) Artificial passive immunity
(D) Natural passive immunity

188. Antigen binding sites present on:
(A) Constant region of heavy chain only
(B) Variable region of heavy chain only
(C) Variable region of both light and heavy chains
(D) Constant region of both light and heavy chains

189. Immunity is generally destroyed in:
(A) All infections (B) All inflammations
(C) HIV infection (D) All diseases

190. Specific immunity is the result of:
(A) 1st line of defense (B) 2nd line of defense
(C) 3rd line of defense (D) 4th line of defense

191. Phagocytosis usually involves:
(A) 1st line of defense (B) 2nd line of defense
(C) 3rd line of defense (D) 4th line of defense

192. All are the examples of 1st line of defense except:
(A) Skin (B) Mucous
(C) Stomach HCL (D) Antibodies

193. Cyclosporin is used to inhibit which type of response:
(A) Cell mediated (B) Cell humoral
(C) Cell signaling (D) Cell to cell

194. Disulfide bridges are present among all except:
(A) Heavy-heavy chain
(B) Light and heavy chain
(C) Light and light chain
(D) All of the above

195. Stronger and specific immunity is found in:
(A) All animals (B) Humans only
(C) Invertebrates only (D) All vertebrates

196. A vaccine contains:
(A) Antigens (B) Antibodies
(C) Macrophages (D) All of the above

197. Vaccine is prepared by using a microorganism that shows association to disease, humoral response is generated by:
(A) B-lymphocyte (B) T-lymphocyte

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(C) Basophils (D) Neutrophils

198. B-lymphocytes originate in human by:
(A) Blood cells (B) Bone marrow
(C) Bursa of fabricus (D) Thymus

199. T-lymphocytes recognize the antigen and attack microorganisms or transplant organ and tissue. This effect is called:
(A) Cell mediated response
(B) Humoral immune response
(C) Active immunity
(D) Passive immunity

200. B-lymphocytes name due to their relationship with:
(A) Blood (B) Bursa of fabricus
(C) Bone marrow (D) Bile duct

201. Which of the following is odd among rest:
(A) Acquired immunity
(B) Specific immunity
(C) Adaptive immunity
(D) Innate immunity

202. Passive immunity is used against:
(A) Malaria (B) Dengue
(C) Typhoid (D) Tetanus

203. _____ Survive for few days and secrete a huge number of antibodies in blood, tissue fluid and lymph:
(A) Memory cells (B) B-lymphocytes
(C) T-lymphocytes (D) Plasma cell

204. Autoimmune disease act as principle of:
(A) Self against self
(B) Self against antigen
(C) Antigen against self
(D) Antigens self-destroyed

205. The prevention of disease by artificial activation of immune response is possible by:
(A) Gene therapy (B) Vaccines
(C) Drug (D) Transposons

206. Type of Antibody that is found in body secretions such as bowel fluid, nasal discharge, and saliva, to prevent bacterial invasion from a mucous membrane.
(A) IgA (B) IgG
(C) IgD (D) IgE

207. It is present in breast milk and protects the gastrointestinal tract of new-born from bacterial and viral infection:
(A) IgA (B) IgG
(C) IgD (D) IgE

208. Which type of antibody transfers from mother to fetus through placenta?
(A) IgA (B) IgG
(C) IgM (D) IgE

209. It was originally related to immunity reactions to parasites. By binding to mast cells and it is believed to be involved in allergies such as pollinosis:
(A) IgA (B) IgG
(C) IgD (D) IgE

210. The most common type of antibodies presents in blood plasma:
(A) IgA (B) IgG
(C) IgD (D) IgE

211. The first antibody appeared in response to an antigen:
(A) IgM (B) IgG
(C) IgA (D) IgE

212. It is usually co-expressed with another cell surface antibody IgM and send signal to B-cell to activate:
(A) IgM (B) IgD
(C) IgA (D) IgE

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213. Largest lymph duct called thoracic lymph duct drains into: (2011)
(A) Subclavian vein
(B) Pulmonary vein
(C) Renal vein
(D) Hepatic portal vein

214. Which protein plays a major role in maintaining osmotic balance? (2011)
(A) Albumin (B) Fibrinogen
(C) Globulin (D) Prothrombin

215. The type of agranulocytes which stay in blood for few hours and then enter the tissues and become macrophages are: (2011)
(A) Lymphocytes (B) Eosinophils
(C) Monocytes (D) Basophils

216. Which vein has oxygenated blood? (2012)
(A) Renal vein (B) Pulmonary vein
(C) Subclavian vein (D) Jugular vein

217. The lymphatic vessels of the body empty the lymph into blood stream at the: (2013)
(A) Bile duct (B) Sub-clavian vein
(C) Abdominal vein (D) Jugular vein

218. Right atrium is separated from right ventricle by: (2013)
(A) Semilunar valve (B) Bicuspid valve

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(C) Tricuspid valve (D) Septum

219. Histamine is secreted by which one of the following cells: (2014)
(A) Basophils (B) Monocyte
(C) Platelets (D) Eosinophils

220. Which one is the most numerous types of white blood cells? (2014)
(A) Eosinophils (B) Neutrophils
(C) Monocytes (D) Lymphocytes

221. Oxygenated blood from lungs to heart is transported by the: (2014)
(A) Pulmonary artery (B) Pulmonary vein
(C) Coronary artery (D) Hepatic artery

222. Which one of the following proteins takes part in blood clotting? (2014)
(A) Prothrombin (B) Immunoglobulin
(C) Fibrinogen (D) Globulin

223. Right atrium is separated from right ventricle by: (2015)
(A) Bicuspid valve (B) Tricuspid valve
(C) Semilunar valve (D) Inter atrial septum

224. The flaps of tricuspid valves are attached to the muscular extensions of right ventricle known as: (2015)
(A) Smooth muscles
(B) Inter coastal muscle
(C) Papillary muscles
(D) Skeletal muscles

225. One complete heartbeat consists of one systole and diastole and last for about: (2015)
(A) 0.8 sec (B) 0.4 sec
(C) 0.2 sec (D) 0.5 sec

226. The heartbeat cycle starts when electric impulses are generated from: (2015)
(A) AV node (B) SA node
(C) SV node (D) PQ node

227. Granulocytes are: (2015)
(A) Monocytes, Eosinophils, Basophils
(B) Neutrophils, Eosinophils, Basophils
(C) Basophils, Macrophages, Neutrophils
(D) Monocytes, Macrophages, Basophils

228. In human the closed sac which surrounds the heart is: (2016)
(A) Endocardium (B) Pericardium
(C) Myocardium (D) Epicardium

229. Chordae tendineae are fibrous cords attached with: (2016)
(A) Cardiac end of stomach valve
(B) Pyloric sphincter of stomach
(C) Tricuspid valve of heart
(D) Eye lid

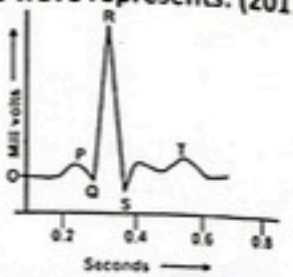
230. Bicuspid valve controls the flow of blood from: (2016)
(A) Right atrium to right ventricle
(B) Left ventricle to aorta
(C) Right ventricle to pulmonary artery
(D) Left atrium to left ventricle

231. Elastic fibers are absent in the wall of: (2017)
(A) Aorta (B) Capillaries
(C) Arteries (D) Veins

232. A type of blood cell that produces heparin is: (2017)
(A) Basophil (B) Eosinophil
(C) Neutrophil (D) Monocyte

233. Thoracic lymph duct of the lymphatic system opens into: (2017)
(A) Superior vena cava (B) Inferior vena cava
(C) Subclavian vein (D) Renal vein

234. In ECG, QRS wave represents: (2017)



(A) Ventricular systole (B) Diastole
(C) Atrial systole (D) Recovery systole

235. Which of the following is agranulocyte cell? (2017-Retake)
(A) Neutophils (B) Basophils
(C) Eosinophils (D) Lymphocytes

236. Bicuspid valve is present in which part of heart? (2017-Retake)
(A) Right atrium and right ventricle
(B) Left atrium and left ventricle
(C) Right atrium and left ventricle
(D) Left atrium and right ventricle

237. Cardiac cycle lasts about: (2017-Retake)
(A) 0.4 sec (B) 0.01 sec
(C) 0.8 sec (D) 0.5 sec

238. Percentage of protein in human blood is: (2017-Retake)
(A) 1-2 (B) 7-9
(C) 7-10 (D) 6-9

239. The thickest chamber of human heart is: (2018)

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(A) Left ventricle (B) Right atria
(C) Right ventricle (D) Left atria

240. **Cell mediated immune response is given by: (2018)**
(A) T-lymphocytes (B) Neutrophils
(C) B-lymphocyte (D) Macrophages

241. **In immunoglobulin / Antibodies two light chains and two heavy chains link to each other by: (2018)**
(A) Covalent bond (B) Hydrogen bond
(C) Ionic bonds (D) Disulphide bond

242. **Which of the following cell does not have nucleus: (2018)**
(A) Platelets (B) Basophils
(C) Eosinophils (D) Neutrophils

243. **Which of the following act as a pacemaker in heart: (2018)**
(A) Bundle of his
(B) Atrioventricular bundles of fibers
(C) Atrioventricular node
(D) Sinoatrial node

244. **Which statement is correct about atrial systole: (2018)**
(A) Atria relaxes and ventricle contracts
(B) Ventricles remain relax while atria contracts
(C) Atria contracts and ventricle also contracts
(D) atria and ventricles are relaxed

245. **Water and minerals move down their concentration gradient through plasmodesmata, to the cells of cortex, endodermis, pericycle and then to sap in the xylem cells. This is also known as: (2019)**
(A) Symplast pathway
(B) Vacuolar pathway
(C) Apoplast pathway
(D) Mineral absorption pathway

246. **Now a days every newborn gets regular shots of vaccines for polio. It contains _____ for polio to make a child immune against disease: (2019)**
(A) Antisera (B) Antibiotics
(C) Antibodies (D) Antigen

247. **Which of the following blood vessel contains semilunar valves: (2019)**
(A) Artery (B) Capillaries
(C) Vein (D) Arterioles

248. **A person got an infection, he became ill but then he survived. What do you think which type of immunity he would have developed? (2019)**
(A) Naturally induced active
(B) Artificially induced active
(C) Active immunity
(D) Passive immunity

249. **In plants which sugar is transported from source to sink through sieve tube: (2019)**
(A) Fructose (B) Sucrose
(C) Glucose (D) Starch

250. **Four plants are present in different environmental conditions. Plant A is present in warm climate with continues rainfall, plant B present in cool forest, plant C present in warm climate with little breeze and plant D is also present in warm climate but with high wind speed. Which one of the above plants will have the highest rate of transpiration? (2019)**
(A) Plant A (B) Plant B
(C) Plant C (D) Plant D

251. **The major function of basophils is to: (2019)**
(A) Destroy small particles by phagocytosis
(B) Release heparin to prevent blood clotting
(C) Inactive inflammations producing substances
(D) Transport of oxygen

252. **Large lymph vessels ultimately form larger lymph ducts, which drains its lymph into: (2019)**
(A) Carotid & Aorta
(B) Vena cava & Aorta
(C) Subclavian vein
(D) subclavian artery

253. **Anti-venom given after a snake bite is an example of: (2019)**
(A) Natural passive immunity
(B) Natural active immunity
(C) Artificial passive immunity
(D) Artificial active immunity

254. **In root the apoplast pathway of water is disrupted when water reaches: (2020)**
(A) Plasmodesmata (B) Endodermis
(C) Cortex (D) Pith

255. **Regarding structure of human heart chordae tendinea is present in: (2020)**
(A) Atria (B) Pulmonary valves
(C) Ventricle (D) Aortic valves

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256. The only vein in human carry oxygenated blood is: (2020)
(A) Femoral (B) Renal
(C) Pulmonary (D) Iliac

257. The cells which play an important role in developing immunity are: (2020)
(A) Monocytes (B) Lymphocytes
(C) Neutrophils (D) Thrombocytes

258. Which of the following blood vessels have the highest pressure of blood? (2020)
(A) Aorta (B) Pulmonary artery
(C) Pulmonary vein (D) Vena cava

259. Autoimmune disease act as the principle of: (2020)
(A) Self against antigen
(B) Antigen against self
(C) Self against self
(D) Antigen self-destroyed

260. Antibodies are manufactured in: (2020)
(A) T-lymphocytes (B) B-lymphocytes
(C) Platelets (D) Red blood cells

261. _____Proteins are produced by W.B.Cs in response to _____ and provide immunity: (2022)
(A) Antibodies, Antigens
(B) Globulin, Histamine
(C) Antibodies, RBCs
(D) Antibodies, WBCs

262. The lymphatic vessel of the body empties the lymph into blood stream at: (2022)
(A) abdominal vein (B) Subclavian vein
(C) Bile duct (D) Jugular vein

263. Flow of blood in capillaries is adjusted by: (2022)
(A) Heart directly
(B) Meta-arterioles
(C) Pre-capillary sphincters
(D) Valves

264. The pressure exerted by the solution separated by semipermeable membrane from the pure water: (2022)
(A) Osmotic pressure (B) Solute potential
(C) Soil potential (D) Solvent potential

265. Descending aorta is bifurcated into two vessels which on further division from femoral artery that supply blood to the thigh muscles of leg: (2023)
(A) Iliac vein (B) Temporal artery
(C) Iliac artery (D) Sciatic artery

266. The final destination of lymph is: (2023)
(A) lymph node (B) Lymph capillaries
(C) Lymphoid organ (D) Subclavian vein

267. The movement of water to lower solute concentration area through a semipermeable membrane is: (2023)
(A) Osmotic potential
(B) Solute potential
(C) Soil potential
(D) Pressure potential

268. The _____ describes how water and dissolve are carried through the cell wall and intercellular gaps of the plants: (2023)
(A) Apoplast theory
(B) Vacuolar theory
(C) Symplast theory
(D) Cytoplasmic theory

269. In an inflammatory response, bradykinin Causes: (ETEA 2024)
(A) Activation of natural killer cells
(B) Blockage in blood vessels
(C) Constriction of blood vessels
(D) Leakage of fluid from blood vessels

270. Which of the following is an example of passive immunity: (ETEA 2024)
(A) Antibodies from mother's milk
(B) Previous chickenpox infection
(C) Inactivated polio vaccine
(D) Live polio vaccine

271. What directly triggers the activation of natural killer cells: (ETEA 2024)
(A) Free radicals
(B) Hydrogen peroxide
(C) Interferons
(D) Oxygen

272. Weakened papillary muscles of right ventricle would result in constant back flow of blood into: (NUMS 2024)
(A) Right atrium (B) left ventricle
(C) Right Ventricle (D) Left atrium

273. Which of the following would not be compromised in the absence of lymphatic system: (NUMS 2024)
(A) Blood Pressure
(B) oxygen Carrying capacity of blood
(C) Blood composition
(D) Defense mechanism

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274. The presence of which molecules distinguish blood from interstitial fluid: (NUMS 2024)
(A) Large proteins and electrolytes
(B) Glucose and RBCs
(C) Antibodies and electrolytes
(D) RBCs and large proteins

275. Plant growing in saline soil face the problem of dehydration due to: (NUMS 2024)
(A) ψw of soil > ψw of root
(B) ψs of soil < ψs of root
(C) ψw of root > ψw of soil
(D) ψw of root = ψw of soil

276. During covid-19 epidemic, the plasma of recovered patients was injected in Covid patients. This proved quite effective. Which component of plasma do you think was responsible for this: (NUMS 2024)
(A) Plasminogen (B) Interferons
(C) Antibodies (D) Interleukin-I

277. Choose the one which is example of artificial active immunity: (NUMS 2024)
(A) Foetus receiving antibodies of mother through placenta
(B) Mother receiving antibodies
(C) Baby receiving MMR shots
(D) Prevention of a decease due to previous infection

278. Which of the following type of T cells are required for the activation of B cells: (NUMS 2024)
(A) Helper T cells (B) Cytotoxic T cells
(C) Suppresser T Cells (D) Memory T Cells

279. How much delay is required in seconds for conductance from the S.A node to A.V node: (SZABMU 2024)
(A) 0.10 (B) 0.15
(C) 0.20 (D) 0.30

280. Which one of the following blood vessels has larger bore, thin walls, and without pulse: (SZABMU 2024)
(A) Aorta (B) Arteries
(C) Capillaries (D) Veins

281. Which one of the following chemicals in blood circulation is the cause of inflammation in upper respiratory tract: (SZABMU 2024)
(A) Acetyl amine (B) Ampicillin
(C) Histamine (D) Tetracycline

282. When a person is exposed to HIV, becomes ill but survive, as a result the immunity developed against disease is called: (SZABMU 2024)
(A) Artificial Active Immunity
(B) Artificial Passive Immunity
(C) Natural Active Immunity
(D) Natural Passive Immunity

283. In the roots, apoplast pathway becomes discontinuous in the endodermis due to the presence of: (SZABMU 2024)
(A) Casparian strips (B) Hydathodes
(C) Pericyclic (D) Plasmodesmata

284. _____ system aids in defending the human body against foreign invaders: (BUMHS 2024)
(A) Reproductive (B) Lymphatic
(C) Digestive (D) None of above

285. Which permits exchange of materials with the tissues: (BUMHS 2024)
(A) Veins (B) Arteries
(C) Capillaries (D) All

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Answer Key

1. C	2. D	3. A	4. D	5. D	6. D	7. C	8. C	9. A	10. A
11. D	12. D	13. C	14. B	15. A	16. D	17. B	18. A	19. B	20. D
21. D	22. A	23. A	24. C	25. B	26. B	27. D	28. C	29. A	30. C
31. B	32. A	33. A	34. A	35. A	36. B	37. C	38. B	39. D	40. A
41. B	42. C	43. A	44. B	45. C	46. B	47. D	48. A	49. B	50. A
51. C	52. C	53. B	54. D	55. C	56. B	57. D	58. C	59. B	60. B
61. C	62. A	63. C	64. A	65. D	66. D	67. B	68. A	69. C	70. C
71. C	72. D	73. A	74. C	75. C	76. C	77. A	78. C	79. B	80. A
81. C	82. B	83. A	84. B	85. B	86. C	87. C	88. B	89. C	90. D
91. B	92. A	93. A	94. C	95. B	96. A	97. A	98. B	99. C	100. A
101. A	102. B	103. D	104. B	105. B	106. D	107. C	108. C	109. C	110. B
111. A	112. C	113. C	114. B	115. C	116. B	117. B	118. B	119. B	120. B
121. B	122. C	123. C	124. C	125. B	126. C	127. D	128. C	129. C	130. D
131. C	132. D	133. D	134. A	135. D	136. B	137. C	138. A	139. A	140. D
141. B	142. B	143. D	144. A	145. A	146. A	147. A	148. D	149. D	150. A
151. A	152. B	153. A	154. B	155. D	156. A	157. B	158. A	159. B	160. D
161. D	162. B	163. D	164. B	165. B	166. B	167. B	168. A	169. B	170. A
171. B	172. A	173. D	174. B	175. C	176. A	177. D	178. C	179. B	180. B
181. D	182. A	183. D	184. D	185. A	186. C	187. C	188. C	189. C	190. C
191. B	192. D	193. A	194. C	195. D	196. A	197. A	198. B	199. A	200. B
201. D	202. D	203. D	204. A	205. B	206. A	207. A	208. B	209. D	210. B
211. A	212. B	213. A	214. A	215. C	216. B	217. B	218. C	219. A	220. B
221. B	222. C	223. B	224. C	225. A	226. B	227. B	228. B	229. C	230. D
231. B	232. A	233. C	234. A	235. B	236. B	237. C	238. B	239. A	240. A
241. D	242. A	243. D	244. B	245. A	246. D	247. C	248. A	249. B	250. D
251. B	252. C	253. C	254. B	255. C	256. C	257. B	258. A	259. C	260. B
261. A	262. B	263. C	264. A	265. C	266. D	267. A	268. A	269. D	270. A
271. C	272. A	273. B	274. D	275. C	276. C	277. C	278. A	279. B	280. D
281. C	282. C	283. A	284. B	285. C					

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UNIT # 10

PROKARYOTES

High Yield Content:

- Structure, Size and Shapes of Bacteria
- Bacterial diseases
- Gram positive and Gram-negative bacteria
- Plasmid, Mesosomes, Spores (Endospore, Exospores), Slime, Capsule, Cell wall, Nucleoid, Conjugation
- Control of Bacteria (Physical & Chemical Methods)

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"Prokaryotes"

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PROKARYOTES (MONERA): KEY CONCEPTS

- **Antonie van Leeuwenhoek (1673)** First to observe and describe **bacteria ("animalcules")** using a simple microscope.
- **Ehrenberg (1882)** introduce the name bacterium.
- **prokaryotic microorganisms**, believed to have appeared **about 3.5 billion years ago** during the **Proterozoic era**
- **Stromatolites** are layered **rock-like structures** formed by the growth of **cyanobacteria (blue-green algae)**
- **Louis Pasteur** Disproved **spontaneous generation** and established the role of bacteria in **fermentation and disease**. He also developed vaccines against anthrax and rabies.
- **Robert Koch** Developed **Germ theory of Disease**, proving that specific bacteria cause specific diseases.
- **In 1861, John Hogg** proposed kingdom Protists to accommodate microorganisms so prokaryotes were placed in this kingdom.
- **In 1866, Ernst Haeckel** made a separate group **"Monera"** for prokaryotes within the same kingdom Protists.
- **In 1937, E-Chatton** differentiated between **prokaryotic and eukaryotic** cells.
- **In 1938, Herbert Copeland** elevated the status of Monera to Kingdom level.
- **In 1969, Robert Whittaker** proposed **five kingdom systems** that incorporated the basic prokaryotic-eukaryotic distinction which has been modified by **Margulis and Schwartz in 1982.**

Domains of life

Domain	Characteristics
Archaea (Archaebacteria)	Prokaryotic (no nucleus), **No peptidoglycan in cell walls**, Live in extreme environments (extremophiles), **earliest life form.** **Examples:** *Methanogens, Halophiles, Thermophiles*
Bacteria (Eubacteria)	Prokaryotic (no nucleus) , **Cell walls contain peptidoglycan**, Unicellular, Diverse environments. **Examples:** *Escherichia coli, Staphylococcus aureus, Bacillus subtilis.*
Eukarya	**Eukaryotic cells (with nucleus)**, Can be unicellular or multicellular **Examples:** Protists, Fungi, Plants, and Animals

Differences Between Bacteria and Archaea

Feature	Bacteria	Archaea
Cell Wall Composition	Contains **peptidoglycan**	Lacks peptidoglycan
RNA Polymerase	Relatively small and simple	Complex **similar to eukaryotes**
rRNA sequences	Many unique to Eubacteria	Many **matches eukaryotic** ones
Introns (non-coding parts of genes)	Absent	Present in some genes
Habitat	Found everywhere: soil, water, humans, etc.	Often in **extreme environments** (hot springs, salty lakes, deep oceans)
Sensitivity to Antibiotics	Sensitive to antibiotics (e.g., penicillin)	**Not sensitive** to typical bacterial antibiotics
Pathogenicity	Some are **pathogenic** to humans and animals	**Non-pathogenic** to humans
Membrane lipids	Carbon chain unbranched	Carbon chain branched

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Size of Bacteria

- Bacterial cells are about one-tenth the size of eukaryotic cells. However, a few species are visible to the unaided eye.

Size of Bacteria

Type	Size
Range	0.1-600 µm
Mycoplasma (Smallest)	100-200 nm
Escherichia coli	1.1-1.5 µm (width), 2.0-6.0 µm (length)
Spirochete	500 µm in length
Staphylococci & Streptococci	0.75-1.25 µm in diameter
Epulopiscium fishelsoni	600 µm long, and 80 µm thick

Shapes of Bacteria

Type	Arrangement	Division	Examples
Coccus	Spherical	No	*Streptococcus pneumonia, Streptococcus pyogenes, Neisseria meningitides, Staphylococcus aureus, Neisseria gonorrhoeae*
Diplococcus	Two cocci	Single plane of division	
Streptococcus	Cocci in chain	Single plane of division	
Staphylococcus	Irregular arrangement	Random planes	
Tetrad	Square of four cocci	Two planes of division	
Sarcina/Octate	Cube of eight cocci	Three planes of division	
Bacillus	Rod shaped	No	*Escherichia coli, Bacillus subtilis, Pseudomonas, Haemophilus influenzae, Clostridium botulinum, Clostridium tetani, Salmonella typhi, Lactobacillus acidophilus*
Diplobacillus	Two bacilli	Single plane of division	
Streptobacillus	Chain of bacilli	Single plane of division	
Coccobacilli	Rod shaped with Spherical ends	No	
Spirals	Spirally coiled	No	*Vibrio cholerae, Hyphomicrobium, Treponema pallidum, Campylobacter jejuni, Helicobacter pylori*
Vibrio	Comma shaped	No	
Spirillum	Thick, rigid spiral	No	
Spirochete	Thin, flexible spiral	No	
Pleomorphism	Variety of shapes		*Helicobacter pylori, Mycoplasma*

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Lipids	Less (only 1-4%)	More (11-12%)
Additional Substances	Teichoic acid and lipoteichoic acid	Lipopolysaccharides, lipoproteins
Overall Thickness	Relatively thicker (20-80nm)	Relatively less thick (8-11nm)
Outer Membrane	Absent	Present
Periplasmic Space	Present in some species	Present in all species
Permeability of Molecules	More penetrable	Less penetrable
Resistance to molecules	Less	More
Porins	Absent	Present
Common Examples	Staphylococcus aureus, Streptococcus pneumoniae, Bacillus anthracis, Bacillus subtilis, Clostridium botulinum, Clostridium tetani, Mycobacterium tuberculosis	Escherichia coli (E. coli), Salmonella species, Pseudomonas, Neisseria gonorrhoeae, Haemophilus influenzae, Vibrio cholerae, Treponema pallidum, Shigella dysenteriae, Helicobacter pylori

Cell Membrane

- It is thin, **flexible structure** beneath the cell wall and completely surrounds the cytoplasm.
- It is very **delicate** in nature and any damage to it results in death of the organism.
- Bacterial membrane **differs** from eukaryotic membrane in **lacking sterols** such as cholesterol.
- **Metabolically more active** than eukaryotic membrane
- It is involved in **transport** of proteins, nutrients, sugars and electrons or other metabolites.
- The plasma membrane of bacteria also contains **enzymes** for **respiratory metabolism (Chemiosmosis).**

Cytoplasmic Matrix

- A **gel-like** substance present between the plasma membrane and the nucleoid.
- Plasma membrane and everything present within it is called **protoplast.**
- Cytoplasmic matrix **lacks membrane bounded organelles** and **cytoskeleton**; however, chromatin/ nuclear body, ribosomes, mesosomes, granules and nucleoid are present in it.

Nucleoid

- Other names for nucleoid are **nuclear body, chromatin body** and **nuclear area**.
- Nucleoid is the nuclear region of bacteria which is not separated from the cytoplasm by nuclear membrane.
- It consists of a single, large circular, double stranded DNA molecule, with single chromosome **(without histone)**, So, bacteria are considered **haploid organisms.**
- It is visible in the light microscope after staining with **Feulgen dye.**
- The nucleoid DNA controls growth and metabolic activities of bacteria.
- **E. coli** closed circle chromosome measures approximately **14000 µm.**

Plasmid

- Circular, Extrachromosomal (non- nuclear) double stranded DNA molecules, **self-replicating but not essential** for bacterial **growth** and **metabolism.**
- Contains **genes of drug resistance**, heavy metal resistance, disease, and insect resistance.
- **pSC 101** has antibiotic resistance gene for tetracycline whereas **pBR 322** has antibiotic resistance gene for tetracycline as well as ampicillin.
- Plasmids are **important vectors** in modern genetic engineering techniques.

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Ribosomes

- Smaller than eukaryotic ribosome and **70s (50s+30s)**.
- They are composed of **RNA** and **proteins (Ribonucleoprotein particles)**.
- May be loosely attached to the cell membrane or plasma membrane.
- They are involved in **protein synthesis/translation.**

Mesosomes

- The cell membrane **invaginates** into the cytoplasm forming structure called as mesosomes. They occur in the form of vesicles, tubules or lamellae.
- They are involved in **DNA replication, cell division,** and export of **exo-cellular enzymes**.
- **Respiratory enzymes** are also present on the mesosomes.

Storage Bodies and Granules

- Since bacteria exist in a very competitive environment where nutrients are usually in short supply. They tend to store extra nutrients when possible.
- The nutrients may be useful e.g., **Glycogen, Sulphur, Fat** and **Phosphate.**
- In addition, cells contain waste materials that are subsequently excreted e.g., **alcohol, lactic acid,** and **acetic acid.**

Spores

- These are metabolically **dormant bodies**, resistant to adverse physical environmental conditions such as light, high temperature, desiccation, pH and chemical agents.
- They may be exospores (external to vegetative cell) or endospores (inside vegetative cell/ inside cell wall).
- Endospores are **more resistant** structures and can **survive for years.**
- They germinate to form vegetative cell under favorable conditions. They normally **develop** at **end stage** of growth of bacteria.

Cysts

- They are dormant, **thick walled, desiccation resistant** form but **not heat-resistant** structures.
- They develop during differentiation of vegetative cells which can germinate under suitable conditions.

Spore	Cyst
Inside (Endospores)	Outside
Resistant to light, temperature, desiccation, pH and chemical agents	Desiccation resistant
Develops at end stage of bacterial growth	Develops during differentiation of bacterial cell.
Bacillus anthracis (anthrax), Clostridium tetani (tetanus), Actinomycetes	*Entamoeba histolytica (intestinal infections), Azotobacter*

REPRODUCTION IN BACTERIA

- **Binary Fission (Amitosis)** → The most common method of bacterial reproduction.

Steps of Binary Fission

- **DNA Replication** → Bacterial chromosome duplicates.
- **Cell Elongation** → The cell grows, and DNA moves to opposite ends.
- **Septum Formation** → A dividing wall (septum) forms in the center.
- **Cell Division** → The cell splits into two identical daughter cells.

Key Features

- Rapid Process (E. coli can divide every **20 minutes**).
- Produces **genetically identical** cells (clones).
- No genetic variation unless mutations occur.

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[illegible]

[illegible] and it is believed to be involved in [illegible] such as pollinosis:

(A) IgA (B) IgG
(C) IgD (D) IgE

[illegible] The most common type of antibodies [illegible] presents in blood plasma:

(A) IgA (B) IgG
(C) IgD (D) IgE

The first antibody appeared in response to an antigen:

(A) IgM (B) IgG
(C) IgA (D) IgE

. It is usually co-expressed with another cell surface antibody IgM and send signal to B cell to activate:

(A) IgM (B) IgD
(C) IgA (D) IgE

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213. Largest lymph duct called thoracic lymph duct drains into: (2011)
(A) Subclavian vein
(B) Pulmonary vein
(C) Renal vein
(D) Hepatic portal vein

214. Which protein plays a major role in maintaining osmotic balance? (2015)
(A) Albumin
(B) Fibrinogen

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Bacterial Growth Curve: When bacteria grow in a closed system, they follow four phases:

- **Lag Phase** → No division, bacteria prepare themselves for division.
- **Log (Exponential) Phase** → Rapid division and growth.
- **Stationary Phase** → Nutrients deplete, trigger endospore formation, growth slows (Growth rate = Death rate)
- **Death Phase** → Cells die due to waste accumulation and lack of nutrients; endospores remain dormant until conditions improve (Death rate > Growth rate).

Genetic Recombination in Bacteria

Feature	Transduction	Transformation	Conjugation
Definition	Gene transfer via bacteriophages (viruses).	Uptake of naked DNA from the environment.	Gene transfer through direct cell-to-cell contact using a pilus.
Mediating Agent	Bacteriophage (Virus)	Free DNA fragments in the environment	F-plasmid (or conjugative plasmid)
Example Bacteria	*Salmonella, Escherichia coli* (E. coli).	*Streptococcus pneumoniae, Neisseria gonorrhoeae.*	*Escherichia coli, Agrobacterium*

Respiration in Bacteria

Type	Oxygen Requirement	Example
Aerobic Respiration	Requires oxygen (O_2)	*Pseudomonas, Mycobacterium tuberculosis*
Anaerobic Respiration	Occurs in absence of oxygen	*Spirochetes, Clostridium*
Facultative Anaerobes	Can survive with or without oxygen	*Escherichia coli, Staphylococcus aureus*
Microaerophiles	Require low oxygen concentration	*Helicobacter pylori, Campylobacter*

IMPORTANCE OF BACTERIA

- Bacteria are very important members of biodiversity from ecological, economical, biotechnological and research.

1- Ecological Importance of Bacteria

- Decomposition of dead/complex organic matter.
- Humus formation increases the fertility of soil.
- Bioremediation etc.

Role of Bacteria as Recyclers

- Bacteria serve as recyclers of nature as they are involved in **decomposition of dead** and complex organic matter in the environment.
- The organic carbon present in dead bodies might **diminish** all the CO_2 from the atmosphere if there were no decomposers present on earth.
- Through this process, other organisms also get benefited, who can use the simple forms of organic compounds/nutrients released from the dead matter of various bacteria.

Role of Bacteria to Increase Soil Fertility

- The partially decaying organic matter of dead organisms is called **humus**. It contains nutrients and increases soil fertility for the growth of plants.
- It also increases the **water retaining** capacity of the soil.
- **Bacteria and fungi** are the only organisms that decompose dead animals and plants.
- **Soil** is the only **source of nitrogen** for plants as they cannot inhale nitrogen directly from the atmosphere.

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- Nitrogen from the atmosphere can be available to the plants through the process of **nitrogen fixation.**
- This process takes place with the help of **pitrogen fixing bacteria** like **Rhizobium** and **Cyanobacteria** in the soil. These species of bacteria convert the **atmospheric nitrogen** into **nitrites** and **nitrates** as a part of their metabolism and make it available to the plants.
- **Arotobacter** is a **free-living**, aerobic bacteria that lives in the soil and can be used as a **bio-fertilizer.**
- **Leguminous plants** have a **mutualistic association** with the bacteria living in their tissues.

Role of Bacteria in Bioremediation

- **Removal or degradation of environmental pollutants** by using living organisms is called bioremediation.
- It involves the use of many bacteria that either naturally **love to eat contaminants** or have been **genetically altered** to give them the taste for toxins.
- Scientists are designing or deploying microbes to purge sites or contaminants such as **oil, radioactive waste, gasoline,** and **mercury.**

2- Economic Importance of Bacteria

- The economic importance of bacteria refers to the role of bacteria in research and technology, plant diseases and in human diseases.

Role of Bacteria in Research and Technology

- Bacteria play an important role in many technological fields, mainly in biological research, **mining, medicine, production of food products, plastics synthesis and sewage treatment.** The overall commercial worth of bacteria in these operations is immense.

Use in Genetics & Genetic Engineering

- Bacteria were used as model organism in number of famous experiments such as the discovery of DNA as heredity material, discovery of semi conservative replication of DNA and central dogma of life etc.
- Many components of bacterial cell are also being used as tool in genetic engineering experiments.
- **Biotechnology products** such as insulin, human growth hormones, tissue plasminogen activator, haemophilia factor VIII, hepatitis B vaccines are produced by bacteria.

Use in Mining

- The miners can **extract metal** from low grade ores by using certain bacteria.
- The bacterium *Thiobacillus ferrooxidans* is the important organism here. It works by catalyzing the oxidation of **metal sulphides, particularly copper sulphate,** so that they are soluble in water i.e. Cu_2S to $2Cu^{2+}$ and SO_4^{2-}.This allows the copper to leach out of the rock.
- *T. ferrioxidans* is also used in the organic leaching of gold and uranium with the help of other bacteria such as **T. thiooxidans** and **Leptospirillum ferrooxidans.**

Use in Production of Complex Organic Molecules

- Bacteria are useful to mankind in the production of complex organic molecules, includes **antibiotics, vitamins, amino acids** and **enzymes.**
- In addition to these compounds, dairy products such as yogurt cheese, butter etc. are also produced with the help of bacteria.

Use in Production of Biodegradable Plastic

- Now a days, biodegradable plastic is made by using two bacterially produced molecules, **Poly-B-hydroxybutyrate and Poly-B-hydroxyvalerate.**
- These molecules make a polymer just like ordinary plastic but have the essential difference that once left out in the compost they can be broken down by bacteria & fungi to become part of the cycle of life again.

Use in Treatment of Wastewater

- Owing to their characteristics of degrading harmful chemicals and pollutants, bacteria naturally help in treatment of wastewater.

Role of Bacteria in Causation of Diseases and Spoilage of Food

- Parasitic bacteria attack plants and cause various diseases, e.g. **fire blight** in **apple, ring diseases** in **potatoes** and **crown gall** etc.

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- **Many human diseases** are caused by bacteria e.g. diphtheria, tetanus, leprosy, meningitis, sore throat, whooping cough also called pertussis etc.
- Bacteria cause decay of wood, leather, fabrics etc.
- Bacteria spoil the food materials by decomposition.

Common Bacterial Diseases in Man

Disease	Causative Bacteria	Major Symptoms	Prevention Methods
Cholera	Vibrio cholerae	Severe watery diarrhea, dehydration, muscle cramps	**Drinking clean water**, proper sanitation, oral cholera vaccine, good personal hygiene
Typhoid Fever	Salmonella typhi	High fever, weakness, abdominal pain, rash	**Typhoid vaccine**, drinking safe water, proper food hygiene, handwashing
Tuberculosis (TB)	Mycobacterium tuberculosis	Chronic cough, chest pain, weight loss, fever	**BCG vaccine**, good ventilation, wearing masks in high-risk areas, early detection and treatment
Pneumonia	Streptococcus pneumoniae	Cough, chest pain, fever, red brown sputum	**Antibiotics**, good hygiene, avoiding smoking, timely treatment of respiratory infections
Whooping Cough (Pertussis)	Bordetella pertussis	Severe coughing fits, vomiting after coughing, "whooping" sound	**DTaP vaccine**, avoiding close contact with infected individuals, good respiratory hygiene
Diphtheria	Corynebacterium diphtheriae	Sore throat, fever, thick gray coating in the throat	**DTP vaccine**, maintaining personal hygiene, avoiding contact with infected persons
Gonorrhea	Neisseria gonorrhoeae	Affected mucous membrane of urinogenital tract, Painful urination,	**Antibiotics**, Safe sexual practices
Syphilis	Treponema pallidum	Painless sore (chancre), skin rashes, fever, swollen lymph nodes.	Safe sexual practices, **Antibiotics**
Tetanus	Clostridium tetani	Muscle stiffness, lockjaw, spasms	**Tetanus vaccine (TT shot)**, proper wound care, using sterile equipment
Plague	Yersinia pestis	Swollen lymph nodes, fever, chills, fatigue	Controlling rodent populations, using insect repellents, avoiding contact with infected animals

CONTROL OF BACTERIA

- Bacterial control is required to prevent diseases and food spoilage.
- Modes of action of different physical and chemical agents result in damage or malfunctions in the cell wall, cell membrane, cytoplasmic enzymes or nucleic acids.

Physical Methods

- The process in which **physical agents** are used to control bacteria/microorganisms is known as **sterilization** and it involves destruction of all life forms.
- In physical methods, steam, dry heat, gas, filtration and radiations are used to control bacteria.

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Type of Physical Methods	Description
Use of heat	➢ Used in microbiological labs for control of microbes. ➢ Both dry heat and moist heat are effective. ➢ Moist heat causes **coagulation of proteins** and kills microbes. ➢ Dry heat cause **oxidation of chemical constituents** of microbes and kill them.
Use of radiations	➢ Certain electromagnetic radiations **below 300 nm** wavelength are effective in killing of microorganisms. ➢ **Gamma rays** are in general used for the sterilization process
Use of Membrane Filters	➢ **Heat sensitive compounds** like antibiotics, sera's, vaccines, enzymes etc. can be sterilized by means of membrane filters.
Pasteurization	➢ Use to kill **non-spore forming bacteria** e.g., milk pasteurized by **heating at 71 °C** for **15 seconds (Flash pasteurization or high-temperature short-time / HTST)** and at **62 °C for 32 minutes (Batch Pasteurization)**. ➢ More effective method of pasteurization of milk is through **UHT (Ultra High Temperature)** in which milk is treated at **140 °C for 3 seconds** and then cooled suddenly in vacuum chamber.
Dehydration	➢ Food is dehydrated so that in dry condition bacteria may not grow. ➢ By dehydration **salt contents increased** so that water in food in not enough for bacterial growth.
Addition of Preservatives	➢ Acid is added to lower the pH. ➢ Some chemicals like **potassium metabisulphite** are added to preserve pickles, candies, jam and breads.

Type of Chemical Method	Description
Antiseptics	➢ Procedure to eliminate or reduce the possibility of infection is called **antisepsis.** ➢ Chemical substances used on living tissues that inhibit the growth of microorganism are called **antiseptics.** ➢ **Examples** are **Povidone-iodine, Iodine tincture.**
Disinfection	➢ Process that eliminates many or all pathogenic microorganisms, except bacterial spores, on **inanimate objects / Non-living surfaces.** ➢ It involves killing of most but not all life forms. ➢ Important chemicals used for disinfection are **oxidizing** and **reducing agents** e.g., **halogens, phenols, H_2O_2, $KMnO_4$, alcohol** and **formaldehyde** etc.
Chemotherapeutics Agents	➢ Chemotherapeutic agents and **antibiotics** work with natural defense and stop the growth of bacteria and other microbes. ➢ They destroy or inhibit the growth of microorganisms in **living tissues.** ➢ These are **sulfonamides, tetracycline** and **penicillin**
Vaccination	➢ It is an important **method of prevention** and treatment to control microbial diseases in humans.

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1. Life has evolved on earth along with three lineages called "Domain" which includes all living organisms. Out of three, _____ domains cover the prokaryotes:
(A) 1
(B) 2
(C) 3
(D) Prokaryotes are not included in domain system

2. _____ structures represent the earliest fossilized record of life on earth:
(A) Stromatolites (B) Endosymbiont
(C) hydrothermal vent (D) Jurassic rocks

3. Earth formed around_____ billion years ago:
(A) 5.5 (B) 3.5
(C) 4.5 (D) 1.5

4. The earliest undisputed evidence of life on earth dates at least from_____ billion years ago:
(A) 5.5 (B) 3.5
(C) 4.5 (D) 1.5

5. Bacterial cells are about _____the size of eukaryotic cell:
(A) 1/100 (B) 1/1000
(C) 1/10 (D) 1/10000

6. Which of the following organelles in today's eukaryotes were once prokaryotic microbes:
(A) Mitochondria (B) Ribosomes
(C) Chloroplast (D) Both A & C

7. Which one of the following structures of bacterial cell is invariable:
(A) Capsule (B) Slime
(C) Plasmid (D) Ribosomes

8. Food poisoning and gas forming rod shape bacterium is:
(A) Shigella (B) Clostridium
(C) Salmonella (D) E.coli

9. Milk is fermented by:
(A) Rhizobium (B) Azotobacter
(C) Lactobacillus (D) clostridium

10. Bacteria differs from viruses in:
(A) Pathogenic nature
(B) Having well defined cytoplasm
(C) Genetic material
(D) Replication

11. Which of the following is not an antibiotic?
(A) Citric acid (B) Cephalosporin
(C) Streptomycin (D) Griseofulvin

12. Monerans Comprises:
(A) Bacteria (B) Algae
(C) Cyanobacteria (D) Both A and C

13. Bacteria living in human large intestine that feed on digested food without harming the host are termed as:
(A) Parasite (B) Symbionts
(C) Predator (D) Commensals

14. The most common and fastest mode of asexual reproduction in bacteria is:
(A) Fission
(B) Sexual reproduction
(C) Budding
(D) Sporulation

15. Pasteurization means:
(A) Sterilization in steam cooker at 100 C for 10 minutes
(B) Heating milk or other liquid at 60-70 C for short duration
(C) A technique for curing people bitten by mad dog
(D) Vaccination for baby against smallpox

16. Cysts are resistant to:
(A) Temperature (B) Heat
(C) Desiccation (D) Radiation

17. Identify the gram-positive bacteria:
(A) E.coli (B) Salmonella
(C) Pseudomonas (D) Clostridium

18. Which of following is a rod shape bacterium?
(A) Salmonella typhi (B) Vibrio Cholerae
(C) Treponema palladium (D) All of these

19. Which of the following statement is correct for plasmid?
(A) Replicate independently of host chromosome (B) Not essential for bacterial growth
(C) Increase the immunity of bacterial cell
(D) All of above

20. Which of the following is incorrect statement for process of conjugation in bacteria:
(A) One bacterium transfers the genetic material to other
(B) Exchange of genetic material between two bacteria
(C) The process involves transfer of only portion of genome
(D) All are correct

21. After the conjugation:
(A) F^- bacteria converted into F^+ bacteria
(B) F^+ bacteria converted into F^- bacteria

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(C) No change takes place between bacteria
(D) Both bacteria changed into different strain

22. The process in which a bacterium takes in DNA from its environment?
(A) Transformation (B) Conjugation
(C) Transduction (D) Binary fission

23. E.coli closed circle chromosomes measures approximately?
(A) 140 µm (B) 14000 µm
(C) 1400 µm (D) 140000 µm

24. Biotechnological products produced by bacteria:
(A) Human Growth Hormone
(B) Insulin
(C) Hepatitis B Vaccines
(D) All of the above

25. The smallest bacteria are some members of:
(A) Mycoplasma (B) Archaebacteria
(C) Eubacteria (D) Cyanobacteria

26. Some bacterial cells are _____ and they can exist in a variety of shapes:
(A) Spherical (B) Pleomorphic
(C) Oval (D) Rod shaped

27. When coccus divides in three planes. It will produce a:
(A) Sarcina (B) Tetrad
(C) Streptococcus (D) Staphylococcus

28. These bacteria very rarely have flagella:
(A) Cocci (B) Bacilli
(C) Spirilli (D) Spirillum

29. Bacteria can also detect and move in response to chemical signals. This type of behavior is called:
(A) Chemotropism (B) Chemotaxis
(C) Locomotion (D) Repulsion

30. The structure used for sexual contact between bacteria is/are:
(A) Flagella (B) Mesosome
(C) Plasmid (D) Pili

31. The cell envelope of bacteria cell includes the following EXCEPT:
(A) Capsule (B) Slime
(C) Cell wall (D) Cell membrane

32. Pick up the components which are comparatively in greater amount in Gram -ve cell wall:
(A) Lipids (B) Peptidoglycan
(C) Teichoic acid (D) Lipoteichoic acid

33. It is very delicate in nature and any damage to it results in death of the bacterium:
(A) Plasma membrane (B) Cell wall
(C) Slime capsule (D) Capsule

34. Nucleoid is visible in the light microscope after staining with:
(A) Safranin (B) Crystal violet
(C) Feulgen stain (D) Acid fuchsin

35. Resistance to bacteria against all types of unfavorable conditions is provided by:
(A) Cyst (B) Spores
(C) Both cyst and spores (D) Mesosome

36. The heterotrophic bacteria may be separated into:
(A) Two group (B) Three groups
(C) Four group (D) Five group

37. Unlike the green plants which have their chlorophyll in chloroplasts, bacterial chlorophyll is:
(A) Found in leucoplast
(B) Found in chromoplasts
(C) Dispersed in cytoplasm
(D) Dispersed in nucleus

38. Probiotics in infant's formula milk are the normal bacterial flora to humans. They keep the babies healthy by doing all of the following actions except: (NUMS 2024)
(A) Produce important vitamins
(B) Kill pathogenic bacteria
(C) Prevent colonization of pathogens
(D) Enhance immunity

39. Tetracycline and its compounds can cause permanent discoloration of teeth in:
(A) Infants (B) Young children
(C) Adult people (D) Old people

40. Milk is pasteurized by heating at _____ C° for _____ seconds and _____ C° for _____ minutes:
(A) 100, 20, 71, 25 (B) 32,15, 71, 32
(C) 71, 15, 62, 32 (D) 32, 71, 62, 32

41. Bacterial membrane is different from eukaryotic membrane in:
(A) Lacking protein
(B) Lacking cholesterol
(C) Lacking polysaccharides
(D) Lacking lipids

42. Moneran are found everywhere on the earth except at/in:
(A) Polar regions (B) Burning fires

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(C) Hot springs (D) Hot and dry deserts

43. **Bacteria were discovered by:**
(A) Leeuwenhoek (B) Tatum
(C) Lederberg (D) Griffith

44. **Nitrogen fixing organism which can be symbiotic is:**
(A) Anabaena (B) Liverworts
(C) Azotobacter (D) Mosses

45. **The bacteria that commonly live in animal and human intestine is:**
(A) Vibrio cholerae (B) Corynebacterium
(C) Bacillus anthracis (D) Escherichia coli

46. **In bacteria the respiratory enzymes are situated in the part of:**
(A) Cell membrane (B) Mitochondria
(C) Cytoplasm (D) Ribosomes

47. **Which one of the following sets includes bacterial diseases?**
(A) Cholera, mumps, measles
(B) Malaria, mumps, poliomyelitis
(C) Tetanus, tuberculosis, measles
(D) Cholera, pneumonia, tuberculosis

48. **The adverse effect of tetracycline is:**
(A) Discoloration of skin
(B) Deafness
(C) Discoloration of teeth
(D) Allergy

49. **Hydrophobia is transmitted:**
(A) By water
(B) By eating meat of rabid animal
(C) By bite of rabid dog
(D) By shaking hand with rabid man

50. **Glycocalyx (mucilage sheath) of a bacterial cell may occur in the form of a loose sheath called ___ or it may be thick and tough called____:**
(A) Capsule, slime layer
(B) Slime layer, capsule
(C) Mesosome, capsule
(D) Mesosome, slime layer

51. **The word Archaeobacteria (a division of bacteria) derived from Greek means:**
(A) True bacteria (B) Ancient bacteria
(C) False bacteria (D) Recent bacteria

52. **Who coined the term Animalcules for microorganisms like Bacteria and protozoa?**
(A) Antonie van Leeuwenhoek
(B) Louis pasture
(C) Robert Koch
(D) Charles Chamberland

53. **Who discovered the bacteria causing tuberculosis and also developed various techniques of media preparation and maintenance of pure culture?**
(A) Robert Koch (B) Louis Pasteur
(C) Leeuwenhoek (D) Robert brown

54. **Which of the following structure is a variable structure in bacteria?**
(A) Chromatin bodies (B) Cell membrane
(C) Ribosome (D) Capsule

55. **The size of Spirochete is**
(A) 0.1 -600 µm (B) 500 µm
(C) 100-200 nm (D) 600 µm

56. **E. coli and example of Enterobacteriaceae is important for causing diarrheal diseases its size is:**
(A) 1.1-1.5 µm (width) 2.0-6.0 µm (length)
(B) 1.1-1.5 µm (Length) 2.0-6.0 µm (width)
(C) 80 µm (Width) 600 µm (Length)
(D) 500 µm (Length), 50 µm (Width)

57. **Which one of the following sets includes bacterial diseases?**
(A) Cholera, mumps, measles, Anthrax, Plaque
(B) Malaria, mumps, poliomyelitis, Botulism, Typhoid
(C) Tetanus, tuberculosis, measles, Gonorrhea, Leprosy
(D) Cholera, pneumonia, tuberculosis, Syphilis, Diphtheria

58. **Human Insulin is being commercially produced from a transgenic species of:**
(A) Escherichia coli (B) Rhizobium
(C) Mycobacterium (D) Saccharomyces

59. **Common Bacterium used in genetic engineering is:**
(A) Rhizobium (B) Diplococcus
(C) Spirillum (D) E coli

60. **Causative agent of Tuberculosis is:**
(A) Streptococcus (B) Mycobacterium
(C) Pneumococcus (D) E. coli

61. **BCG vaccine is preventing measure against:**
(A) Tuberculosis (B) Typhoid
(C) AIDS (D) Cholera

62. **Which one of the following is autotrophic?**
(A) Clostridium (B) Rhizobium
(C) Anabaena (D) Azotobacter

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63. Gram staining differentiates bacteria by the chemical and physical properties of their:
(A) Cytoplasm (B) Cell wall
(C) Cell membrane (D) Plasmid

64. Which statement is true for Gram negative bacteria:
(A) Have a thick layer of peptidoglycan in the cell wall
(B) Retains the crystal violet dye
(C) They are stained pink or red by the counterstain
(D) All are correct

65. Which of Following bacteria do not stain by Gram's method:
(A) E coli
(B) Mycoplasma
(C) Spirochete
(D) Treponema palladium

66. Which of the following is used as decolorizer in Gram's staining method:
(A) Crystal violet
(B) Iodine
(C) Alcohol/Acetone
(D) Safranin / Carbol fuchsin

67. This is a free-living aerobic non-photosynthetic nitrogen-fixing bacterium:
(A) Azospirillium (B) Nostoc
(C) Rhizobium (D) Azotobacter

68. For bacterial transduction, which of these statements is correct:
(A) Transfer of genes from one to another bacteria by conjugation
(B) Transfer of some genes from one to another bacteria through virus
(C) Bacteria obtained DNA from other external sources
(D) Bacteria obtain its DNA from the mother cell

69. The first bacterium isolated was:
(A) Coccus (B) Bacillus
(C) Vibrio (D) Spirochete

70. Which of the following bacteria are thick rigid and spiral?
(A) Spirillum (B) Spirochete
(C) Coccus (D) Bacillus

71. Which of the following has a chain arrangement?
(A) Streptobacillus (B) Streptococci
(C) Staphylococci (D) Both A and B

72. A bacterium with tuft of flagella at both poles is called:
(A) Lophotrichus (B) Monotrichous
(C) Peritrichous (D) Amphitrichous

73. Which of the following structure provides greater pathogenicity to the bacteria?
(A) Capsule (B) Slime
(C) Cell Wall (D) Cell membrane

74. Example of bacteria requiring low concentration of oxygen is:
(A) Campylobacter (B) Spirochetes
(C) E. coli (D) Pseudomonas

75. Who developed the vaccine against anthrax?
(A) Louis Pasteur (B) Edward Jenner
(C) Leuwenhoek (D) Alexander Fleming

76. Which of following statement is not true for Plasmid:
(A) Circular, double-stranded DNA molecules in bacteria
(B) Carry genes that benefit the survival of the organism
(C) Required for metabolism of bacteria
(D) All are correct for Plasmid

77. In contrast to eukaryotes, prokaryotic flagella:
(A) Made up of flagellin protein
(B) Made of pilin protein
(C) Made of tubulin protein
(D) Made of actin protein

78. Chemical substances used on living tissues that inhibit the growth of microorganism are called:
(A) Antiseptics (B) Disinfectants
(C) Antibiotics (D) Vaccines

79. Rapid growth at exponential ratio occurs in which phase of bacterial growth:
(A) Lag phase
(B) Log Phase
(C) Stationary Phase
(D) Decline/Death Phase

80. Which of the bacterium is resistant to penicillin as it lacks a cell wall?
(A) Spirochetes (B) Cyanobacteria
(C) Mycoplasmas (D) Bdellovibrios

81. Bacteria differs from viruses in the presence of:
(A) Cytoplasm (B) True nucleus
(C) Causing disease (D) All of the above

82. Transduction in bacteria is mediated by:
(A) Cosmid (B) F-Factor

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(C) Phage vector (D) Plasmid vector

83. **The germ theory of disease was postulated by:**
(A) Robert Koch (B) Louis Pasteur
(C) Edward Jenner (D) Lamarck

84. **Anthrax is caused by:**
(A) Vibrio (B) Bacillus
(C) Salmonella (D) Virus

85. **Food poisoning is caused by:**
(A) Entamoeba histolytica
(B) E Coli
(C) Clostridium botulinum
(D) Corynebacterium diphtheria

86. **Diphtheria is caused by:**
(A) Bacteria (B) Virus
(C) Nematods (D) Protozoans

87. **Which of the following is set of bacterial diseases:**
(A) Cholera, typhoid and mumps
(B) Malaria, mumps and poliomyelitis
(C) Tetanus, tuberculosis and measles
(D) Diphtheria, leprosy and plague

88. **Which of these is a cocci occurring in pairs?**
(A) Diplococci (B) Streptococci
(C) Tetracocci (D) None of the above

89. **Flagella in bacteria enables them to:**
(A) Reproduce
(B) Locomote
(C) Thrive in nutrient agar
(D) Adhere to tissue surfaces

90. **Which of these bacterial components is least likely to contain useful antigens?**
(A) Cell wall (B) Flagella
(C) Ribosomes (D) Capsule

91. **Which of the statements regarding gram staining is wrong?**
(A) Mycobacterium tuberculosis stains blue because of the thick lipid layer
(B) Salmonella stains blue because of a thick peptidoglycan layer
(C) Escherichia coli stains pink because of a thin peptidoglycan layer
(D) Mycoplasma pneumoniae is not visible in the Gram's stain because it has no cell wall

92. **Prokaryotic cells are more resistant to osmotic shock than eukaryotic cells because:**
(A) Their cell wall is composed of peptidoglycan
(B) They are selectively permeable
(C) They contain osmoregulating porins
(D) They block water molecules from entering the cell

93. **This is true about the cell wall of gram-positive bacteria:**
(A) Cell wall comprises of many layers
(B) The cell wall is thicker than the associated gram-negative bacteria
(C) Cell wall comprises of teichoic acids
(D) All of the above

94. **What is Chemotaxis?**
(A) Swimming towards a bacteria
(B) Swimming away of a bacteria
(C) In the presence of a chemical compound, swimming towards or away of a bacteria
(D) None of these

95. **Which of these is exposed on the outer surface of a gram-negative bacterium?**
(A) Braun lipoprotein
(B) O-antigen of lipopolysaccharide (LPS)
(C) Polysaccharide portion of lipoteichoic acid
(D) Electron transport system components

96. **This is analogous to mesosomes of bacteria:**
(A) Golgi apparatus of eukaryotes
(B) Lysosomes of eukaryotes
(C) Mitochondria of eukaryotes
(D) None of the above

97. **All the bacteria fix nitrogen except:**
(A) Rhizobium (B) E. coli
(C) Azotobacter (D) Cyanobacteria

98. **The iodine used in gram staining serve as:**
(A) Chelator (B) Catalyst
(C) Mordant (D) Cofactor

99. **The ability of bacteria to change their morphological form frequently is termed as:**
(A) Lysogeny (B) Plaeomorphism
(C) Alteromorphism (D) All of these

100. **All are the characteristics responsible for the better survival of encapsulated bacteria except:**
(A) High pathogenicity
(B) withstand dehydration
(C) strict adhesion to internal surface
(D) easy recognition by host

101. **Which of the following bacterial structures is involved in maintaining cell shape and preventing osmotic lysis?**
(A) Capsule (B) Flagellum
(C) Pili (D) Cell wall

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102. Which of the following structures allows bacteria to survive in harsh environments by forming a protective, dormant structure?
(A) Capsule (B) Flagellum
(C) Endospore (D) Cell membrane

103. Which of the following structures is responsible for the transfer of genetic material from one bacterium to another through direct contact?
(A) Capsule (B) Flagellum
(C) Pili (D) Cell membrane

104. Bacteria that appear as curved rods or comma-shaped structures are known as:
(A) Cocci (B) Bacilli
(C) Vibrio's (D) Spirochetes

105. Which of the following methods are commonly used to control bacterial growth in laboratory settings?
(A) Genetic engineering (B) Sterilization
(C) Immunization (D) Gene therapy

106. Antibiotic resistance is a significant concern in bacterial infections. What is one of the primary causes of antibiotic resistance?
(A) Inadequate hand hygiene
(B) Overuse and misuse of antibiotics
(C) Exposure to ultraviolet (UV) radiation
(D) Lack of vaccination

107. Which of the following statements best describes the importance of bacteria in the environment?
(A) Bacteria are responsible for the majority of infectious diseases.
(B) Bacteria play a vital role in recycling nutrients and decomposing organic matter.
(C) Bacteria have no significant impact on the environment.
(D) Bacteria are solely responsible for the production of oxygen in the atmosphere.

108. Which of the following methods is commonly used to control bacterial infections in humans?
(A) Genetic engineering (B) Antiviral drugs
(C) Antifungal drugs (D) Antibiotics

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109. The structure which contains the gene for drug resistance in bacteria are: (2011)
(A) Nucleoids (B) Chromatin bodies
(C) Mesosomes (D) Plasmids

110. Antibiotics that kill microbes immediately are called: (2011)
(A) Microbistatic (B) Biostatic
(C) Microbicidal (D) Chemotherapeutic

111. Mesosomes are infoldings of the cell membrane and are involved in: (2012)
(A) DNA replication (B) Protein synthesis
(C) RNA synthesis (D) Metabolism

112. Most widespread problem of the antibiotic misuse is the: (2012)
(A) Rapid cure
(B) Disturbance of metabolite
(C) Increased resistance in pathogens
(D) Immunity

113. Antibiotics are produced by fungi and certain bacteria of group: (2013)
(A) Oomycetes (B) Actinomycetes
(C) Ascomycetes (D) Basidiomycetes

114. Which statement about bacteria is true? (2013)
(A) Gram positive bacteria have more lipids in their cell wall
(B) Lipids are absent in cell wall of both gram positive and gram-negative bacteria
(C) Both have equal amount of lipids
(D) Gram negative bacteria have more lipids in their cell wall

115. Which one of the following antibiotics causes permanent discoloration of teeth in young children if it is misused? (2014)
(A) Penicillin (B) Sulphonamide
(C) Streptomycin (D) Tetracycline

116. Cyanobacteria are: (2015)
(A) Photo autotrophic bacteria
(B) Saprotrophic bacteria
(C) Chemosynthetic bacteria
(D) Parasitic bacteria

117. During unfavorable conditions certain bacteria produce: (2015)
(A) Ribosomes (B) Mitochondria
(C) Plasmids (D) Spores

118. Many bacteria are motile due to presence of: (2016)
(A) Flagella (B) Cilia
(C) Pili (D) Microtubules

119. _____is an invagination of cell membrane which helps in cell division: (2016)
(A) Fimbriae (B) Mesosome
(C) Nucleoid (D) Endospore

120. DNA molecule in prokaryotes is: (2017)
(A) Single, circular, double stranded molecule, not bounded by membrane

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(B) Double, circular molecule
(C) Linear, double stranded molecule
(D) Single, circular, double stranded molecule, membrane bound

121. Nucleoid is a structure NOT found in: (2017)
(A) Campylobacter (B) Spirochete
(C) Cyanobacteria (D) Goblet cells

122. The cell wall structure of a cell of unknown origin was studied and found to contain polysaccharide chain linked with short chain of amino acid. What do you think it can be? (2017)
(A) Bacteria (B) Algae
(C) Fungi cell (D) Cortex cell

123. Ribosomes present in prokaryotes are: (2017)
(A) 80S (B) 50S
(C) 60S (D) 70S

124. Functionally, mesosomes can be compared with: (2017)
(A) Ribosomes (B) Polysomes
(C) Mitochondria (D) Golgi bodies

125. Students were asked to give a guess about a unicellular organism with darkly stained nucleus. Which one of the following can be straight away excluded from the list: (2017)
(A) Paramecium (B) Plasmodium
(C) Amoeba (D) Lactobacillus

126. Binary fission is a characteristic cell division NOT found in: (2017)
(A) Pseudomonas (B) Euglena
(C) Campylobacter (D) E. coli

127. In which one of the following shapes, gut living symbiont Escherichia coli is found? (2017)
(A) Round (B) Spiral
(C) Oval (D) Rod

128. Arrangement of coccus bacteria in chain is called: (2017-Retake)
(A) Streptococci (B) Tetrad
(C) Staphylococci (D) Sarcina

129. Find the characteristic true for Gram +ve bacteria: (2017-Retake)
(A) Periplasmic space present in all
(B) Two major layers
(C) Less lipids than Gram -Ve
(D) Outer membrane present

130. DNA of bacteria is present in: (2017-Retake)
(A) Nucleoid (B) Mitochondria
(C) Nucleus (D) Mesosome

131. If lipopolysaccharides did not appear in the wall of bacteria on staining, then it will be known as: (2018)
(A) Gram negative (B) Gram positive
(C) Capsule (D) Both A & B

132. Rod shape bacteria are known as: (2018)
(A) Spirilla (B) Spirochete
(C) Bacilli (D) Cocci

133. Select the method which cause the oxidation of constituent of bacterial cells: (2020)
(A) Steam (B) Filtration
(C) Dry heat (D) Radiation

134. Which of the following is true about the structure of typical bacterium? (2020)
(A) It has a cell wall
(B) It has a genetic material
(C) It has a cytoplasm
(D) All of the above

135. Which of the following is a prokaryote? (2022)
(A) Protista (B) E.coli
(C) Amoeba (D) Fungi

136. Number of layers present in Gram negative bacterial cell wall: (2022)
(A) One (B) Three
(C) Two (D) Four

137. The division of cocci in three planes from sarcina, which is cube of _____ cocci? (2022)
(A) 2 (B) 4
(C) 8 (D) 16

138. Which of the following statement is correct? (2022)
(A) Tuberculosis and Pneumonia is caused by gram positive bacteria
(B) Tuberculosis and Pneumonia is caused by gram negative bacteria
(C) Pneumonia is a lungs disease caused by gram negative bacteria
(D) Tuberculosis is a lungs disease caused by gram negative bacteria

139. Nitrifying bacteria are example of: (2022)
(A) Heterotrophic bacteria
(B) Chemosynthetic bacteria
(C) Saprophytic bacteria
(D) Parasitic bacteria

140. Cell wall of prokaryotic cell is composed of: (2023)
(A) carbohydrate
(B) carbohydrate and protein
(C) Protein

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(D) Protein and lipids

141. Which structure of prokaryotic cell will play the role of mitochondria: (2023)
(A) Spore (B) Nucleoid
(C) Cysts (D) Mesosome

142. Number of major layers of cell wall in gram positive bacteria: (2023)
(A) 1 (B) 2
(C) 3 (D) 4

143. The division of cocci in three planes from sarcina, which is cube of _____ cocci? (2023)
(A) 2 (B) 4
(C) 8 (D) 16

144. All of the following are disinfectants to control bacterial growth EXCEPT: (2023)
(A) Tincture of iodine
(B) Mercuric chloride
(C) Potassium permanganate
(D) Hydrogen peroxide

145. Which of the following is an example of spiral shaped bacteria: (2023)
(A) Diplococcus Pneumoniae
(B) Escherichia coli
(C) Hyphomicrobium
(D) Pseudomonas

146. Bacterial cell has ability to maintain its shape through: (2023)
(A) Cell wall (B) Capsule
(C) Slime (D) Cell wall & Slime

147. Helicobacter pylori is an example of: (2023)
(A) Cocci (B) Pleomorphic
(C) Bacilli (D) Spiral

148. Respiration in Pseudomonas bacteria is: (UHS 2024)
(A) Aerobic (B) Anaerobic
(C) Facultative (D) Microaerophilic

149. Prokaryotic cell lacks: (UHS 2024)
(A) Mesosomes
(B) Ribosomes
(C) Storage bodies
(D) Membrane bounded organelles

150. Bacterial genome become diploid: (UHS 2024)
(A) After fertilization of gametes
(B) Before Spore formation
(C) During binary fission
(D) After binary fission

151. One of the following is CORRECT regarding flagella in bacteria: (UHS 2024)
(A) Made up of microtubules
(B) Contain centriole
(C) Originate from basal bodies
(D) They are immotile

152. Which option is CORRECT about endospore: (UHS 2024)
(A) Has a short dormant period
(B) Contain moisture for survival
(C) Metabolically active
(D) Endures extreme conditions

153. Bacteria divide at exponential rate during which growth phase: (UHS 2024)
(A) Lag (B) Log
(C) Stationary (D) Decline

154. Mesosomes are the invagination of bacterial cell structure: (UHS 2024)
(A) Cell wall (B) Cell membrane
(C) Plasmid (D) Cysts

155. The Peptidoglycan cell wall is specific to: (ETEA 2024)
(A) Amoeba (B) Bacteria
(C) Protozoa (D) Virus

156. Bacteria that lack flagella are called (ETEA 2024)
(A) Amphitrichous (B) Atrichious
(C) Lophotrichous (D) Peritrichous

157. Antibiotics can be used against: (ETEA 2024)
(A) Herpes simplex (B) Influenza
(C) Polio (D) Salmonella typhi

158. Which of the following bacteria mostly produces Endospores (ETEA 2024)
(A) Both gram negative and positive bacteria
(B) Gram negative
(C) Gram positive
(D) Mycobacteria

159. _____ is used in the production of Humulin (ETEA 2024)
(A) Bacteria (B) Fungi
(C) Protozoa (D) Virus

160. Which of the following is NOT true about plasmids found in streptococci: (ETEA 2024)
(A) Carry fewer genes than the chromosome
(B) Replicate autonomously from the chromosome
(C) They are considered as genetic element
(D) The bacterial chromosome depends on plasmids for replication.

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Answer Key

1. B	2. A	3. C	4. B	5. C	6. D	7. D	8. C	9. C	10. B
11. A	12. D	13. B	14. A	15. B	16. C	17. D	18. A	19. D	20. B
21. A	22. A	23. B	24. A	25. A	26. B	27. A	28. A	29. B	30. D
31. D	32. A	33. A	34. C	35. B	36. A	37. C	38. B	39. B	40. C
41. B	42. B	43. A	44. C	45. D	46. A	47. D	48. C	49. C	50. B
51. B	52. A	53. A	54. D	55. B	56. B	57. D	58. A	59. D	60. B
61. A	62. C	63. B	64. C	65. B	66. C	67. D	68. B	69. B	70. A
71. D	72. D	73. B	74. A	75. A	76. C	77. A	78. A	79. B	80. C
81. A	82. C	83. A	84. B	85. C	86. A	87. D	88. A	89. B	90. C
91. B	92. A	93. D	94. C	95. B	96. C	97. B	98. C	99. B	100. A
101. D	102. C	103. C	104. C	105. B	106. B	107. B	108. D	109. D	110. C
111. A	112. C	113. B	114. D	115. D	116. A	117. D	118. A	119. B	120. A
121. D	122. A	123. D	124. C	125. D	126. B	127. D	128. A	129. C	130. A
131. B	132. C	133. C	134. D	135. B	136. C	137. C	138. A	139. B	140. B
141. D	142. A	143. C	144. A	145. C	146. A	147. B	148. A	149. D	150. C
151. C	152. D	153. B	154. B	155. B	156. B	157. D	158. C	159. A	160. D

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REPRODUCTION: KEY CONCEPTS

- Reproduction is a fundamental biological process through which living organisms produce offspring.
- It is essential for the survival of species and evolution of life on Earth.

Types of Reproduction

Features	Sexual Reproduction	Asexual Reproduction
Number of Parents	Two parents (male and female).	Single parent.
Gametes Involved	Involves the fusion of male and female gametes (fertilization).	No gametes involved.
Genetic Variation	Offspring are genetically diverse due to gene mixing.	Offspring are genetically identical (clones).
Reproductive Rate	Slower reproductive rate.	Rapid reproduction.
Examples	Fertilization (External and internal) in animals. Syngamy (Fertilization) in plants. Pollination in plants.	Binary Fission, Budding, Fragmentation, Sporulation (Spore Formation), Vegetative Propagation, Regeneration, Parthenogenesis, Cloning, Apomixis

MALE REPRODUCTIVE SYSTEM

- The male reproductive system includes **Gonads, Accessory ducts, Accessory glands** and **Copulatory organ (Penis).**

Gonads

- The testes are male gonads which are situated outside the abdomen within a skin pouch, called scrotum.
- Each testis is divided into **250-300 lobules** and each lobule contains **1-4** tightly coiled and highly complex duct system called **seminiferous tubules** which are the sites for **spermatogenesis.**
- **Testes** also act as **endocrine glands (produce testosterone).**
- **Seminiferous tubules** also contain **sertoli cells/nurse cells**, which provide liquid medium, protection and nourishment to sperms.
- **Sertoli cells** secrete **inhibit hormone** which serves to control the **spermatogenesis** at normal rate.
- **Interstitial cells/leading cells** are present between the seminiferous tubules and **secrete testosterone**, essential for **production of sperms** and development of **secondary sexual characteristics** during puberty.
- Both germinal epithelial cells and sterol cells are under the control of **FSH** while interstitial cells are under the control of **ICSH/LH.**

Male Accessory Ducts

Structure	Functions
Seminiferous Tubules	Produce sperm through the process of spermatogenesis.
Rete Testis	Collects sperm from seminiferous tubules and channels them to efferent ducts.
Efferent Ductulus	Transport sperm from the rete testis to the epididymis.
Epididymis	Matures and stores sperm temporarily before ejaculation.
Vas Deferens (Main sperm duct)	Carries mature sperm from the epididymis to the ejaculatory ducts.
Ejaculatory Ducts	Transports sperm and seminal fluid to the urethra.
Urethra (Urinogenital duct)	Serves as the passage for semen during ejaculation and urine during excretion.

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Urethra (Urinogenital duct)	Serves as the passage for semen during ejaculation and urine during excretion.

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Male Accessory Glands

Accessory Gland	Location	Function
Seminal Vesicles	Junction of sperm duct and ejaculatory duct.	Produces 60–70% of semen. Secrete an alkaline fluid rich in **fructose, prostaglandins, ascorbic acid** and **coagulating enzymes** (vesiculase) to nourish and enhance **sperm motility.**
Prostate Gland	Encircles the urethra just below the bladder.	Produces 20–30% of semen. Produces milky and slightly acidic fluid contains **citric acid, enzymes (hyaluronidase), zinc,** to **activate sperm** and liquefy semen.
Bulbourethral Glands (Cowper's Glands)	Junction of ejaculatory duct and urethra.	Produces 05–10% of semen. Secretes a **clear, mucus-like fluid** that lubricates and **neutralizes acidity** in the urethra.

Spermatogenesis

- Sperm formation in males. This process takes place in the **inner/germinal epithelium** of seminiferous tubules.
- The spermatogonia is divided by mitosis, forming a **primary spermatocyte** which undergoes **meiosis-I,** forming two smaller haploid daughter cells, called **secondary spermatocytes.**
- Each secondary spermatocyte after **meiosis-II** produces two daughter cells, called **spermatids.** Each spermatid is a round, non-motile, and haploid cell.
- **Spermiogenesis** is a process in which spermatids change into motile and active sperms. During this process, a **spermatid elongates, sheds its excess cytoplasm,** and **form a tail.**
- A normal **sperm count** is at least **15 million sperm** per milliliter of semen.

Spermatogonia (2n) →(Mitosis/Differentiation) →**Primary Spermatocyte (2n)** → (Meiosis I) → **Secondary Spermatocyte (n)** → (Meiosis II) → **Spermatids (n)** → (Spermiogenesis/Differentiation) → **Spermatozoa/sperm (n)**

Hormonal Control of Male Reproductive System

Feature	GnRH	FSH	LH/ICSH	Testosterone	Inhibin
Released from	Hypothalamus	Anterior Pituitary	Anterior Pituitary	Leydig Cells	Sertoli Cells
Chemical Nature	Polypeptide	Glycoprotein	Glycoprotein	Steroid	Protein
Role	Control the release of pituitary gonadotropins	Stimulate spermatogenesis stimulate sertoli cells	Stimulates Leydig cells to release testosterone	Growth and development of germinal epithelium	Control the spermatogenesis at normal rate

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Structure of Sperm	
Part	**Description**
Head	Contains the nucleus (carries genetic material) and an acrosome cap. The acrosome (derived from the Golgi apparatus) contains enzymes (e.g., hyaluronidase) to penetrate the egg (Fertilization).
Neck	A short region connecting the head and midpiece, containing a centriole (plays a role in the initial division of the fertilized egg).
Midpiece	Contains numerous mitochondria arranged spirally around the axial filament. Provides energy (ATP) for sperm motility by oxidative phosphorylation.
Tail (Flagellum)	A long, whip-like structure made of microtubules in a 9+2 arrangement. It Propels the sperm forward, enabling movement toward the egg.

FEMALE REPRODUCTIVE SYSTEM

- The reproductive role of the female is **more complex** than male.
- She not only has to **produce gametes**, but her body must be **prepared to nurture** a developing embryo for a period of approximately **nine months.**

Gonads (Ovaries)

- Ovaries are female gonads which **produce ova** and **release hormones.**
- The **paired ovaries** flank the uterus on each side and each ovary is held in place within the **peritoneal cavity** by **several ligaments.**
- The ovaries are solid, **ovoid structures**. Within the ovary are many **tiny sac-like** structures called **ovarian follicles**, each of which consists of an immature egg, called an **oocyte.**
- In adult women, one of the ripening follicles ejects its oocyte from the ovary **(turn by turn)** in each month. This event is called **ovulation.**
- Normally, **12 eggs** produced by **human female** in **a year, 6** by **each ovary.**

Oviducts (Fallopian Tube / Uterine Tube)

- The oviducts form the **initial part** of the female duct system. They receive the ovulated oocyte and are the site where **fertilization** generally occurs.
- It transfers developing ovum from ovary towards the uterus.

Uterus (Womb)

- The uterus or womb is a hollow, **muscular organ**, shaped somewhat like an **inverted pear**. The uterus has **three portions: the fundus, the body** and **the cervix.**
- The oviducts join the uterus just below the fundus & the opening of the cervix leads to the vaginal canal.
- Cervix is a narrow entrance to the uterus from the vagina. It is normally blocked by a plug of mucus.

Layers of Uterus wall	
Layer	**Description**
Perimetrium	Outermost thin serous membrane derived from the peritoneum.
Myometrium	Myometrium is the middle thick muscular layer composed of bundles of Myometrium smooth muscle, which contracts rhythmically during childbirth and menstrual cramps.
Endometrium	The endometrium is the inner spongy lining of the uterine cavity. It Supports implantation of the fertilized egg and forms the maternal part of the placenta. The main functions of uterus are to receive, retain, and nourish a fertilized ovum. **Stratum functionalis:** Sheds during menstruation. **Stratum basalis:** Regenerates the functional layer.

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Vagina (Birth Canal)

- The vagina (opening is called **vulva**) is a thin-walled long tube and extends from the cervix to the body exterior.
- It provides a **passageway for delivery** of an infant and for menstrual flow. The **urethra** is embedded in its anterior wall.

Oogenesis

- **Gametogenesis** in the female is known as oogenesis and result in the formation of ova/egg.
- Oogenesis **starts before birth** when oogonia divide mitotically to produce **primary oocytes.**
- A female fetus's ovaries contain about **7 million oocytes** by the **5th month of pregnancy**. Most of oocyte degenerates and about **1-2 million at birth. At puberty** the number of oocytes decrease to **300,000** and only **500 oocytes mature** into eggs during women's life. No new oocytes are created after birth.
- These primary oocytes are enclosed in groups of **follicle cells.**
- **Primary oocytes** undergo meiosis-I but are **arrested at prophase-I (longest arrest 13-14 years)**
- At puberty, primary oocyte completes **meiosis-I** and gives rise to **haploid secondary oocyte** along with **1st polar body.**
- **Secondary oocyte** undergoes **meiosis-II** but arrested in **metaphase-II** (for few days) . It is released in this stage from ovary and does not proceed further until fertilization.
- If **fertilization occurs**, then secondary oocyte divides to form **ovum** and **2nd polar body.**
- In human female only one ovum is usually discharged from the ovary at one time, this phenomenon is called **ovulation.**

Primordial Germ Cells → **Oogonia (2n)** → (Mitosis) → **Primary Oocyte (2n)** → (Arrested in Prophase I until puberty) → Primary Oocyte (2n) → (Meiosis I completes at puberty) → **Secondary Oocyte (n) + First Polar Body (n)** → Secondary Oocyte (n) → (Arrested in Metaphase II until fertilization) → (If fertilization occurs) → **Ovum (n) + Second** Polar Body (n)

Overview / Summary of Gametogenesis in Humans

Features	Spermatogenesis	Oogenesis
Location	Occur in testes	Occur mainly in ovaries
Meiotic Division Results in	Equal division of cytoplasm	Unequal division of cytoplasm
Number of Gametes Produce	Four	One egg and two to three polar bodies
Size of the Gamete	Relatively smaller	Relatively larger
Duration	Un-interrupted process	Interrupted process
Onset	Begins at puberty	Begins during fetal life
Release of gametes	Continuous	Monthly (From puberty till menopause)
End	Lifelong (But reduces with age)	Terminates with menopause
Growth phase	Short	Prolonged
Gamete Motility	Yes	No

MENSTRUAL CYCLE / FEMALE REPRODUCTIVE CYCLE

- In female, production of **egg** is a **cyclic activity** as compared to male.
- Oestrous cycle is reproductive cycle in all mammalian female except humans. In human female, it is called menstrual cycle.

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REPRODUCTION

- Menstrual cycle **involves changes in the structure and function of the whole reproductive system.**
- Ovulation and menstruation occur at puberty.
- **Menarche (11-13 age)**: Start of menstrual cycle is called.
- **Menopause (45-55 age):** Complete stop or end of menstrual cycle.
- This cycle is completed in approximately 28 days (average of 21-35 days).
- The events of the menstrual cycle involve the ovaries **(ovarian cycle)** and the uterus **(uterine cycle).** Events of menstrual cycle are regulated by **pituitary gonadotropins (FSH & LH).**

Ovarian Cycle

Phase	Time Frame	Key Events
Follicular Phase (Pre-Ovulatory phase)	Days 1–13	Development and maturation of Follicles , driven by FSH. Dominant follicle forms and secretes estrogen.
Ovulation	Day 14 (mid-cycle)	Mature follicle (Graafian follicle) ruptures, releasing a secondary oocyte triggered by LH.
Luteal Phase (Post-Ovulatory phase)	Days 15–28	Ruptured follicle transforms into the corpus luteum, which secretes progesterone (Maintains the endometrium for implantation.)

Uterine Cycle

Phase	Time Frame	Key Events
Menstrual Phase	Days 1-5	➢ In this phase, the **uterus sheds** all but the deepest part of its endometrium. ➢ The thick, hormone-dependent functional layer of the endometrium detaches from the uterine wall, a process that is accompanied by bleeding for **3-5 days.** ➢ The detached tissue and blood pass out through the vagina as the **menstrual flow.** ➢ At the beginning of this stage, ovarian hormones are at their lowest normal levels and gonadotropins are beginning to rise. Then FSH level begins to rise.
Proliferative Phase	Days 6-14	➢ Follicle stimulating hormone **(FSH)** during the first days of the cycle stimulates few ovarian follicles. ➢ Only one follicle develops, and rest stops to grow and finally disintegrate **(follicle atresia),** while one dominant follicle in the ovary continue to mature and becomes mature follicle **(Graafian or vesicular follicle),** in which oogenesis occurs. ➢ FSH also stimulates the graafian follicle to **secrete estrogen** which in turn governs the **vascularization of endometrial** lining of uterine wall. ➢ Estrogen has **negative feedback upon FSH,** therefore, as the concentration of estrogen rises the level of FSH falls. This is a signal for anterior pituitary to release LH. ➢ At the end of the proliferative stage (day 14) LH causes ovulation which takes less than five minutes. ➢ LH also converts the ruptured follicle to a **yellowish glandular mass** called **corpus luteum.**

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Secretory phase	Days 15–28	➢ During the secretory phase, the **endometrium prepares** for implantation of an embryo. ➢ **Rising levels of progesterone** from the corpus luteum act on the endometrium, causing the arteries to extend and converting the functional layer to a **glandular secretory layer** ➢ The uterine glands enlarge, coil and begin secreting nutritious glycogen into the uterine cavity. ➢ **If fertilization does not occur**, the corpus luteum begins to degenerate towards the end of the secretory phase as LH blood levels decline. ➢ **Progesterone levels fall**, depriving the endometrium of hormonal support and endometrial cells die, setting the stage for menstruation to begin on 28th day.

Feature	Oestrous Cycle	Menstrual Cycle
Occurrence	All mammals except human	Human female
Release of Estrogen	At low level	At higher level
If fertilization does not occur	Resorption of endometrium	Destruction and discharge of endometrium (Menstrual flow)
Ovulation	Requires physical stimulus of mating	Under hormonal control

BIRTH

Total gestation period (Pregnancy) is usually **280 days** (Count from the last Menstrual period / LMP) or **266 days** (Count from the date of conception).

- **Placenta** is a temporary, disc-shaped organ that forms during pregnancy and connects the developing fetus to the mother's uterus. There is **no mixing of fetal and maternal blood** in placenta and exchange takes place by **diffusion.**
- **Placentation** involves contributions from both the **mother** and the **fetus.**
- **Fetal Contribution**: The **chorion** (outermost fetal membrane) develops finger-like projections called **chorionic villi** that invade the maternal endometrium.
- **Maternal Contribution**: The **decidua basalis** (part of the endometrium directly under the embryo) interacts with chorionic villi to form the maternal portion of the placenta.
- **Umbilical cord** is a flexible, tube-like structure that connects the developing fetus to the placenta. It serves as the lifeline between the mother and the fetus, facilitating the exchange of nutrients, oxygen, and waste products. It contains **Two Umbilical Arteries**: Carry deoxygenated blood and waste from fetus to placenta and **One Umbilical Vein**: Carries oxygenated blood and nutrients from placenta to fetus.
- During fetal development, **pituitary gland** produces **LTH** and **placenta** secrete **placental lactogen**, both stimulate mammary development for **lactation.**
- From the beginning of **3rd month** of pregnancy, human embryo is referred to as the **fetus.**
- Most of the **major organs** formed by the **12th week** of pregnancy and remainder of gestation period are taken up by growth.
- Decrease in progesterone level in mothers' blood is the **onset of Birth.**

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Hormonal Involvement in Birth (Positive feedback)

Fetal Pituitary gland → ACTH → Adrenal gland (fetus)→ Corticosteroids → crosses the placenta → enter mothers' blood → Decrease progesterone production → stimulate mother Pituitary gland→ Oxytocin production → Induce labor pain→ Contraction of uterus wall→ Production of prostaglandin→ Enhance uterine contractions further→ Relaxin softens the cervix and pelvic ligaments → Baby delivered

- Umbilical cord (naval string) ligated, and baby is detached from mother.
- Within **10-45 minutes** after birth, the uterus contracts and separates the placenta from the wall of uterus then passes out through the vagina. This is called **after birth.**
- Average **loss of blood** is about **350 cm^3.**

IN.VITRO FERTILIZATION / TEST TUBE BABIES

- It means fertilization outside of the female body and is the most effective types of assisted reproductive technology.
- It is often used when a woman's fallopian tubes are blocked or when a man produces few sperms.
- This technique involves fertilizing one or more eggs outside the body and then transferring the fertilized eggs/pre-embryos back into the uterus.

Procedure

i. Isolation of Eggs

- In this procedure, the ovary is stimulated with a drug, (having fertility FSH) to produce several eggs.
- Eggs can be collected from the follicle by sucking out the fluid contents of mature follicles with a fine hollow needle which is inserted through the abdominal wall under general anesthetic.

ii. Collection of Sperms

- Sperms are collected from the male partner and washed in a culture fluid to remove seminal fluid.

iii. Fertilization

- About 100,000 healthy sperms are added to each egg about six hours after egg collection. This is done in a glass dish or tube. The fertilized eggs are grown for about two days, after which they are usually at 2 to 8 cell stage.

iv. Implantation into the Uterus

- After examination under the microscope, the embryo is transferred through the cervix into the uterus using a fine plastic tube.
- She is subsequently treated with progesterone to promote favorable uterine environment for implantation of embryos.

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SEXUALLY TRANSMITTED DISEASES

Feature	Gonorrhea	Syphilis	Genital Herpes	AIDS
Causative Agent	Gram-Negative Bacterium	Gram-Negative Bacterium (Spirochaete)	Virus	Virus
Name of pathogen	*Neisseria gonorrhoeae*	*Treponema pallidum*	Herpes simplex type II	HIV
Main parts Affected	Mucous membrane of urinogenital tract, eye infection to baby.	Damage to reproductive organs, eyes, bones, joints, CNS, heart, skin. Infection proceeds in 3 stages	Infection of genitalia, genital soreness & Wind ulcers, damage to eyes & CNS in infants.	Destruction of immune system
Source of Transmission	Sexual contact	Sexual contact	Sexual contact	Sexual contact
Treatment	Antibiotics	Antibiotics	Anti-viral drugs	Anti-viral drugs

DISORDERS OF REPRODUCTIVE SYSTEM

Causes of Male infertility

i. **Azoospermia:** State of no sperm at ejaculation. It may be caused if sperm ducts are blocked due to infection
ii. **Oligospermia:** Condition in males where the **sperm count is lower (below 15 million) than the normal** level.
iii. **Sperm deformities:** Change in shape of sperm.
iv. **Autoimmune disorder:** Immune **system backfires**, antibodies attack own sperms and reduce sperm count.

Causes of Female infertility

i. **Failure to ovulate:** Sometime the hypothalamus or **pituitary gland** fails to produce hormones normally, with the result that either no follicle develops **(lack of FSH)**, or egg release is affected **(lack of LH)**.
ii. **Endometriosis:** It is the condition where small piece of **endometrium start growing** in other places such as ovaries. This can be infertility because it becomes difficult for an egg to be released and become implanted to the womb (uterus).
iii. **Blocked oviduct:** In some females, the infertility is due to the disease, causing blockage of fallopian tube.
iv. **Uterus damage:** Fibroids are **benign** (non-cancerous) tumors that grow from the walls of the uterus, can cause infertility.
v. **Cervical mucus defects:** During ovulation, mucus in the **cervix becomes** thinner so that sperms can swim through it more easily. If there is a problem with the mucus, it can make it harder to conceive.

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1. Each testis consists of a highly complex duct system called:
(A) Ejaculatory ducts
(B) Seminiferous tubules
(C) Epididymis
(D) Sperm ducts

2. These increase in size and differentiate into primary spermatocytes:
(A) Secondary spermatocytes
(B) Spermatids
(C) Spermatogonia
(D) Sperms

3. In infected pregnant women, virus can be transmitted to infant during birth causing damage to eyes and CNS of the infant is:
(A) Gonorrhoa (B) Syphilis
(C) Genital Herpes (D) AIDS

4. Mature sperms are formed from spermatids through:
(A) Meiosis-I (B) Meiosis-II
(C) Mitosis (D) Differentiation

5. During human meiosis and fertilization which cells are diploid?
(A) Primary spermatocyte, primary oocyte, and zygote.
(B) oogonia, spermatid, egg
(C) Secondary oocyte, secondary spermatocyte, second polar body
(D) Secondary polar body, embryo, spermatogonia

6. How many Blood vessels are in the placenta:
(A) Two: One artery & one vein
(B) Three: two artery & one vein
(C) Three: One artery & two vein
(D) Four: two artery & two vein

7. In humans, which meiotic phase has the longest duration?
(A) Anaphase I in females
(B) Prophase I in females
(C) Prophase II in males
(D) Metaphase II in females

8. Which one of the following is a part of male reproductive system only:
(A) Urethra
(B) Bulbourethral gland
(C) Gonads
(D) Urinary bladder

9. Between the seminiferous tubules are____ which secrete _____:
(A) [illegible]
(B) Germ cells, testosterone
(C) Interstitial cells, testosterone
(D) Interstitial cells, oxytocin

10. What is the correct trajectory of sperm during ejaculation?
(A) Ejaculatory duct, epididymis, vas deferens, urethra
(B) Epididymis, ejaculatory duct, vas deferens, urethra
(C) Epididymis, vas deferens, ejaculatory duct, urethra
(D) Vas deferens, ejaculatory duct, urethra

11. Germ cells in the ovary produce:
(A) One oogonium (B) Many oogonia
(C) Infinite oogonia (D) Few oogonia

12. Oogonia divide mitotically to form:
(A) Secondary oocytes (B) Primary oocytes
(C) Ovum (D) Egg

13. These are enclosed in a group of follicle cells:
(A) Oogonia (B) Primary oocytes
(C) Secondary oocytes (D) Ova

14. After ovulation the ovum is transferred to:
(A) Uterus (B) Cervix
(C) Sperm duct (D) Oviduct

15. Both ovarian cycle and uterine cycle are regulated by pituitary:
(A) Somatotropins (B) Thyrotrophins
(C) Gonadotropins (D) Corticotrophins

16. What is spermiogenesis?
(A) A process happening in the sperm duct.
(B) Shedding of unnecessary cytoplasm.
(C) The process of meiosis in males.
(D) Selection of spermatogonia to become sperm.

17. Uterine tube opens into:
(A) Uterus (B) Cervix
(C) Vagina (D) Ovary

18. The fertilization of the ovum takes place in:
(A) Proximal part of oviduct
(B) Proximal part of ovary
(C) Distal part of oviduct
(D) Distal part of ovary

19. It enters the uterus, where it is implanted:
(A) Zygote
(B) Fertilization ovum
(C) Unfertilized ovum
(D) Fertilized ovum or zygote

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20. Which hormonal change is linked with the menses period of uterine cycle?
(A) Increased secretion of progesterone by the corpus luteum
(B) Decreased levels of progesterone and estrogen
(C) Increased levels of follicle stimulating hormone and luteinizing hormone
(D) Increased secretion of estrogen

21. Urethra and vagina have _____ openings to the exterior:
(A) Independent (B) Common
(C) Homologous (D) Multiple

22. How many chromatids and chromosomes should one expect to find in a secondary spermatocyte in a human?
(A) 46 chromatids, 46 chromosomes
(B) 23 chromatids, 23 chromosomes
(C) 92 chromatids, 46 chromosomes
(D) 46 chromatids, 23 chromosomes

23. The events of the ____ involve the ovarian cycle and the uterine cycle:
(A) Life cycle (B) Menstrual cycle
(C) Oestrous cycle (D) Uterine cycle

24. It stimulates the development of several primary follicles:
(A) LH (B) ICSH
(C) FSH (D) GH

25. It stimulates the endometrium and vascularizes it:
(A) LH (B) FSH
(C) Estrogen (D) Progesterone

26. It inhibits the FSH secretion but stimulates the LH secretion:
(A) Progesterone (B) Estrogen
(C) LTH (D) Prolactin

27. Which hormone is consistently positively correlated with thickening of the endometrium?
(A) FSH (B) LH
(C) Estrogen (D) Progesterone

28. Which structures are responsible for maintaining levels of Progesterone earlier and later in pregnancy?
(A) Placenta earlier and ovaries later
(B) Placenta earlier and umbilical cord later
(C) Corpus luteum earlier and placenta later
(D) Uterus earlier and ovaries later

29. If fertilization does not occur, it starts degenerating:
(A) Corpus luteum (B) Follicle
(C) Ovary (D) Uterus

30. Ovulation is timed to coincide with:
(A) Menstruation
(B) Conception
(C) Thickening of uterine walls
(D) Fertilization

31. In human female, periodic reproductive cycle is completed in approximately:
(A) 30 days (B) 27 days
(C) 28 days (D) 29 days

32. What would be a direct result of an enzymatic deficiency on the acrosome?
(A) Egg would not complete metaphase II
(B) Primary spermatocyte would not become secondary spermatocyte
(C) Implantation may occur in uterine tube
(D) Spermatid would not become primary spermatocyte

33. It harms the eyes of infant:
(A) Gonorrhea
(B) Syphilis
(C) Genital Herpes
(D) Gonorrhea and Genital Herpes both

34. It is caused by spirochaete, Treponema pallium:
(A) Syphilis (B) Genital Herpes
(C) AIDS (D) Gonorrhea

35. Which one of the following is caused by a retrovirus:
(A) AIDS (B) Gonorrhea
(C) Syphilis (D) Genital Herpes

36. During pregnancy hormones are responsible for maintaining pregnancy. What kind of event will lead to miscarriages during pregnancy?
(A) Increasing levels of estrogen
(B) Stimulation of progesterone secretory tissues
(C) Decreasing levels of oxytocin
(D) Early degeneration of corpus luteum

37. Maximum thickening of the uterine wall occurs in:
(A) Menstruation phase (B) Proliferative phase
(C) Secretory phase (D) Ovulation phase

38. The outermost layer of newly ovulated ovum is:

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(A) Zona pellucida (B) Corona radiate
(C) Chorioallantois (D) Amnion

39. In events of ovarian cycle, ovulation occurs before:
(A) Maturation of follicle
(B) Formation of early corpus luteum
(C) Regression of corpus luteum
(D) Development of follicle

40. If the reproductive cycle is not being completed in its normal 28 days, it means female is:
(A) Malnourished
(B) Emotionally disturbed
(C) Malnourished or/and emotionally disturbed
(D) Sterile

41. Gametogenesis in human male is:
(A) Repeated process till puberty
(C) Discontinuous process
(B) Cyclic process till puberty
(D) Continuous process

42. The spermatogonia are derived from:
(A) Testicular cells (C) Meristematic cells
(B) Germinal cells (D) Stem cell

43. Primary spermatocyte from spermatogonia is formed by:
(A) Ovulation (C) Meiosis II
(B) Meiosis I (D) Differentiation

44. Walls of seminiferous tubules are made of:
(A) Interstitial cells (B) Epithelial cells
(C) Endothelial cells (D) Vas efference

45. The condition for completion of meiosis II in female reproductive cycle:
(A) Menstruation (B) Ovulation
(C) Puberty (D) Fertilization

46. What main process occurs at proximal part of oviduct?
(A) Ovulation (B) Conception
(C) Fertilization (D) Menstruation

47. If fertilization occurs, corpus luteum:
(A) Starts degenerating
(B) Is maintained
(C) Starts regenerating
(D) Promotes ovulation

48. Luteinizing hormone causes rupturing of _____ to release ovum:
(A) Primary follicle (B) Corpus luteum
(C) Mature follicle (D) Ovary

49. Development and secretions interstitial cells is under the control of:
(A) Testis (B) Adrenals
(C) Pituitary (D) Testosterone

50. Germ cells is female reproductive system are present in:
(A) Genitalia (B) Ovaries
(C) Oviducts (D) Uterus

51. Premature birth or miscarriage can happen if secretion of _____ is disturbed:
(A) Progesterone (B) LH
(C) FSH (D) Oxytocin

52. The given figure shows a diagrammatic sketch of a portion of human male reproductive system. Identify the parts labelled as A, B and C and select the correct option:

(A) A – Seminal vesicle, B– prostate, C– bulbourethral gland
(B) A – seminal vesicle, B– bulbourethral gland, C– prostate
(C) A – ureter, B- prostate, C– bulbourethral gland
(D) A – ureter, B- prostate, C– seminal vesicle

53. Seminal plasma in humans is rich in:
(A) Fructose, Calcium and certain enzymes
(B) Fructose and certain enzymes but poor in calcium
(C) Glucose and certain enzymes but have no calcium
(D) Fructose and calcium but have no enzymes

54. Identify the parts labelled as A, B, C, d and E of the given diagram of a human sperm and select the correct option:

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(A) A-Plasma membrane, B- Aerosome, C-Nucleus, D- Neck, E- Mitochondria
(B) A- Acrosome, B- Plasma membrane, C-Centriole, D- Middle piece, E-Mitochondria
(C) A- Plasma membrane, B- Acrosome, C-Nucleus, D- Middle piece, E- Mitochondria
(D) A- Acrosome, B- Plasma membrane, C-Mitochondria, D- Tail, E- Centriole

55. **Uterus is linked by ovary with:**
(A) Vagina (B) Cervix
(C) Oviduct (D) Urethra

56 **Sperms are nourished & protected by fluid released by:**
(A) Bulbourethral glands (B) Sertoli cells
(C) Interstitial cells (D) Epididymis

57. **Sperm maturation and storage takes place within:**
(A) Oviduct (B) Epididymis
(C) Vas deferens (D) Seminiferous tubular

58. **Ovary produces Estrogen under the stimulus of:**
(A) LH (B) ICSH
(C) FSH (D) LTH

59. **Zona pellucida is the covering that surround:**
(A) Primary oocyte (B) Secondary oocyte
(C) Ovary (D) Sperm

60. **Progesterone develops the endometrium to make uterus receptive for:**
(A) Ovulation (B) Implantation
(C) Fertilization (D) Menstruation

61. **The first step in ovarian menstrual cycle is the release of:**
(A) LH (B) Estrogen
(C) FSH (D) Progesterone

62. **Seminiferous tubules open into:**
(A) Epididymis (B) Bladder
(C) Vas deferens (D) Urethra

63. **Corpus luteum is the _____ glandular structure:**
(A) White (B) Red
(C) Yellowish (D) Purple

64. **Ovulation takes place at ____ day of menstrual cycle:**
(A) 14th (B) 27th
(C) 20th (D) 28th

65. **Follicle atresia means _____ of the follicular cells:**
(A) Ovulation (B) Maturation
(C) Proliferation (D) Degeneration

66. **On puberty, development of primary follicles is stimulated by:**
(A) ICSH (B) LH
(C) FSH (D) Estrogen

67. **A type of cells in human testes which produce testosterone is called:**
(A) Interstitial cells (B) Sertoli cells
(C) Germ cells (D) Spermatocytes

68. **Breakdown of endometrium during menstruation is due to:**
(A) Increase in level of LH
(B) Increase in level of progesterone
(C) Decrease in level of progesterone
(D) Increase in level of estrogen

69. **Oogonia are produced in germ cells of:**
(A) Both uterus and cervix
(B) Uterus
(C) Cervix
(D) Ovary

70. **Syphilis is a sexually transmitted disease which is caused by:**
(A) Neisseria gonorrhea
(B) Pseudomonas
(C) Treponema pallidium
(D) Mycobacterium evium

71. **Discharge of ovum or secondary oocyte form ovary or from Graffian follicle is called:**
(A) Fertilization (B) Felliumferition
(C) Pollination (D) Ovulation

72. **Which one of the following differentiates directly into mature sperm?**
(A) Primary spermatocyte
(B) Spermatogonia
(C) Secondary spermatocyte
(D) Spermatid

73. **The oocyte released during ovulation is in:**
(A) Anaphase I (B) Metaphase I
(C) Prophase I (D) Metaphase II

74. **Causative agent of a sexually transmitted disease that affects mucous membrane of the urinogenital tract is:**
(A) Staphylococcus aureus
(B) Neisseria gonorrhea
(C) Treponema pallidum
(D) Escherichia coli

75. **All of the following are gland of male reproductive system except:**
(A) Prostate gland

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(B) Bulbourethral gland
(C) Seminal vesicle
(D) Corpus luteum

76. which one of the following hormones is essential for the successful production of sperms:
(A) LH
(B) Gonadotropin hormone
(C) Testosterone
(D) Follicle stimulating hormone

77. The fertilization of ovum takes place in the proximal part of the:
(A) Uterus (B) Oviduct
(C) Placenta (D) Urethra

78. Pregnancy is maintained by the:
(A) LTH (B) Progesterone
(C) Corticosteroids (D) LH and FSH

79. Following the fertilization the zygote will be found embedded in the:
(A) Ovary (B) Oviduct
(C) Uterus (D) Vagina

80. The tube in a male along which gametes travel from the testis to the urethra is called:
(A) Ureter (B) Vas deferens
(C) Penis (D) Fallopian tube

81. Spermatogenesis occurs in the male in the:
(A) Cowper's gland (B) Prostate gland
(C) Testis (D) Seminal tube

82. What one of the following structure / glands is responsible for the development of secondary sexual characteristic in female human being?
(A) Placenta (B) Ovary
(C) Thyroid (D) Uterus

83. Which of the following is mismatched?
(A) Interstitial cells: Testosterone production
(B) Seminiferous tubules: Sperm production
(C) Epididymis: Storage and maturation of sperm
(D) Sertoli cell: Secretion of Semen

84. FSH:
(A) Only in female (B) Produce sperm
(C) Controlled by GnRH (D) Both b & c

85. Energy source to the sperm is:
(A) Fructose (B) Glucose
(C) Ribose (D) Pentose

86. The function of Sertoli cells is _____ sperm:
(A) Protection
(B) nourishment in tubules of testis
(C) Fluid secretion
(D) All

87. A layer of cells around secondary oocytes is:
(A) Corona radiata (B) Chorion
(B) Zona pellucida (D) Both A and B

88. Uterus opens into vagina through:
(A) Cervix. (B) Oviduct.
(C) Urethra (D) Ureter

89. How does a zygote differ from an egg:
(A) More chromosomes
(B) Less chromosomes
(C) Consist of more cell
(D) Divide by meiosis

90. primary spermatocyte develops from:
(A) Spermatogonia (B) Germination
(C) Germinal layer (D) Hormones

91. Tests are lie outside of body in a sac called:
(A) Scrotum (B) Abdominal cavity
(C) Body (D) Sac

92. The cells of the germinal epithelium of the seminiferous tubules of testes by repeated cell division produce:
(A) Spermatocytes (B) Spermatids
(C) Sperms (D) Spermatogonia

93. The human testes contain within them a large number of:
(A) Uriniferous tubules
(B) Fallopian tubules
(C) Epididymis
(D) Seminiferous tubules

94. The female reproductive hormones secreted by human pituitary are commonly known as:
(A) Gonadotrophins (B) Somatotropins
(C) Estrogens (D) Androgens

95. Uterus of the human female opens into the:
(A) Urethra (C) Ureter
(B) Vagina (D) Cervix

96. The inner soft wall of the human uterus is called:
(A) Ectometrium (C) Exometrium
(B) Endometrium (D) Myometrium

97. In human how many Ova are usually discharged from the ovary at one time:
(A) One (C) Two
(B) Three (D) Four

98. The yellowish glandular structure, corpus luteum, starts secreting a hormone called:
(A) FSH (B) Progesterone
(C) Estrogen (D) Testosterone

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99. In-between seminiferous tubules there are interstitial cells which secrete hormone:
(A) Estrogen (B) Testosterone
(C) progesterone (D) Oxytocin

100. luteinizing hormone induces:
(A) Flowering (B) Ovulation
(C) Vernalization (D) Menopause

101. Fluid secreted by Cowper's gland provides sperms:
(A) Acidic (B) Protection
(C) Nourishment (D) Alkaline fluid

102. The discharge of blood and cell debris is known as:
(A) Menstruation (B) Bleeding
(C) Ovulation (D) Abortion

103. The end or complete stop of the menstrual cycle is called:
(A) Menarche (B) Genopause
(C) Menopause (D) Repopause

104. The follicles are broken down by a degenerative process known as:
(A) Follicle broker (B) Follicle atresia
(C) Follicle luteum (D) Follicle asteria

105. The release of Ovum from the follicle is called:
(A) Ovulation (B) Menstruation
(C) Follicle atresia (D) Menace

106. In male which gland secrete bulk of the semen (70 to 80%):
(A) Seminal vesicle (C) Bulbourethral
(B) Prostate (D) Cowper's

107. In which phase of human female menstrual cycle, endometrium prepares for the implantation of embryo?
(A) Proliferative phase
(B) Secretory phase
(C) Menstrual phase
(D) Ovulation phase

108. Events of menstrual cycle are regulated by the:
(A) Ethylene (B) Auxins
(C) Gonadotropins (D) Gibberellins

109. Syphilis is caused by:
(A) Spirochete (B) Water blooms
(C) Viruses (D) Cyanobacteria

110. In syphilis follow may damage:
(A) CNS (B) Bone joint
(C) Reproductive organ (D) All of these

111. Hormone responsible for the milk ejection after parturition:
(A) ICSH (B) Prolactin
(C) ACTH (D) Oxytocin

112. Oxytocin has receptor sites on:
(A) Uterus
(B) Mammary Glands
(C) Vagina
(D) Uterus and Mammary Glands

113. Which is associated with testosterone:
(A) Development of testis
(B) Increasing muscle and Bone mass
(C) Growth of body hairs
(D) All A, B, C

114. A cell produced at an early stage in the formation of spermatozoa:
(A) Spermatogonia
(B) Primary Spermatocytes
(C) Secondary spermatocytes
(D) Spermatids

115. Which produce androgen under pulsatile control of pituitary LH:
(A) Leydig cells (B) Anterior lobe
(C) Hypothalamus (D) Sertoli cells

116. In the 28 days human ovarian cycle, the ovulation takes place typically on:
(A) Day 5th of the cycle
(B) Day 14th of the cycle
(C) Day 7th of the cycle
(D) Day 27th of the cycle

117. If menstrual cycle in women is of 35 day long, then what would be the possible ovulation day?
(A) Day 10th of the cycle
(B) Day 14th of the cycle
(C) Day 21st of the cycle
(D) Day 28th of the cycle

118. Ovulation in the human female normally take place during the menstrual cycle:
(A) At the beginning of the proliferative phase
(B) Just before the end of the secretory phase
(C) At the end of the proliferative phase
(D) At the end of the secretory phase

119. Pick up diploid cell:
(A) Primary polar body

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(B) Secondary spermatocyte
(C) Secondary polar body
(D) Primary spermatocyte

120. The process of differentiation of a spermatozoa from a spermatid is known as:
(A) Spermatogenesis
(B) Spermatogenesis
(C) Spermiogenesis
(D) Gametogenesis

121. During gametogenesis in humans _____ undergo meiosis I:
(A) Spermatogonia
(B) Primary oocytes
(C) Oogonia
(D) Secondary spermatocytes

122. A steroid hormone involved in menstrual cycle is:
(A) FSH (B) Progesterone
(C) LH (D) Oxytocin

123. Conversion of secondary oocyte to ovum occurs via:
(A) Mitosis (B) Meiosis-II
(C) Meiosis-I (D) Differentiation

124. How many sperms are formed from a primary spermatocyte?
(A) 1 (B) 3
(C) 2 (D) 4

125. Following are the products of mitosis, meiosis-II and differentiation, respectively:
(A) Secondary spermatocytes, spermatids and sperms
(B) Primary spermatocytes, secondary spermatocytes, spermatids and sperms
(C) Spermatogonia, spermatids and sperms
(D) Primary spermatocytes, secondary spermatocytes, sperms and spermatids

126. It begins at puberty and lasts throughout life:
(A) Sperm Production
(B) Production and Release of Eggs
(C) Release of Sperms
(D) Production and Release of sperms

127. Which one of following cells have homologous pairs of chromosomes:
(A) Primary spermatocytes
(B) Spermatids
(C) Secondary spermatocytes
(D) Sperms

128. Which is non-motile, having one fourth of the amount of DNA as compared to spermatogonia cells:
(A) Primary spermatocytes
(B) Spermatids
(C) Secondary Spermatocyte
(D) Sperms

129. Ovum released from ovary during oogenesis is actually:
(A) Primary Oocyte (B) Oogonium
(C) Secondary Oocyte (D) Egg

130. _____ is to egg and _____ is to embryo:
(A) Ovary, Vagina (B) Ovary, Oviduct
(C) Oviduct, Uterus (D) Ovary, Uterus

131. Spirally twisted bacteria can cause _____STD:
(A) Gonorrhea (B) Syphilis
(C) Genital Herpes (D) AIDS

132. The sperm carrying away vessel from testes is:
(A) Vasa efferentia
(B) Seminiferous tubules
(C) Epididymis
(D) Rette testes

133. Estrogen, the female hormone is _____ in nature:
(A) Protein (B) Amino acids
(C) Steroid (D) Glycoprotein

134. How many mature eggs are typically produced by each ovary of a non-pregnant woman each year?
(A) 6 (B) 24
(C) 12 (D) 52

135. Which cell of the ovary undergoes meiosis during the development of egg?
(A) Germ cells (B) Primary oocytes
(C) Oogonia (D) Follicle cells

136. The sequence for the discharge of sperms is:
(A) Seminiferous tubules, vas deferens, epididymis, urethra
(B) Vas deferens, seminiferous tubules, epididymis, urethra
(C) Seminiferous tubules, epididymis, vas deferens, urethra
(D) Vas deferens, seminiferous tubules, urethra, epididymis

137. Spermatogonia differentiate directly into?
(A) Primary spermatocytes

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(B) Spermatozoa
(C) Secondary spermatocytes
(D) Spermatids

138. Corpus luteum develops under the influence of:
(A) Progesterone (B) Estrogen
(C) FSH (D) LH

139. Correct sequence of hormone secretion from beginning of menstruation is:
(A) FSH, progesterone, estrogen
(C) Estrogen, FSH, progesterone
(B) FSH, estrogen progesterone
(D) Estrogen, progesterone, FSH

140. Menstruation is caused by sudden reduction of the:
(A) Estrogen
(B) Progesterone
(C) Both but especially progesterone
(D) Both but especially Estrogen

141. A sac of skin that hangs from the body at the front of the pelvis, between the legs:
(A) Pouch (B) Marsupium
(C) Scrotum (D) Peritoneum

142. FSH stimulates the production of estrogen hormone which has two targets _____ and _____:
(A) Uterus, posterior pituitary
(B) Uterus, anterior pituitary
(C) Ovaries, uterus
(D) Ovaries, hypothalamus

143. During estrous cycle, which one causes ovulation in female:
(A) Physical mating (B) ICSH hormone
(C) Estrogen (D) Conception

144. A type of somatic cell around which spermatids develop in the tubules of the testis:
(A) Interstitial cells (B) Sertoli cells
(C) Leydig cells (D) follicle cells

145. Following is not a part of male reproductive system:
(A) Ureter (B) Epididymis
(C) Urethra (D) Ejaculatory duct

146. A scar on the surface of the ovary that is a remnant of ovulation:
(A) Corpus luteum (B) Corpus albican
(C) Corpus callosum (D) Corpuscles

147. Corpus luteum that develops after ovulation from ruptured follicle during luteal phase is ____ in nature:
(A) Endocrine (B) Exocrine
(C) Dual gland (D) Non-Secretory

148. Menstrual cycle is controlled by hormones of:
(A) Pituitary (B) Hypothalamus
(C) Pancreas (D) Ovary

149. Male sex cells that carry a man's genetic material.
(A) Spermatozoa
(B) Spermatogonia
(C) Spermatocytes
(D) Germinal epithelium

150. Maturation of spermatids into mature spermatozoa
(A) Spermiogenesis (B) Spermatogenesis
(C) Sperms activation (D) Gametogenesis

151. An organelle that develops over the anterior (front) half of the head in the spermatozoa (sperm cells) of many animals including humans
(A) Acrosome (B) Golgi apparatus
(C) Mitochondria (D) All A, B, C

152. Acrosome is a cap like structure which is derived from:
(A) Mitochondria (B) Golgi apparatus
(C) Lysosome (D) Ribosome

153. Reproduction is a means through which:
(A) Species tend to maintain themselves
(B) Is essential for population to survive
(C) May be source of genetic variations
(D) All of these

154. Pick up diploid cell:
(A) First polar body
(B) Secondary polar body
(C) Secondary oocyte
(D) Primary spermatocyte

155. Which of following cell undergo meiosis I:
(A) Spermatogonia
(B) Primary oocyte
(C) Oogonia
(D) Secondary spermatocytes

156. Conversion of secondary oocyte to ovum occurs via:
(A) Mitosis (B) Meiosis II
(C) Meiosis I (D) Differentiation

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157. Each secondary spermatocyte in the end gives rise to _____sperms:
(A) One (B) Two
(C) Three (D) Four

158. In Human female, ovulation stage of _____almost coincides with the initiation of secretory phase of_____ cycle:
(A) Uterine cycle, Ovarian cycle
(B) Ovarian cycle, Ovulation
(C) Ovarian cycle, Uterine cycle
(D) Uterine cycle, Menstruation

159. Which hormone make endometrium receptive for implantation of zygote:
(A) Estrogen (B) LH
(C) FSH (D) Progesterone

160. 100 primary spermatocytes after undergoing spermatogenesis give rise to:
(A) 100 sperms (B) 400 Sperms
(C) 200 Sperms (D) 500 Sperms

161. The first hormone stimulates the production of second hormone and second hormone inhibits the reproduction of first hormone. This phenomenon exists in:
(A) Estrogen and FSH respectively
(B) Progesterone and Estrogen respectively
(C) Estrogen and Progesterone respectively
(D) FSH and Estrogen Respectively

162. Longest phase of ovarian and uterine cycle is:
(A) Menstruation (B) Secretory
(C) Proliferative (D) Ovulation

163. Haploid male sexual cell formed after meiosis from spermatocytes that eventually matures into a spermatozoan:
(A) Spermatids
(B) Spermatogonia
(C) Primary spermatocytes
(D) Secondary spermatocytes

164. Pair of two convoluted tubular glands that lie behind the urinary bladder of mammals:
(A) Prostate gland (B) Seminal vesicle
(C) Cowper's gland (D) All

165. A walnut-sized gland located between the bladder and the penis:
(A) Prostate (B) Seminal vesicle
(C) Cowper's gland (D) None of these

166. Pea sized glands present inferior to the prostate gland in the male reproductive system:
(A) Seminal Vesicle (B) Prostate gland
(C) Cowper's gland (D) Testes

167. Everyday a healthy adult male makes about
(A) 50 million sperms
(B) 200 million sperms
(C) 600 million sperms
(D) 500 million sperms

168. Sertoli cells produce:
(A) LH (B) FSH
(C) Inhibin (D) LTH

169. In human female, the process of oogenesis starts:
(A) When individual is at the stage of puberty
(B) When the individual is at the stage of infancy
(C) When the individual is at the stage of foetus
(D) When individual is at the stage of childhood.

170. Which hormone is responsible for the development of male secondary sexual characteristics, such as body hair and deepening of the voice?
(A) Testosterone (B) Estrogen
(C) Progesterone (D) Prolactin

171. What is the function of the epididymis in the male reproductive system?
(A) Production of sperm
(B) Transport of sperm to the urethra
(C) Storage and maturation of sperm
(D) Secretion of seminal fluid

172. In humans, sperm production continues:
(A) Upto the end of puberty
(B) Upto the middle of old age
(C) Throughout the life
(D) Throughout the puberty

173. Which of the following structures produces the majority of seminal fluid?
(A) Prostate gland (B) Seminal vesicles
(C) Cowper's gland (D) Epididymis

174. Which of the following structures is responsible for regulating the temperature of the testes?
(A) Epididymis (B) Vas deferens
(C) Scrotum (D) Prostate gland

175. Which of the following hormones is responsible for stimulating the production of testosterone in the testes?
(A) Luteinizing hormone (LH)
(B) Follicle-stimulating hormone (FSH)

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(C) Estrogen
(D) Progesterone

176. Which male reproductive duct is responsible for the transport of urine and semen out of the body?
(A) Vas deferens (B) Seminal vesicles
(C) Prostate gland (D) Urethra

177. Which of the following male reproductive ducts is responsible for producing a clear, lubricating fluid that is released before ejaculation?
(A) Vas deferens (B) Seminal vesicles
(C) Prostate gland (D) Cowper's gland

178. Which of the following male reproductive ducts is responsible for adding alkaline fluid to the semen to neutralize the acidic environment of the vagina?
(A) Vas deferens (B) Seminal vesicles
(C) Prostate gland (D) Cowper's gland

179. What is the function of the acrosome in the sperm?
(A) It provides energy for movement.
(B) It contains enzymes that help the sperm penetrate the egg.
(C) It contains the genetic material.
(D) It helps to protect the sperm from the acidic environment of the vagina.

180. Which part of the sperm contains the genetic material?
(A) Head (B) Midpiece
(C) Tail (D) Acrosome

181. Which of the following processes occurs during spermiogenesis?
(A) The division of spermatogonia
(B) The division of primary spermatocytes
(C) The transformation of spermatids into spermatozoa
(D) The fusion of sperm and egg

182. During which phase of spermatogenesis does DNA replication occur?
(A) Spermatogonium phase
(B) Primary spermatocyte phase
(C) Secondary spermatocyte phase
(D) Spermatid phase

183. What is the name of the type of cell that gives rise to sperm during spermatogenesis?
(A) Spermatocyte (B) Spermatogonium
(C) Spermatozoon (D) Epididymis

184. Which of the following conditions occurs when the endometrial tissue grows outside of the uterus?
(A) Endometriosis (B) Ovarian cancer
(C) Cervical cancer (D) Uterine fibroids

185. What is the name of the phase in the menstrual cycle during which the endometrium is shed if fertilization does not occur?
(A) Ovulation (B) Proliferative phase
(C) Secretory phase (D) Menstrual phase

186. Which of the following hormones is responsible for thickening the endometrium in preparation for pregnancy?
(A) Estrogen
(B) Progesterone
(C) Follicle-stimulating hormone (FSH)
(D) Luteinizing hormone (LH)

187. What is the name of the muscular opening between the uterus and the vagina?
(A) Ovary (B) Fallopian tube
(C) Cervix (D) Endometrium

188. Which of the following structures in the female reproductive system is responsible for nourishing and protecting a developing fetus?
(A) Ovary (B) Fallopian tube
(C) Cervix (D) Uterus

189. Which of the following structures is responsible for producing eggs in the female reproductive system?
(A) Ovaries. (B) Uterus
(C) Fallopian tubes (D) Cervix

190. What is the name of the phase in the menstrual cycle when the uterine lining begins to thicken?
(A) Menstrual phase (B) Proliferative phase
(C) Secretory phase (D) Ovulatory phase

191. Which of the following structures produces estrogen during the menstrual cycle?
(A) Ovaries (B) Fallopian tube
(C) Uterus (D) Cervix

192. What happens to the oocyte if it is not fertilized after ovulation?
(A) It is reabsorbed by the body
(B) It is expelled during menstruation
(C) It remains in the fallopian tube
(D) It becomes a corpus luteum

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193. In humans, oogenesis begins:
(A) Before birth
(B) During puberty
(C) At fertilization
(D) During menopause

194. What is the primary hormone produced by the corpus luteum?
(A) Luteinizing hormone (LH)
(B) Follicle-stimulating hormone (FSH)
(C) Estrogen
(D) Progesterone

195. Which of the following hormones is responsible for maintaining the uterine lining during the menstrual cycle?
(A) Luteinizing hormone
(B) Progesterone
(C) Follicle-stimulating hormone
(D) Estrogen

196. Which sexually transmitted disease is often characterized by a sore or ulcer at the site of infection?
(A) Genital Herpes (B) Gonorrhoea
(C) Syphilis (D) Chlamydia

197. Which sexually transmitted disease can be cured with antibiotics if caught early?
(A) Herpes (B) Gonorrhoea
(C) HIV (D) HPV

198. In IVF (In Vitro Fertilization), where is the fertilization of the egg by the sperm carried out?
(A) In the fallopian tube
(B) In the uterus
(C) In a laboratory dish
(D) In uterus

199. During oogenesis, each oocyte ultimately gives rise to:
(A) One viable ovum (B) Two viable ovum
(C) Three viable ovum (D) Four viable ovum

200. Seminal fluid contains:
(A) Fructose (B) Citrate
(C) Ascorbic acid (D) All of these

201. Major part of semen is secreted by?
(A) Prostate glands (B) Cowper's gland
(C) Seminal vesicles (D) Bartholin glands

202. Common duct formed by the union of vas deferens and duct from seminal vesicles is:
(A) Urethra
(B) Ejaculatory duct
(C) Epididymis
(D) Seminiferous tubules

203. Correct sequence of cell stages in spermatogenesis is:
(A) Spermatocytes, spermatids, spermatogonia, spermatozoa
(B) Spermatogonia, Spermatocytes, spermatids, spermatozoa
(C) Spermatocytes, spermatogonia, spermatozoa, spermatids
(D) Spermatogonia, Spermatocytes, spermatozoa, spermatids

204. How many secondary spermatocytes are required to produce 400 spermatozoa:
(A) 40 (B) 100
(C) 200 (D) 400

205. The actual genetic part of sperm is its:
(A) Head (B) Tail
(C) Middle piece (D) Whole of it

206. The lytic enzyme released by sperm is:
(A) Acrosome (B) Ligase
(C) Hyaluronidase (D) Testosterone

207. Which organelle take part in acrosome synthesis of sperm:
(A) Mitochondria (B) Golgi bodies
(C) Ribosomes (D) Centriole

208. Conversion of spermatid into spermatozoa is called:
(A) Spermatogenesis (B) Spermiogenesis
(C) Cytokinesis (D) Vitellogenesis

209. Which part of sperm provide energy for its movement?
(A) Tail (B) Head
(C) Middle piece (D) Acrosomes

210. Spermatogenesis is influenced by:
(A) FSH (B) LTH
(C) LH (D) TSH

211. How many ova and sperms will be formed from 100 secondary oocytes and 50 secondary spermatocytes:
(A) 25 Ova and 200 Sperms
(B) 100 Ova and 50 Sperms
(C) 100 Ova and 100 Sperms
(D) 100 Ova and 200 Sperms

212. Testosterone is secreted by:
(A) Mast cells (B) Sertoli cells
(C) Leydig cells (D) Kupffer cells

213. In the male human beings, sperm contain autosomes and:
(A) Only one Y-chromosome

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(B) Only one X-chromosome
(C) Both X and Y-chromosomes
(D) Either X or Y-chromosome

214. How many centrioles are normally found in a sperm:
(A) One (B) Two
(C) Many (D) None

215. Acrosome is a type of:
(A) Flagellum (B) Lysosome
(C) Enzyme (D) Ribosome

216. Which one is unpaired gland in male reproductive system:
(A) Seminal vesicle
(B) Prostate gland
(C) Cowper's gland
(D) Bulbourethral gland

217. Spermatogonia is formed by which cell division:
(A) Mitosis (B) Meiosis-I
(C) Meiosis-II (D) Amitosis

218. Spermatids is formed by which cell division:
(A) Mitosis (B) Meiosis-I
(C) Meiosis-II (D) Amitosis

219. Which of following represent a condition where the motility of sperm is highly reduced:
(A) Azoospermia (B) Polyspermy
(C) Oligospermia (D) Athenospermia

220. How many mature eggs are typically produced by both ovary of a nonpregnant women each year:
(A) 6 (B) 12
(C) 24 (D) 56

221. Menopause occurs in female at the age of:
(A) 55-60 Years (B) 50-55 Years
(C) 45-50 Years (D) 35-40 Years

222. In the absence of pregnancy, corpus luteum:
(A) Becomes active, secrete FSH and LH
(B) Degenerate after some time
(C) Is maintained by progesterone
(D) Produce a lot of oxytocin and relaxin

223. Withdrawal of which of the following hormone immediate cause of menstruation:
(A) FSH (B) LH
(C) Estrogen (D) Progesterone

224. Corpus luteum is found in:
(A) Ovary (B) Uterus
(C) Oviduct (D) Vagina

225. The phase of menstrual cycle in human female that lasts for 3-7 days is:
(A) Luteal phase (B) Follicular phase
(C) Menstruation (D) Ovulatory phase

226. Onset of menstruation is due to:
(A) Increase in level of progesterone
(B) Fall in level of progesterone
(C) Increase in level of FSH
(D) Increase in level of LH

227. Shortest phase in the menstruation cycle of women's is:
(A) Menses (B) Luteal phase
(C) Ovulatory phase (D) Follicular phase

228. Ovary secretes large quantity of estrogen during:
(A) Pregnancy
(B) Lactation
(C) Preovulatory period
(D) Postovulatory period

229. Vaginal orifice and urethral orifice open into:
(A) Vulva (B) Cervix
(C) Labia majora (D) Labia minora

230. Fertilization of sperm and ova take place in:
(A) Ampulla of oviduct
(B) Fimbriae of oviduct
(C) Isthmus of oviduct
(D) Uterus

231. Endometrium is the lining of:
(A) Vagina (B) Uterus
(C) Oviduct (D) Bladder

232. Which of the following statements is incorrect about menstruation:
(A) The menstrual fluid can easily clot
(B) During menstruation about 40ml blood is lost
(C) The beginning of the cycle is called menarche
(D) At menopause in the female, there is especially abrupt increase in gonadotrophin hormones

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233. A type of cells in human testes which produce testosterone is called: (2011)
(A) Interstitial cells (B) Sertoli cells
(C) Germ cells (D) Spermatocytes

234. Breakdown of endometrium during menstruation is due to: (2011)
(A) Increase in level of LH
(B) Increase in level of progesterone

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(C) Decrease in level of progesterone
(D) Increase in level of estrogen

235. Oogonia are produced in germ cells of: (2011)
(A) Both uterus and cervix
(B) Uterus
(C) Cervix
(D) Ovary

236. Luteinizing hormone triggers: (2011)
(A) Cessation of oogenesis
(B) Ovulation
(C) Breakdown of oocyte
(D) Development of zygote

237. Syphilis is a sexually transmitted disease which is caused by: (2011)
(A) HIV/ AIDS
(B) Treponema pallidum
(C) Pseudomonas pyogenes
(D) Neisseria gonorrhea

238. Discharge of ovum or secondary oocyte from ovary or from Graafian follicle is called: (2012)
(A) Fertilization (B) Pollination
(C) Ovulation (D) Menstruation

239. Second meiotic division in the secondary oocyte proceeds as far as: (2012)
(A) Metaphase (B) Prophase
(C) Telophase (D) Anaphase

240. Which one of the following differentiates directly into mature sperm? (2012)
(A) Primary spermatocyte
(B) Secondary spermatocyte
(C) Spermatid
(D) Spermatogonia

241. Uterus opens into the vagina through: (2012)
(A) Cervix (B) Fallopian tube
(C) Vulva (D) Oviduct

242. Spermatogonia differentiate directly into: (2013)
(A) Secondary spermatocytes
(B) Spermatozoa
(C) Spermatids
(D) Primary spermatocyte

243. Treponema pallidum causes: (2013)
(A) Gonorrhea (B) AIDS
(C) Syphilis (D) Genital Herpes

244. What is the location of interstitial cells in testis? (2013)
(A) Inside the seminiferous tubules
(B) Among germinal epithelial cells
(C) Around the tests
(D) Between the seminiferous tubules

245. A type of cells in human testes which produce testosterone are called: (2013)
(A) Sertoli cells (B) Germ cells
(C) Spermatocytes (D) Interstitial cells

246. The hormone produced from corpus luteum is: (2013)
(A) Prolactin
(B) Progesterone
(C) Follicle stimulating hormone
(D) Luteinizing hormone

247. Testosterone is produced by which one of the following: (2014)
(A) Sertoli cells (B) Interstitial cells
(C) Germinal epithelium (D) Spermatogonia

248. The oocyte released during ovulation is in: (2014)
(A) Anaphase I (B) Metaphase I
(C) Prophase I (D) Metaphase II

249. Yellow glandular structure formed after release of egg from follicle is called: (2014)
(A) Corpus callosum (B) Corpus luteum
(C) Graffian follicle (D) Follicle atresia

250. On puberty, development of primary follicles is stimulated by: (2014)
(A) ISCH (B) LH
(C) Estrogen (D) FSH

251. Causative agent of a sexually transmitted disease that affects mucous membrane of the urinogenital tract is: (2014)
(A) Staphylococcus aureus
(B) Neisseria gonorrhea
(C) Treponema pallidum
(D) Escherichia coli

252. In human testis, which structure is responsible for carrying sperm from inside the testis? (2015)
(A) Seminiferous tubules
(B) Seminal vesicle
(C) Urinogenital duct
(D) Vasa efferentia

253. In which part of female reproductive system fertilization takes place? (2015)
(A) Proximal part of oviduct
(B) Placenta
(C) Uterus
(D) Vagina

254. In females, FSH stimulates the ovary to

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produce: (2015)
(A) Progesterone (B) Estrogen
(C) Lactogen (D) Oxytocin

255. Syphilis, sexually transmitted disease is caused by: (2015)
(A) HIV
(B) Neisseria gonorrhea
(C) Treponema pallidum
(D) Type '2' virus

256. In which phase of human female menstrual cycle, endometrium prepares for the implantation of embryo: (2015)
(A) Proliferative phase (B) Secretary phase
(C) Menstrual phase (D) Ovulation phase

257. Events of menstrual cycle are regulated by the: (2016)
(A) Catecholamine
(B) Somatotrophins
(C) Gonadotrophins
(D) Adrenocorticotrophins

258. Decrease of FSH and increase of estrogen cause pituitary gland to secrete: (2016)
(A) Somatotropin
(B) Testosterone
(C) Luteinizing Hormone
(D) Spermatogonium

259. AIDS is caused by: (2016)
(A) Bacteria (B) Fungi
(C) Virus (D) Algae

260. Syphilis is a sexually transmitted disease and can also damage:(2017)
(A) Hair
(B) Peripheral nervous system
(C) Heart
(D) Birth canal

261. _____ is structure in female reproductive system where fertilization takesplace: (2017)
(A) Ovaries (B) Cervix
(C) Uterus (D) Oviduct

262. Which one of the following directly develops into sperms?(2017)
(A) Primary spermatocyte
(B) Secondary spermatocytes
(C) Spermatids
(D) Spermatogonia

263. FSH stimulates the production of estrogen hormone which has two targets____and: (2017)
(A) Uterus, posterior pituitary
(B) Uterus, anterior pituitary
(C) Ovaries, uterus
(D) Ovaries, hypothalamus

264. Which of the following hormone suppresses ovulation? (2017-Retake)
(A) Progesterone
(B) FSH
(C) Insulin
(D) Prolactin

265. Which of the following hormone causes ovulation? (2017-Retake)
(A) LH (B) Estrogen
(C) Progesterone (D) FSH

266. All of the following are the parts of male reproductive system except: (2017-Retake)
(A) Epididymis
(B) Cervix
(C) Seminiferous tubules
(D) Bulbourethral gland

267. Meiosis occurs in human females during: (2017-Retake)
(A) Ovulation
(B) Spermatogenesis
(C) Gametogenesis
(D) Spermiogenesis

268. Which of the following hormone acts on the uterus wall of thickening? (2018)
(A) Progesterone
(B) Zona pellucida
(C) Follicle stimulating hormone
(D) Oxytocin

269. Which hormone causes the contraction walls of uterus during the process of birth? (2018)
(A) FSH (B) STH
(C) Oxytocin (D) LTH

270. In human female egg is fertilized in: (2018)
(A) Ovary (B) Vagina
(C) Oviduct (D) Uterus

271. Which hormone is released in females in response to FSH from pituitary gland: (2018)
(A) Estrogen (B) ADH
(C) Oxytocin (D) Progesterone

272. Which of the following hormone stimulates the ovulation from the follicle into oviduct? (2019)
(A) Luteinizing hormone
(B) Follicle stimulating hormone
(C) Estrogen

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(D) Progesterone

273. **Inside ovary, primary oocyte divides through first meiotic division forming two haploid cells, secondary oocyte and: (2019)**
(A) Polar body (B) Follicle cell
(C) Oogonium (D) Ovum

274. **Which hormonal pair would maintain the endometrium and make it receptive for implantation of embryo? (2019)**
(A) Luteinizing hormone and progesterone
(B) Estrogen and follicle stimulating hormone
(C) Luteinizing hormone and follicle stimulating Hormone
(D) Estrogen and progesterone

275. **During spermatogenesis, the _____ which are haploid cells eventually mature into spermatozoa / mature sperms: (2019)**
(A) Secondary spermatocytes
(B) Primary spermatocytes
(C) Spermatogonia
(D) Spermatids

276. **Which of the following represents the changes that occur in the ovary and the uterus approximately every 28 days involving evolution with the breakdown and loss of the lining of the uterus? (2020)**
(A) Ovulation (B) Menstrual cycle
(C) Uterine cycle (D) Embryo formation

277. **Which of the following disease is sexually transmitted? (2020)**
(A) Tuberculosis (B) AIDS
(C) Dengue fever (D) Cholera

278. **Which of the following hormones of the pituitary gland regulate the menstrual cycle? (2020)**
(A) Follicle stimulating hormone and estrogen
(B) Luteinizing hormone and estrogen
(C) Follicle stimulating hormone and luteinizing hormone
(D) Estrogen and progesterone

279. **Each human testis is divided into: (2022)**
(A) 50-100 lobules (C) 200-300 lobules
(B) 150-200 lobules (D) 250-300 lobules

280. **Which cells in the human males are responsible for the release of testosterone? (2022)**
(A) Pituitary Gland
(B) Hypothalamus
(C) Sertoli cells
(D) Leydig cells or interstitial cells

281. **Fertilized ovum is implanted and undergoes further development in the: (2022)**
(A) Ovary (B) Uterus
(C) Oviduct (D) Cervix

282. **Level of luteinizing hormone (LH) is maximum in blood during which stage of menstrual cycle? (2022)**
(A) Menstrual stage (C) Ovulation stage
(B) Proliferative stage (D) Secretory stage

283. **Major source of transmission of syphilis is: (2022)**
(A) Blood transfusion
(B) Insect bite
(C) Contaminated water
(D) Sexual contact

284. **Production of Follicle-stimulating hormone (FSH) and Luteinizing Hormone (LH) from the pituitary gland of female is controlled by: (2023)**
(A) Ovary (B) Uterus
(C) Stimulated follicles (D) Hypothalamus

285. **The term menopause means: (2023)**
(A) Start of menstruation
(B) Start of ovulation
(C) Stop of ova production
(D) Degeneration of ovaries

286. **The function of hyaluronidase enzyme is: (2023)**
(A) Penetration of the sperm into the ovum
(B) Entrance of the sperm into the vagina
(C) Entrance of the sperm into the fallopian Tube
(D) Inactivation of sperms after their failure to fertilize ovum

287. **In human females, what is the small, pear-shaped, muscular, distensible, sac-like organ where gestation takes place? (2023)**
(A) Uterus (B) Kidney
(C) Fallopian tube (D) Stomach

288. **The labour pains to expel fetus are due to action of oxytocin on: (2023)**
(A) Endometrium (B) Myometrium
(C) Perimetrium (D) Ovaries

289. **Female reproductive system consists of all of the following except: (UHS 2024)**
(A) Ovaries
(B) Cervix
(C) Oviduct

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Answer Key

1. B	2. C	3. C	4. D	5. A	6. B	7. B	8. B	9. C	10. C
11. B	12. B	13. B	14. D	15. C	16. B	17. A	18. A	19. D	20. B
21. A	22. D	23. B	24. C	25. C	26. B	27. D	28. C	29. A	30. C
31. C	32. A	33. D	34. A	35. A	36. D	37. C	38. B	39. B	40. C
41. D	42. B	43. D	44. B	45. D	46. C	47. B	48. C	49. C	50. B
51. A	52. A	53. A	54. C	55. C	56. B	57. B	58. C	59. B	60. B
61. C	62. A	63. C	64. A	65. D	66. C	67. A	68. C	69. D	70. C
71. D	72. D	73. D	74. B	75. D	76. C	77. B	78. B	79. C	80. B
81. C	82. B	83. D	84. D	85. A	86. D	87. A	88. A	89. A	90. A
91. A	92. D	93. D	94. A	95. B	96. B	97. A	98. B	99. B	100. B
101. D	102. A	103. C	104. B	105. A	106. A	107. B	108. C	109. A	110. D
111. D	112. D	113. D	114. A	115. A	116. B	117. C	118. C	119. D	120. C
121. B	122. B	123. B	124. D	125. C	126. D	127. A	128. B	129. C	130. D
131. B	132. A	133. C	134. A	135. B	136. C	137. A	138. D	139. B	140. C
141. C	142. C	143. A	144. B	145. A	146. B	147. A	148. A	149. A	150. A
151. A	152. B	153. D	154. D	155. B	156. B	157. B	158. C	159. D	160. B
161. D	162. B	163. A	164. B	165. A	166. C	167. B	168. C	169. C	170. A
171. C	172. C	173. B	174. C	175. A	176. D	177. D	178. C	179. B	180. A
181. C	182. B	183. B	184. A	185. D	186. B	187. C	188. D	189. A	190. B
191. A	192. B	193. A	194. D	195. B	196. A	197. B	198. C	199. A	200. D
201. C	202. B	203. B	204. C	205. A	206. C	207. B	208. B	209. C	210. A
211. C	212. C	213. D	214. B	215. B	216. B	217. A	218. C	219. D	220. B
221. C	222. B	223. D	224. A	225. C	226. B	227. C	228. C	229. A	230. A
231. B	232. A	233. A	234. C	235. D	236. B	237. B	238. C	239. A	240. C
241. A	242. D	243. C	244. D	245. D	246. B	247. B	248. D	249. B	250. D
251. B	252. D	253. A	254. B	255. C	256. B	257. C	258. C	259. C	260. C
261. D	262. C	263. B	264. A	265. A	266. B	267. C	268. A	269. C	270. C
271. A	272. A	273. A	274. D	275. D	276. B	277. B	278. C	279. D	280. D
281. B	282. C	283. D	284. D	285. C	286. A	287. A	288. B	289. D	290. B
291. B	292. D	293. B	294. A	295. C	296. B	297. A	298. A	299. D	300. A
301. C	302. D	303. D	304. C	305. C	306. C	307. A	308. B	309. D	

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UNIT # 12

SUPPORT AND MOVEMENT

High Yield Content:

- Cartilage and Bones
- Divisions of Human Skeleton
- Types of Joints
- Arthritis and Gout
- Types of muscles
- Structure and Ultra-Structure of Skeletal Muscles
- Mechanism of Muscle Contraction

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"Support & Movement"

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SUPPORT & MOVEMENT: KEY CONCEPTS

- Human skeletal system consists of **Cartilage** and **Bones**. The skeleton acts as a framework that supports soft tissues.
- It allows **free movement** through the action of muscles across joints.
- The study of bones and cartilage is called **osteology**.

Difference Between Bone and Cartilage

Features	Cartilage	Bone
Definition	Relatively less rigid connective tissue than bones.	Most rigid connective tissue
Collagen	Loosely packed, and **type-II**	Densely packed, and **type-I**
Types	Three types ➢ Hyaline ➢ Elastic ➢ Fibrocartilage	Two Types ➢ Compact ➢ Spongy
Cells types	Only one type ➢ Chondrocytes	**Three types of cells** ➢ Osteoblasts (Bone Forming cells) ➢ Osteoclasts (Bone dissolving cells) ➢ Osteocytes (Mature Bone cells)
Blood vessels/supply	Absent	Present
Minerals	No deposition of minerals	Deposit minerals such as calcium, carbonates, phosphates etc.
External covering	Covered by perichondrium	Covered by periosteum
Reshaping	No	Yes
Healing	No	Yes
Presence	Some places like joints, external ears, trachea etc.	Almost all parts of endoskeleton

Types of Cartilage

Cartilage Type	Location	Functions
Hyaline Cartilage	Movable joints, nose, larynx and trachea, bronchi, costal cartilage,	Most abundant type in human body. Provides smooth surfaces for joint movement.
Elastic Cartilage	External ear/pinnae and the epiglottis.	Provides flexibility while maintaining shape and support
Fibrocartilage	Intervertebral discs, pubic symphysis, menisci of the knee,	Provides strength and shock absorption in areas of high compression and tension.

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Structural Parts of Bone

Parts	Description
Periosteum	Outer fibrous membrane covering the bone, rich in nerves and blood vessels
Endosteum	A membrane lining the inner surface of the bony wall.
Compact Bone	Dense, solid outer layer of the bone provides site for muscle attachment and deposited with calcium phosphate.
Spongy (Cancellous) Bone	Porous, lightweight inner layer, found at the ends of long bones and inside flat bones.
Diaphysis	Shaft of a long bone, made primarily of compact bone.
Epiphysis	Expanded ends of a long bone, composed of spongy bone covered by compact bone.
Medullary Cavity	Hollow space within the diaphysis, containing yellow bone marrow in adults.
Red Bone Marrow	Found in spongy bone, primarily in flat bones and the epiphyses of long bones.
Yellow Bone Marrow	Found in the medullary cavity of long bones.
Haversian Canals	narrow tube in bone that carries blood vessels and nerve fibers.

DIVISIONS OF HUMAN SKELETON

- There are about **350 bones** in an **infant** and **206** in **adult** human.
- The human skeleton is primarily divided into two divisions i.e., **axial skeleton (80 bones)** and **appendicular skeleton (126 bones)**.

Axial Skeleton

- Axial skeleton provides basic framework of body and includes those skeletal parts which are present along the central axis of the body, like **skull, vertebral column, rib cage and sternum.**
- Primary function of skull is **protection of brain**, while vertebral column provides protection to **spinal cord.** It has four curvatures.

Axial Skeleton

Major Parts	Sub-Parts		Bones
Head (29 bones)	Skull (22 bones)	Cranium / Brain box (8 bones)	• Paired (2): Parietal & Temporal bones • Unpaired (4): Frontal, Occipital, Sphenoid, Ethmoid
		Face (14 bones)	• Paired (6): Maxilla, Zygomatic, Nasal, Lacrimal, Palatine, Inferior Concha. • Unpaired (2): Mandible, Vomer
	Ear ossicles (6 bones)	_____	• 3 pairs, each associated with an ear • Malleus, incus, stapes **(smallest bone)**
	Hyoid Bone (1)	_____	• Small single bone which lies at the base of skull, below the tongue. • Does not articulate with any other bone.

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Vertebral Column (33 vertebrae, or 26 bones)		Cervical	➢ 7 vertebrae found in the neck region ➢ **Atlas** is the 1st cervical vertebrae while **Axis** is the 2nd cervical vertebrae.
		Thoracic	➢ **12 vertebrae** found in the chest region. ➢ These are ribs carrying vertebrae, having large spinous processes.
		Lumbar	➢ **5 vertebrae** and found in the abdominal region.
		Pelvic	➢ **9 vertebrae**, anterior 5 join to form **sacrum**. ➢ Sacrum articulates with the iliac bones of the hip bone to form the back of the pelvis. ➢ Posterior 4 joins to form coccyx **(tail bone)**.
Rib cage (24 bones/12 pairs of ribs)			➢ 12 pairs articulate posteriorly with thoracic vertebrae. ➢ 10 pairs of ribs connected anteriorly with sternum either directly or through costal cartilage. ➢ 7 pairs (1st to 7th pair) connect anteriorly with sternum directly **(True ribs)**. ➢ 3 pairs (8th, 9th and 10th) connect with be sternum through costal cartilages **(False ribs)**. ➢ 2 pairs (11th and 12th) are of **floating ribs** since they don't attach to the sternum ➢ The rib cage provides support for a semi- vacuum chamber called chest cavity.
Sternum/chest bone (1 bone)			➢ It is a flat bone that sits at the front of the chest and is connected to the ribs with cartilage.

Appendicular Skeleton

Major Parts	Bones
Pectoral Girdle (4)	➢ To scapula (Shoulder blade) ➢ To clavicle (Collar bone/ Beauty bone) connects scapula with sternum.
Upper limb/Fore limb (30x2)	➢ 1 Humerus (Upper arm), it is a long bone, the end of which has a spherical head, which fits into the **glenoid cavity**. ➢ 1 Radius and ulna (Forearm). **Radius** is a **outer bone** (on the thumb side) while **ulna** is long and slightly bigger bone and located on the **inner side** of the forearm. ➢ 8 carpals (Wrist bones), consist of two rows of eight short bones. ➢ 5 metacarpals, making up palm of the hand. ➢ 14 phalanges (Fingers/ Digits), each finger possesses three phalanges except thumb which comprises of two phalanges.
Pelvic Girdle (2)	➢ Pelvic girdle attaches the hind limb to the vertebral column and consists of 2 coxal / hip bones. ➢ Each **coxal bone** is formed by the fusion of three bones i.e., ilium, ischium and pubis. ➢ The two halves of the pelvic girdle are joined at the pubic symphysis. A cavity called **acetabulum** is also present.

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Lower limb/ Hind limb (30x2)	➢ 1 Femur (Upper leg) or the **thighbone** is a **longest** and **strongest** bone in the human body with a head, which fits into the acetabulum. ➢ **1 Patella (Knee cap)** is embedded in **long tendon** which runs over knee joint. ➢ 1 Tibia (Shin bone) and 1 fibula (Lower leg) ➢ **7 Tarsals (Heel)** which are tightly attached to form the ankle. ➢ **5 Meta-tarsals (Sole)** which articulates with the tarsals and phalanges to form the sole of the foot. ➢ 14 Phalanges (Digits/ Toes) are small bones which make up the toes. ➢ Each toe of the foot possesses three phalanges except big toe, which comprises of two phalanges.

Joints Formed by the Bones of Human Skeleton

Joint	Type	Formation
Shoulder Joint	Ball & Socket Joint	Head of humerus & glenoid cavity of scapula
Elbow Joint	Hinge Joint	Distal end of humerus and proximal ends of radius & ulna
Wrist Joint	Multistage Joint	Distal ends of radius & ulna and carpals
Hip Joint	Ball & Socket Joint	Head of femur & acetabulum of hip bone
Knee Joint	Hinge Joint	Distal end of femur and proximal ends of tibia & fibula
Ankle Joint	Multistage Joint	Distal ends of tibia & fibula & tarsals
Superior Radioulnar	Pivot Joint	Proximal ends of radius and ulna.

JOINTS

- A joint or articulation is a place where **two or more bones** and **cartilage come together.**
- The scientific study of the structure and function of joints is called **arthrology.**
- They give **mobility** to the **skeleton** and hold the skeletal parts together.

Classification of Joints

Features	Fibrous joints (Immoveable)	Cartilaginous joints (Slightly Immoveable)	Synovial joints (Freely Moveable)
Structure	Adjacent bones are directly connected to each other by fibrous connective tissue consisting of collagen	Adjacent Bones are united by fibrocartilage or hyaline cartilage	Ends of bones are covered with hyaline cartilage and held together by a capsule of dense fibrous surrounding, tube-like tissue. The joint capsule is composed of an outer layer of ligaments and inner lining of synovial membrane.
Joint cavity	Absent	Absent	Yes, specifically called synovial cavity and is filled with synovial fluid
Location	Bones of skull, Root of tooth and socket of jawbones	Costal cartilages that attach ribs with the sternum, pubic symphysis Between wrist and ankle bones	Hinge joint, Pivot joint, Ball and socket joint
Functions	Support and protection to delicate structures	Gliding of bones	Free movement of skeleton

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Types of Synovial Joints

Types	Description	Examples	Movements Allowed
Hinge Joint	➢ Cylindrical projection of one bone fits into a trough-shaped surface on another ➢ Allows movement in one plane (like a hinge). ➢ Pair of muscles are arranged in the same plane as that of joints.	Elbow, knee, ankle, and interphalangeal joints.	Single plane/Two directions Flexion and extension.
Ball & Socket Joint	➢ A spherical head fits into a cup-like socket. ➢ Two pairs of muscles, present perpendicular to each other.	Shoulder joint, hip joint.	Multiple planes/several directions Flexion, extension, abduction, adduction, rotation, circumduction.
Pivot Joint	➢ Allows rotation around a single axis.	Atlantoaxial joint (between atlas and axis), proximal radioulnar joint.	Rotation (e.g., shaking head).
Condyloid Joint	➢ An oval-shaped surface fits into an elliptical cavity.	Wrist joint, metacarpophalangeal joints (knuckles).	Flexion, extension, abduction, adduction, circumduction.
Saddle Joint	➢ Both surfaces are saddle-shaped and fit together.	Thumb joint (carpometacarpal joint of the thumb).	Flexion, extension, abduction, adduction, circumduction.
Plane (Gliding) Joint	➢ Flat or slightly curved surfaces allow sliding movements.	Intercarpal joints, intertarsal joints, acromioclavicular joint.	Gliding or sliding movements.

ARTHRITIS AND GOUT

- It is the **inflammation of joints** characterized by degeneration and damage to the joint tissue.
- The typical symptoms of arthritis include pain after walking which may later occur even at rest, creaki sounds in joints, difficulty in getting up from a chair and pain on walking up or down stairs.
- **Osteoarthritis** is a **progressive disease** in which the articular cartilages gradually soften and disintegrat It affects knee, hip and intervertebral joints.
- **Rheumatoid arthritis** is the result of an **auto-immune disorder** in which synovial membrane becom inflamed due to faulty immune system.
- **Gouty arthritis** results from a **metabolic disorder** in which an abnormal amount of uric acid is retained the blood and sodium urate crystals are deposited in the joints.

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MUSCLES

- Muscles are the specialized tissues of **mesodermal origin**.
- The study of muscles is called **myology**.
- The most distinguishing functional characteristic of muscles is their ability to **transform ATP into mechanical energy**.
- Earliest forms of muscles to be evolved are **smooth muscles** which are present throughout animal kingdom.
- **Cardiac muscles and skeletal muscles** are found only in vertebrates. Cardiac muscles have intercalated disc.
- They also function to hold body parts in postural positions, movement of body fluids and heat production.

Types of Muscles

Features	Smooth	Cardiac	Skeletal
Muscle appearance	Unstriped /Non-striated	Irregular stripes	Regular stripes/Striated
Cell shape	Spindle	Branched	Spindle or cylindrical
Number of nuclei	One per cell	One cell per	Many per cell
Speed of contraction	Slow	Intermediate	Slow to rapid
Fatigue	Not possible	Not possible	Possible
Contraction caused by	Spontaneous, stretch, nervous system, Hormones	Spontaneous	Nervous system
Voluntary Control	Usually no control	Usually no control	Have control
Location	Blood vessels, GIT, other hollow organs	Heart only	Associated with bones
Function	Controls movement of substances through hollow organs	Pumps blood	Moves the skeleton and heat production

STRUCTURE AND ULTRA-STRUCTURE OF SKELETAL MUSCLE

- The muscles that are **attached to the skeleton** and are associated with the **movement of bones** are called skeletal muscles.
- The skeletal muscles are **consciously controlled** and therefore, are called **voluntary muscles.**
- Generally, each end of the entire muscle is attached to bone by a bundle of **collagen**, non- elastic fibers known as **tendons.**

Feature	Tendon	Ligament
Nature	Less elastic connective tissue	More elastic connective tissue
Function	Attaches muscle to bone	Holds bones at joints

- **Epimysium:** The outermost layer of connective tissue that surrounds the entire skeletal muscle
- **Perimysium:** The connective tissue layer that surrounds and Muscle bundles (Fascicles).
- **Endomysium:** The thin layer of connective tissue that surrounds the individual muscle fibers (cells).

Structural scheme of skeletal muscles.

Skeletal muscles → Muscle bundles (Fascicles) → Muscle fibers/Cells → Myofibrils → Sarcomere (smallest contractile unit of muscle fiber) → **Myofilament** (Actin and Myosin).

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Skeletal Muscle Fibers

- Each muscle fiber is a long, cylindrical and **multinucleate** huge cell with a diameter of about **10-100**.
- **Sarcoplasm** of the muscle fiber is similar to the cytoplasm of other cells, but it contains usually **large amount of stored glycogen** and unique oxygen binding protein e.g. **myoglobin.**
- The sarcolemma of muscle fibres penetrates deep into the cell to form a hollow elongated tube, the **transverse tubule/T-tubule.**
- **Sarcoplasmic reticulum** is like endoplasmic reticulum but **devoid of ribosomes** so **SER**. These act as **store-house of Ca^{+2}.**

Myofibrils

- Each muscle fibre is seen to contain a large number of myofibrils, **1-2 um in diameter** that run in parallel fashion and extend entire length of cell.
- Myofibril has series of **dark and light bands.**
- **Dark band** is called **A-band** because it is **anisotropic** i.e., it can polarize visible light.
- **Light band** is called **I-band** because it cannot polarize visible light.
- Each A-band has a lighter stripe in its mid-section called **H-zone.**
- The H-zone is bisected by a dark line called **M-line.**
- The I-band has midline called **Z-line.**
- **Sarcomere** is the region of a myofibril between two successive Z-lines and is the **smallest contractile functional unit** of muscle fibres.

Ultra-structure of Myofilaments

- Myofilament is made up of thick and thin filament. The **central thick filaments** extend the entire length of the **A-band** while the **thin filaments** extend across the **I-band** and partly into A-band.

Thick Filament

- Thick filament is about **16 nm** in **diameter** and is composed of **myosin.**
- Each myosin molecule has a tail terminating in **two globular heads.**
- Each **thick filament** contains about **300 myosin** molecules bundled together with their tails forming the central part of the thick filament and their heads facing outward and in opposite directions at each end.
- **Myosin heads** are sometimes called **cross bridges** because they link the thick and thin myofilaments together during contraction.
- Each **myosin filament** is surrounded by **six actin filaments** on each end.

Thin Filaments

- Thin filaments are **7-8 nm thick** and are composed of three proteins e.g., actin, tropomyosin and troponin.
- The **actin molecules** are arranged in **two chains** which twist around each other like a twisted double strand of pearls.
- The **kidney-shaped** polypeptide subunits of actin, called **globular actin (G-actin)**, bear the active sites to which the myosin heads attach during contraction.
- Twisting around the actin chains are two strands of another protein, **tropomyosin.** When the muscle is at rest, the tropomyosin is disposed in such a way that it **covers the sites on the actin chain** where head of myosin becomes attached.
- The other major protein in thin filament is **troponin**. It is actually **three polypeptide** complexes and found at regular intervals on the thin myofilaments. One of these polypeptides **(TnI)** is an inhibitory subunit that binds actin; another **(TnT)** binds to tropomyosin and helps position it on actin. The third **(TnC)** binds with **calcium.**
- Both troponin and tropomyosin help control the myosin-actin interactions involved in contraction.

T-Tubules, T-System & Triad

- The **sarcolemma** of muscle fiber cell **penetrates deep** into the cell to form hollow elongated tube, the **transverse tubule or T-tubule**, the **lumen** of which is **continuous** with the **extracellular fluid.**

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- Thousands of T-tubules of each muscle cell are collectively called **T-system**. It extends and encircles the myofibril at the level of Z-line or A-I junction.
- The T-tubule and the terminal portion of the adjacent envelope of sarcoplasmic reticulum form **triads** at regular interval along the length of the fibril.

MECHANISM OF MUSCLE CONTRACTION

Sliding Filament Model

- In **1954, H. Huxley and A. F. Huxley** and their colleagues suggested a hypothesis to explain all **events** in **muscle contraction.**
- According to this model, the **thin filaments slide past the thick** ones so that actin and myosin filaments overlap to greater degree.

Events in Sliding filament model

- Z-line is brought close together
- I-band shortens
- The H-zone disappear
- In this process of contraction, the cross bridges of thick filament become attached to binding sites in the actin filament. The cross bridges then contract to pull the actin filament towards the center of the sarcomere.

Control of Cross Bridges

- Muscle contraction is initiated by nerve impulse arriving at the **neuromuscular junction**. All the fibers innervated by a single motor neuron are a motor unit and contract simultaneously.
- **Nerve impulse** from sarcolemma penetrates into the muscle fiber through **T-tubule**. Then it is carried through the T-tubule to the adjacent SR.
- The **calcium gates** of sarcoplasmic reticulum open releasing calcium in cytosol by passive transport.
- When Ca^{2+} **binds** with the **troponin molecules**, they cause them to move slightly. This has the effect of **displacing the tropomyosin** and **exposing** the binding sites for the **myosin head.**
- Once the **myosin head** has become **attached** to the **actin filament, ATP is hydrolyzed,** and the **cross** bridges goes to its cycle and result in muscle contraction.
- **Rigor Mortis** is stiffening of the body after death. Since ATP is required to break the bond between actin and myosin, which get deficient after death, thus the bridges can't be broken, and the body gets stiff.

Cross Bridge Cycle

Step	Event	Outcome
1	ATP binds to myosin	Myosin head detaches from actin, breaking the cross-bridge.
2	ATP hydrolysis	ATP is converted into ADP + Pi, causing the myosin head to cock into a high-energy position.
3	Myosin head binds to actin	Myosin head attaches to a new binding site on actin, forming a cross-bridge.
4	Power stroke	Release of ADP + Pi causes the myosin head to pivot, pulling the actin filament towards the center of the sarcomere (contraction).
5	ATP binds again	Myosin head detaches from actin and the cycle repeats.

All or None Response

- The contraction of each muscle fibre is based on 'all or none' principle i.e. all of its fibrils participate in contraction.
- However, the **degree of contraction** depends upon the **number of fibers** that participate in contraction.

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Energy for Muscle Contraction

- Energy for muscle contraction comes from **ATP**. Supply of ATP is maintained by the **aerobic breakdown of glucose** in muscle cell, which comes from stored glycogen in the cell.
- When more energy is required due to high metabolism, it is provided by another energy storing substance called **creatine phosphate.**
- Sometimes during oxygen deficiency or very high metabolic activity, such as prolonged or strenuous muscular activity, ATP requirement is met by **anaerobic breakdown of glucose** into lactic acid. Lactic acid accumulation cause **muscle fatigue.**
- **At rest, 1/5 of lactic acid is broken aerobically** and its energy is used to change the remaining **4/5 lactic acid** into glucose by **Cori Cycle** in **liver.**

Effect of Exercise on Muscles

- The amount of work a muscle does is reflected in changes in the muscle itself. For example;
  I. Increase in size of the muscle
  II. Increase in its strength
  III. More efficient and fatigue resistant
  IV. Capillaries surrounding muscle fibers and mitochondria in it increases
  V. Synthesize more myoglobin
- Complete immobilization of muscle leads to muscle weakness and severe **atrophy.**

Parts of Muscle

Part	Description
Origin	The **fixed attachment point** of a muscle to a bone, that remains relatively stationary when the muscle contracts.
Insertion	The insertion is where the muscle attaches to a bone that does **move** when the muscle contracts.
Belly:	The belly of a muscle is the **thickest or largest part** of the muscle that **contracts** and expands to allow movement.

Principle of leverage

Type	Description	Example
First Order Lever	The **fulcrum** is between **effort** and **load**. This type of lever allows for a balance of force or speed.	**Neck muscles** during head extension: The atlanto-occipital joint is the fulcrum, the effort is applied by the neck muscles, and the load is the weight of the head.
Second Order Lever	The **load** is between the **fulcrum** and the **effort**, providing a mechanical advantage by allowing a small effort to lift a large load.	**Wheelbarrow** or **Calf raise**: The ball of the foot is the fulcrum, the weight of the body is the load, and the effort comes from the calf muscles.
Third Order Lever	The **effort** is between the **fulcrum** and the **load**, which is more efficient for speed and range of motion but less efficient in lifting heavy loads.	**Biceps curl**: The elbow is the fulcrum, the biceps generate the effort, and the load is the weight in the hand.

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1. Which statement correctly identifies a similarity between cartilage and bone?
(A) Both are produced by specialized mesenchymal cells.
(B) Both are avascular
(C) Both are sites of haematopoiesis
(D) Both are innervated

2. It has branched cells:
(A) Cardiac muscles (B) Skeletal muscles
(C) Smooth muscles (D) Voluntary muscles

3. It has uninucleate cells with pointed ends:
(A) Cardiac muscles (B) Skeletal muscles
(C) Voluntary muscles (D) Smooth muscles

4. The collagen fibers of bones are hardened by the deposition of:
(A) Calcium carbonate
(B) Calcium phosphate
(C) Calcium silicate
(D) Calcium carbide

5. Following are the characteristics of a spongy bone EXCEPT:
(A) Rich in blood vessels (B) Light
(C) Porous (D) Strong

6. Muscles causing movement of food in stomach are:
(A) Striated (B) Un-striated
(C) Specialised (D) Cardiac

7. Which of the following is incorrect about visceral muscles?
(A) Non-striated muscle (smooth muscle)
(B) Located in inner walls of hollow visceral organs of the body
(C) Involuntary muscle
(D) They are under voluntary control

8. Smooth muscles help in:
(A) Transportation of food through the digestive tract
(B) Transfer of gametes through genital tract
(C) Micturition by urinary bladder
(D) All

9. Cardiac muscle is characterized by all, except:
(A) Striated appearance
(B) Involuntary control
(C) Branching pattern
(D) Attach with bones

10. The axial skeleton includes the skull, the vertebrae, the ribs and:
(A) Clavicle (B) Scapula
(C) Sternum (D) Pubis

11. It is made up of cranium and facial bones:
(A) Rib cage (B) Vertebral column
(C) Skull (D) Spine

12. Eight bones protect the brain and collectively give rise to:
(A) Cranium (B) Rib cage
(C) Skull (D) Vertebral column

13. Number of facial bones in human skeleton is:
(A) 08 (B) 29
(C) 14 (D) 06

14. Pick up the unpaired facial bone:
(A) Maxillary bone (B) Zygomatic bone
(C) Lacrimal bone (D) Vomer bone

15. Vertebral column has how many curvatures normally?
(A) Three (B) Four
(C) Five (D) Six

16. Nineteenth vertebra of human vertebral column belongs to:
(A) Cervical vertebrae (B) Thoracic vertebrae
(C) Lumbar vertebrae (D) Pelvic vertebrae

17. Posterior four vertebrae of pelvic region form:
(A) Coccyx (B) Pelvis
(C) Sacrum (D) Pubis

18. How many pairs of ribs are connected anteriorly and directly to the sternum:
(A) 8 pairs (B) 7 pairs
(C) 10 pairs (D) 12 pairs

19. Pectoral girdle comprises up of:
(A) Scapula, suprascapula and clavicle
(B) Sternum, scapula and clavicle
(C) Pelvic bone, sacrum and clavicle
(D) Sternum, clavicle and pelvic bone

20. Humerus forms ball and socket joint with:
(A) Radius (B) Ulna
(C) Scapula (D) Pelvic bone

21. Which of the following is NOT a function of the human skeletal system?
(A) Fatty acid storage
(B) Protection of organs
(C) Primary glycogen storage
(D) Calcium storage

22. The framework of palm of hand is formed by:
(A) Tarsals (B) Metatarsals
(C) Carpals (D) Metacarpals

23. Fusion of ileum, ischium and pubis gives rise to:
(A) Pectoral girdle (B) Pelvic girdle
(C) Coxal Bone (D) Coccyx

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24. The proximal end of femur makes a:
(A) Hinge joint
(B) Ball and socket joint
(C) Pivot joint
(D) Multistage joint

25. Our forehead consists of:
(A) Parietal bones (B) Temporal bones
(C) Occipital bones (D) Frontal bone

26. Cheek bone is scientifically called as:
(A) Lacrimal bone (B) Zygomatic bone
(C) Sphenoid bone (D) Ethmoid bone

27. The ceiling of our oral cavity consists of:
(A) Lacrimal (B) Mandible
(C) Palatine bones (D) Zygomatic bones

28. The inner membrane of synovial joint is:
(A) Fibrous capsule
(B) Synovial membrane
(C) Nucleus pulposus
(D) Annulus fibrosus

29. Ligament is a modified part of:
(A) Fibrous capsule
(B) Synovial membrane
(C) Nucleus pulposus
(D) Annulus fibrosus

30. The "Insertion" is attached to the:
(A) Moveable bone (B) Immoveable bone
(C) Porous bone (D) Compact bone

31. They provide maximum flexibility:
(A) Ball and socket joint (B) Hinge joint
(C) Pivot joint (D) Knee joint

32. Triceps and biceps are examples of:
(A) Voluntary muscles
(B) Skeletal muscles
(C) Striped muscles
(D) Voluntary, skeletal and striped muscles

33. These are huge cells:
(A) Skeletal muscle fibres
(B) Smooth muscle fibres
(C) Involuntary muscle fibres
(D) Cardiac muscle fibres

34. When viewed in high magnification, each muscle fibre is seen to contain a large number of:
(A) Muscle bundles (B) Muscle cells
(C) Myofilaments (D) Myofibrils

35. Diameter of a myofibril is:
(A) 1-2 μm (B) 10-100 μm
(C) 7-8 μm (D) 16 μm

36. Which type of synovial joint is multiaxial, allowing motion in more than one plane of movement?
(A) Plane Joint (B) Pivot Joint
(C) Saddle Joint (D) Hinge joint

37. Which of following is major organic component of bone:
(A) Keratin (B) Collagen
(C) Elastin (D) None

38. Which connective tissue connects and stabilizes adjacent bones:
(A) Cartilage (B) Tendons
(C) Ligaments (D) Fascia

39. It extends the entire length of the A-band of sarcomere called:
(A) Actin filaments
(B) Central thick filament
(C) Thin filaments
(D) Thin and thick filaments

40. Twisting around the actin chains are two strands of another protein:
(A) Troponin (B) Tropomyosin
(C) Myosin (D) Collagen

41. When cross bridges contract they pull the actin filament towards the:
(A) Centre of the sarcomere
(B) Ends of the sarcomere
(C) Right side of the sarcomere
(D) Left side of the sarcomere

42. When muscle is required to contract, calcium ions bind with the:
(A) Tropomyosin molecule
(B) Actin molecule
(C) Troponin molecule
(D) Collagen molecule

43. The lumen of the T-tubules of sarcolemma is continuous with:
(A) Intercellular fluid (B) Extracellular fluid
(C) Intracellular fluid (D) Lumen of the cell

44. Contractures or state of continuous contraction results because the cross bridges are unable to detach in:
(A) Cramp (B) Tetany
(C) Muscle fatigue (D) Tetanus

45. Select the correct matching form the following considering muscle fibre:
(A) Plasma membrane of muscle fibre - Sarcoplasm
(B) Cytoplasm of muscle fibre – Sarcolemma
(C) Endoplasmic reticulum of muscle fibre –

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Sarcoplasmic reticulum
(D) O_2 binding protein-Myoglobin and haemoglobin

46. The functional unit of the contractile system in the striped muscle is:
(A) Z band
(B) A band
(C) Myofibril
(D) Area between two Z-line

47. The dark bands of a skeletal muscle are known as:
(A) Isotropic bands (B) Anisotropic bands
(C) Intercalated disc (D) Cross bridges

48. Binding of Ca^{2+} with _____ in the skeletal muscles and leads to the exposure of the binding site for _____ on the filament _____:
(A) Troponin, myosin, actin
(B) Troponin, actin, relaxin
(C) Actin, myosin, troponin
(D) Tropomyosin, myosis, actin

49. Repeated activation of the muscles can lead to accumulation of _____ due to anaerobic breakdown of glycogen in there, cause fatigue:
(A) Ethanol (B) Lactic acid
(C) Citric acid (D) Butyric acid

50. Diameter of muscle fiber is:
(A) 1 µm – 2 µm (B) 7 µm – 8 µm
(C) 10 µm – 100 µm (D) 16 µm

51. Which filament changes its position during contraction?
(A) Thick (B) Myosin
(C) Thin (D) Tubulin

52. Aerobic exercise cause increase is:
(A) No. of mitochondria
(B) Myoglobin content of muscle
(C) No. of blood vessels
(D) All

53. Once the myosin head has become attached to the actin filament:
(A) ATP is synthesized, and the bridge goes to its cycle
(B) ATP is hydrolysed, and the bridge goes to its cycle
(C) ATP is synthesized, and the bridge becomes fixed
(D) ATP is hydrolysed, and the bridge becomes fixed

54. Tropomyosin is present around:
(A) Myosin (C) M-line
(B) Thick filament (D) Actin

55. Fatigue muscle gets normal after a time this is because:
(A) Muscle become tolerant to lactic acid after few minutes
(B) Muscle gets dehydrated
(C) Lactic acid is converted back to glucose
(D) Lactic acid is converted into muscle protein

56. In case of rigor mortis
(A) No glycogen available
(B) No lactic acid available
(C) No ATP available
(D) No SR available

57. During relaxation actin move:
(A) Away from center of sarcomere
(B) Actin do not move
(C) Toward center of Sarcomere
(D) Toward Z-line

58. Which of the following disappear?
(A) H zone (B) Myosin
(C) Actin (D) Ca^{+2}

59. Troponin can bind to all of the following except:
(A) Actin (B) Tropomyosin
(C) Myosin (D) Calcium

60. Which change does not occur during muscle contraction?
(A) I-band shortens
(B) A-band broadens
(C) H-zone disappears
(D) Z-lines come closer

61. Each myosin molecule has a tail terminating in:
(A) Two Globular heads (B) Two linear heads
(C) A globular head (D) A Linear head

62. The neurotransmitter that diffuses across a synapse and produces an impulse in the cell membrane of a muscle cell is _____:
(A) Acetylcholine (B) Epinephrine
(C) Serotonin (D) Dopamine

63. The thin filament is comprised of which three molecules?
(A) Troponin, tropomyosin, actin
(B) Tropomyosin, titin, actin.
(C) Troponin, tropomyosin, titan
(D) Actin, myosin, troponin.

64. When more energy is required in muscle contraction the energy can be produced through:
(A) Fructose (B) Glucose

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(C) Lactic acid (D) Phosphocreatine

65. **Which of these statements is correct regarding muscle contraction?**
(A) Calcium binds to tropomyosin for contraction
(B) Muscle contraction continues for long periods after nervous stimulation ceases.
(C) The cross bridges bind to the actin and shorten the sarcomeres
(D) Magnesium is needed to strengthen the contracting muscle cell.

66. **Myosin tail consists of _____ long polypeptide chains coiled together:**
(A) Two (B) Four
(C) Three (D) Multiple

67. **_____ is required to break cross bridges:**
(A) Ca^{+2} (B) ATP
(C) Contraction (D) Lactate

68. **The contractile protein of skeletal muscle involving ATPase activity as:**
(A) Tropomyosin (B) Myosin
(C) Alpha-actin (D) Troponin

69. **Mature bone cells are:**
(A) Osteoblast (B) Stem cells
(C) Osteoclast (D) Osteocytes

70. **Bone dissolving cells are:**
(A) Osteoblast (B) Stem cells
(C) Osteoclast (D) Osteocytes

71. **Early in development, when bone is replacing cartilage, the_____invade and dissolve the cartilage:**
(A) Osteoblast (B) Stem cells
(C) Osteoclast (D) Osteocytes

72. **As bone grows, the matrix of bone is hardened and the_____ are gradually entrapped with in it:**
(A) Osteoblasts (B) Stem cells
(C) Osteoclasts (D) Osteocytes

73. **The ends of a bone on a joint are covered by:**
(A) Hyaline cartilage (B) Fibro cartilage
(C) Elastic cartilage (D) Tendon

74. **The flexible part of nose and ear pinnae are made up of:**
(A) Tendon (B) Ligament
(C) Elastic cartilage (D) Hyaline cartilage

75. **The living cells of cartilage are called:**
(A) Thrombocytes (B) Erythrocytes
(C) Osteocytes (D) Chondrocytes

76. **The collagen that surrounds the chondrocytes is secreted by:**
(A) Thrombocytes (B) Erythrocytes
(C) Osteocytes (D) Chondrocytes

77. **The most abundant type of cartilage in human body is:**
(A) Tendon (B) Ligament
(C) Hyaline cartilage (D) Elastic cartilage

78. **A connective tissue attaching bone with a bone is called:**
(A) Tendon (B) Ligament
(C) Hyaline cartilage (D) Elastic cartilage

79. **Number of bones in human skull in?**
(A) 8+14 (B) 14+10
(C) 22+4 (D) 14+7

80. **Type of muscle having regular striations and many nuclei per cell?**
(A) Smooth muscles (B) Cardiac muscles
(C) Skeletal muscles (D) Cartilage muscles

81. **Pick correct order of sequence of vertebrae according to their location in the body?**
(A) Cervical, Thoracic, Lumbar, Pelvic
(B) Thoracic, Lumber, Cervical, Pelvic
(C) Lumber, Thoracic, Cervical, Pelvic
(D) Cervical, Thoracic, Pelvic, Lumbar

82. **Total number of free ribs is:**
(A) 12 (B) 10
(C) 4 (D) 3

83. **Which of following is correct number of forelimb bones with respect to the arrangement?**
(A) 8 carpals, 5 metacarpals, 14 phalanges
(B) 5 carpals, 8 metacarpals, 14 phalanges
(C) 5 metacarpals, 8 carpals, 14 phalanges
(D) 8 metacarpals, 5 carpals, 14 phalanges

84. **The type of joint found in vertebrae and inter-coxal bones is:**
(A) Synovial joint (B) Cartilaginous joint
(C) Fibrous joint (D) Hinge joint

85. **It is an example of freely movable joints:**
(A) Synovial joint (B) Hinge joints
(C) Ball and socket joints (D) Fibrous joints

86. **The structure which secretes fluid to reduce the friction between the moving joints is:**
(A) Synovium (B) Fibrous capsule
(C) Ligament (D) Cartilage

87. **One of the earliest form of muscles to evolve and is found throughout animal kingdom is:**
(A) Cardiac muscles (B) Skeletal muscles
(C) Smooth muscles (D) Heart muscles

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89. It is a long cylindrical cell with multiple oval nuclei arranged just beneath its sarcolemma:
(A) Muscle (B) Muscle bundle
(C) Skeletal muscle (D) Muscle fibre

90. Identify the muscles shown in picture:

(A) Smooth Muscles (B) Skeletal Muscles
(C) Degenerated muscles (D) Cardiac Muscles

91. _____ is 16 nm in diameter:
(A) Actin (B) Troponin
(C) Myosin (D) tropomyosin

92. The neurotransmitter stored in axon in nerve endings at neuromuscular junction is:
(A) Glycine (B) Nicotine
(C) Epinephrin (D) Acetylcholine

93. Cross bridge is defined as:
(A) Myosin joined with actin
(B) Troponin combined with Calcium
(C) Actin binds to troponin
(D) None of these is correct

94. A condition marked by intermittent muscular spasms, caused by malfunction of the parathyroid glands and a consequent deficiency of calcium.:
(A) Fatigue (B) Tetany
(C) Tetanus (D) Cramps

95. Painful involuntary contraction of a muscle or muscles, typically caused by fatigue or strain:
(A) Atrophy (B) Tetany
(C) Hypertrophy (D) Cramp

96. The length of the myofibril from one Z-band to the next is known as:
(A) Sarcomere (B) Sarcoplasm
(C) Sarcolemma (D) Muscle fiber

97. The calcium ions released during a muscle fiber contraction attach with:
(A) Myosin (B) Tropomyosin-T
(C) Troponin-I (D) Troponin-C

98. The pigment which stores oxygen in muscles is:
(A) Haemoglobin (B) Myosin
(C) Myoglobin (D) Actinomyosin

99. A disease caused by the accumulation of lactic acid either in thigh or hip muscles is related to:
(A) Muscle fatigue (B) Tetanus
(C) Degeneration (D) Tetany

99. Liver helps in producing ATP from glucose by:
(A) Glycogen → Glucose
(B) Glucose → Lipid
(C) Glucose → Glycogen
(D) Glucose → Protein

100. Each muscle fiber is surrounded by a membrane which is called:
(A) Sarcomere (C) Twitch fiber
(B) Sarcolemma (D) Capsule

101. Three types of joints are shown below, sort out the ball and socket joint:

(A) Image C (C) Image B
(C) Both A and C (D) Image A

102. Part of pectoral girdle is:
(A) Ileum (B) Glenoid cavity
(C) Acetabulum (D) Sternum

103. Scapula and clavicle form:
(A) Pelvic girdle (B) Pectoral girdle
(C) Skull (D) Vertebral column

104. Study of joints known as:
(A) Osteology (B) Arthrology
(C) Craniology (D) Kinesiology

105. Pectoral girdle, pelvic and limb bones constitute:
(A) Visceral skeleton
(B) Outer skeleton
(C) Axial skeleton
(D) Appendicular skeleton

106. Acromion process is part of:
(A) Vertebral Column (B) Pelvic girdle
(C) Femur (D) Pectoral girdle

107. Cranium of a man is made up:
(A) 8 bones (B) 12 bones
(C) 16 bones (D) 14 bones

108. Which of the following is sesamoid bone?
(A) Pelvic (B) Patella
(C) Pterygoid (D) Pectoral girdle

109. The number of floating ribs and true ribs in human body:
(A) 6 pairs, 8 pairs (B) 5 pairs, 4 pairs
(C) 3 pairs, 2 pairs (D) 2 pairs, 7 pairs

110. How many bones are present in human skull?
(A) 32 (B) 22
(C) 12 (D) 42

111. Number of cervical and thoracic vertebrae in

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human is:
(A) 7, 12 (B) 7, 10
(C) 7, 11 (D) 7,14

112. Saddle joint occurs between:
(A) Carpal and first metacarpal of thumb
(B) Femur and pelvic girdle
(C) All the vertebrae
(D) Phalanges

113. A cranial bone related to ear is:
(A) Occipital (B) Frontal
(C) Nasal (D) Temporal

114. These facial bones are unpaired:
(A) Lacrimal, Vomer (B) Vomer, Mandible
(C) Nasal, Vomer (D) Palatine, Mandible

115. It is an outcome of irregularities in metabolism of nitrogenous waste:
(A) Osteoporosis
(B) Osteoarthritis
(C) Gouty arthritis
(D) Rheumatoid arthritis

116. The clavicle articulates with ____ of scapula:
(A) Acromion process
(B) Glenoid cavity
(C) Acetabulum cavity
(D) Ball and socket joint

117. Synovial fluid is secreted by:
(A) Blood
(B) Cartilage
(C) Bone
(D) Synovial membrane

118. A joint between humerus and radio Ulna is:
(A) Ball and socket (B) Pivot
(C) Gliding (D) Hinge

119. The other name of kneecap is:
(A) Clavicle (B) Patella
(C) Radius (D) Femur

120. Elbow joint is an example of:
(A) Ball and socket joint (B) Pivot joint
(C) Hinge joint (D) Gliding joint

121. Three the following pairs of human skeletal parts are correctly matched with their respective inclusive skeletal category and one pair is not matched:

Pairs of skeletal parts	Category:
(A) Malleus and stapes	ear ossicles
(B) Sternum and ribs	axial skeleton
(C) Clavicle and glenoid cavity	Pelvic girdle
(D) Humerus and ulna	Appendicular skeleton

122. Select the correct statement regarding the specific disorder of muscular skeletal system:
(A) Myasthenia gravis – Auto immune disorder with inhibits sliding of myosin filaments
(B) Gout inflammation of joints due to extra deposition of calcium
(C) Muscular dystrophy – age related shortening of muscles.
(D) Osteoporosis – decrease in bone mass and higher chances of fractures with advancing age.

123. Which of the following is not a function of the skeletal system?
(A) Locomotion
(B) Production of erythrocytes
(C) Storage of minerals
(D) Production of body heat

124. Which of the following joints would allow movement in several directions?
(A) Ball and socket joint (B) Fibrous joint
(C) Cartilaginous joint (D) Synovial joint

125. The pivot joint between atlas and axis is a type of:
(A) Cartilaginous joint (B) Synovial joint
(C) Saddle joint (D) Fibrous joint

126. Select the correct option:
(A) 8th, 9th and 10th pairs of ribs articulate directly with the sternum.
(B) 11th and 12th pairs of ribs are connected to the sternum with the help of hyaline cartilage.
(C) Each ribs is a flat thin bone and all the ribs are connected dorsally to the thoracic vertebrae and ventrally to the sternum.
(D) There are seven pairs of vertebrosternal, three pairs of vertebrochondral and two pairs of vertebral ribs.

127. Rigor mortis is:
(A) Contraction of muscles after death
(B) Contraction of muscles before death
(C) Shivering of muscles
(D) None

128. Unstriped muscles are also known as:
(A) Visceral (B) Smooth
(C) Involuntary (D) All

129. ATPase cavity found in:
(A) Myosin filament (B) Actin filament
(C) Both (D) None

130. Longest smooth muscles are:
(A) Intestine (B) Stomach
(C) Uterus (Pregnant) (D) Urinary bladder

131. Immediate source of energy for muscle contraction is:
(A) Glucose
(B) GTP
(C) ATP

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(D) Creatine phosphate

132. One myosin filament in the myofibril of skeletal muscle fibre is surrounded by how many actin filaments?
(A) Two (B) Four
(C) Six (D) Three

133. Least blood supply will be present in:
(A) Skeletal muscle (B) Cardiac muscle
(C) Smooth muscle (D) All of the above

134. The H-Zone in the skeletal muscle fibre is due to:
(A) Extension of myosin filaments in the central portion of the A – Band
(B) The absence of myofibrils in the central portion of A – band
(C) The central gap between myosin filaments in the A band
(D) The central gap between actin filaments extending through myosin filaments in the A band

135. Smooth muscles are:
(A) Involuntary, Cylindrical, Striated
(B) Voluntary, Spindle-Shaped, uninucleate
(C) Involuntary, Fusiform, non-striated
(D) Voluntary, Multinucleate, Cylindrical.

136. Name the ion responsible for unmasking of active sites for myosin for cross bridge activity during muscle contraction.
(A) Sodium (B) Potassium
(C) Calcium (D) Magnesium

137. Calcium is important in skeletal muscle contraction because it:
(A) Binds to troponin to remove the masking of active sites on action for myosin.
(B) Activates the myosin ATPase by binding to it.
(C) Detaches the myosin head from the actin filament.
(D) Prevents the information of bonds between the myosin cross bridges and the actin filament.

138. In a muscle fibre Ca^{++} is stored in:
(A) Sarcoplasmic reticulum
(B) Sarcosome
(C) Sarcomere
(D) Sarcolemma

139. In a resting state, the central part of thick filament which is not overlapped by thin filament is called:
(A) A-Band (B) M-Line
(C) H-Zone (D) I – Band

140. Which points are correct about visceral muscles?
(A) These are located in the inner walls of hollow visceral organs of the body
(B) They do not exhibit any striations
(C) Their activities are not under the voluntary control of the nervous system
(D) All of the above

141. Which muscles is functionally myogenic type?
(A) Cardiac muscle (B) Smooth muscle
(C) Voluntary muscle (D) All of these

142. Which of the following is NOT a bone of the human skull?
(A) Parietal bone (B) Occipital bone
(C) Femur (D) Temporal bone

143. Which bone in the human body is the longest?
(A) Humerus (B) Tibia
(C) Femur (D) Ulna

144. Which of the following bones is NOT part of the human vertebral column?
(A) Sacrum (B) Coccyx
(C) Scapula (D) Cervical vertebrae

145. What is the name of the bone that forms the kneecap?
(A) Patella (B) Tibia
(C) Fibula (D) Femur

146. What is the name of the bone in the human foot that connects the ankle and the toes?
(A) Metatarsal (B) Phalange
(C) Tarsal (D) Calcaneus

147. What is the name of the joint that connects the thigh bone (femur) to the pelvis and allows for hip rotation and movement?
(A) Ball and socket joint (B) Hinge joint
(C) Pivot joint (D) Gliding joint

148. What is the name of the joint that connects the thigh bone (femur) to the shin bone (tibia) and allows for knee movement?
(A) Hinge joint
(B) Ball and socket joint
(C) Pivot joint
(D) Gliding joint

149. What is the name of the joint that connects the radius and ulna bones in the forearm and allows for rotation of the forearm?
(A) Hinge joint
(B) Ball and socket joint
(C) Pivot joint
(D) Gliding joint

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150. What is the name of the joint that connects the two pelvic bones at the front of the body and allows for limited movement during childbirth?
(A) Hinge joint
(B) Ball and socket joint
(C) Symphysis joint
(D) Pivot joint

151. What is the name of the connective tissue that surrounds individual muscle fibers and bundles them together to form skeletal muscles?
(A) Tendon (B) Ligament
(C) Fascia (D) Cartilage

152. What is the name of the process by which muscle fibers increase in size and strength in response to regular exercise or physical activity?
(A) Atrophy (B) Hypertrophy
(C) Hyperplasia (D) Fibrosis

153. What is the name of the neurotransmitter that is released from motor neurons and stimulates skeletal muscle fibers to contract?
(A) Acetylcholine (B) Norepinephrine
(C) Dopamine (D) Serotonin

154. What is the name of the protein that is responsible for generating force in skeletal muscles during contraction?
(A) Actin (B) Myosin
(C) Troponin (D) Tropomyosin

155. The fibrous tissue envelop that surrounds the skeletal muscles:
(A) Epimysium (B) Endomysium
(C) Perimysium (D) Periosteum

156. The connective tissues that ensheaths each individual muscle fibre or muscle cell:
(A) Epimysium (B) Endomysium
(C) Perimysium (D) Periosteum

157. A sheath of dense connective tissues around the muscle bundles or fascicles:
(A) Epimysium (B) Endomysium
(C) Perimysium (D) Periosteum

158. _____ is a membrane that covers the outer surface of all bones except the articulate surfaces:
(A) Epiphyses (B) Diaphysis
(C) Periosteum (D) Perichondrium

159. A layer of connective tissues that surround the cartilage of developing bones:
(A) Epiphyses (B) Diaphysis
(C) Periosteum (D) Perichondrium

160. Rounded ends or tip of the long bone is called:
(A) Epiphyses (B) Diaphysis
(C) Periosteum (D) Perichondrium

161. The central part of shaft of the bone which usually contains bone marrow and adipose tissue:
(A) Epiphyses (B) Diaphysis
(C) Periosteum (D) Perichondrium

162. The microscopic tubes in the bones that allows blood vessels and nerves to travel through them to supply the osteocytes:
(A) Haversian canals (B) Lacuna
(C) Volkman canals (D) Perichondrium

163. What is the name of the protein that blocks myosin binding sites on actin during muscle relaxation?
(A) Troponin (B) Tropomyosin
(C) Myoglobin (D) Titin

164. What is the name of the bone that forms the back of the skull?
(A) Frontal bone (B) Parietal bone
(C) Occipital bone (D) Temporal bone

165. What is the name of the small bone in the middle ear that helps transmit sound waves?
(A) Incus (B) Stapes
(C) Malleus (D) Cochlea

166. Which bone of the forearm is located on the side of the thumb?
(A) Radius (B) Ulna
(C) Scapula (D) Clavicle

167. What is the name of the bone that makes up the lower jaw?
(A) Maxilla (B) Mandible
(C) Temporal bone (D) Occipital bone

168. Which type of cartilage is found in the intervertebral discs?
(A) Hyaline cartilage (B) Elastic cartilage
(C) Fibrocartilage (D) Articular cartilage

169. What is the name of the process by which bone tissue is formed?
(A) Ossification (B) Resorption
(C) Calcification (D) Mineralization

170. What type of bone cell is responsible for bone resorption?
(A) Osteoblast (B) Osteoclast
(C) Osteocyte (D) Chondrocyte

171. What happens to calcium ions during muscle relaxation?

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(A) They are actively transported back to SR
(B) They remain bound to troponin, preventing muscle contraction.
(C) They are stored in the mitochondria
(D) They are broken down into ATP, powering muscle relaxation.

172. **What is the role of calcium ions in muscle contraction?**
(A) Calcium ions initiate the breakdown of ATP, which powers muscle contraction.
(B) Calcium ions facilitate the binding of actin and myosin, leading to muscle contraction.
(C) Calcium ions relax the muscle fibers, leading to muscle contraction.
(D) Calcium ions prevent muscle fibers from contracting.

173. **Which of the following statements is true about smooth muscle contraction?**
(A) Smooth muscle can generate more force than skeletal muscle.
(B) Smooth muscle contractions are faster than skeletal muscle contractions.
(C) Smooth muscle can maintain sustained contractions for longer periods of time.
(D) Smooth muscle contractions are under voluntary control.

174. **Which of the following statements is true about the regulation of cardiac muscle contraction?**
(A) Cardiac muscle contractions are under voluntary control.
(B) Cardiac muscle contraction is regulated by the autonomic nervous system and hormones.
(C) Cardiac muscle contractions are solely dependent on the presence of calcium ions
(D) Cardiac muscle contractions are not regulated and occur spontaneously.

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175. **Muscle is made up of many cells which are referred to as: (2011)**
(A) Myofilaments (B) Sarcolemma
(C) Myofibrils (D) Muscle fiber

176. **The length of the myofibril from one Z-band to the next is known as: (2011)**
(A) Sarcomere (B) Sarcoplasm
(C) Sarcolemma (D) Muscle fiber

177. **The calcium ions released during a muscle fiber contraction attach with: (2011)**
(A) Myosin (B) Tropomyosin
(C) Actin (D) Troponin

178. **A muscle condition resulting from the accumulation of lactic acid and ionic imbalance is called: (2011)**
(A) Tetany (B) Cramp
(C) Muscle fatigue (D) Tetanus

179. **The pigment which stores oxygen in muscles is: (2012)**
(A) Haemoglobin (B) Myosin
(C) Myoglobin (D) Actinomyosin

180. **Each muscle fibre is surrounded by a membrane which is called: (2012)**
(A) Sarcomere (B) Twitch fibre
(C) Sarcolemma (D) Capsule

181. **When calcium ions are released from the sarcoplasmic reticulum, they bind with during muscle contraction: (2012)**
(A) Tropomyosin (B) Cytosol's ions
(C) Sarcolemma (D) Troponin

182. **Human and mammalian skeleton can be divided into two parts, Axial Skeleton and_____: (2012)**
(A) Appendicular skeleton
(B) Endoskeleton
(C) Exoskeleton
(D) Hydrostatic skeleton

183. **Last four vertebrae in humans are fused to form a structure called: (2012)**
(A) Sacrum (B) Pubis
(C) Cervical vertebrae (D) Coccyx

184. **The length of the myofibril from one Z-band to the next is described as: (2013)**
(A) Sarcolemma (B) Muscle fibre
(C) Sarcoplasm (D) Sarcomere

185. **The calcium ions released during a muscle fibre contraction attach with: (2013)**
(A) Troponin (C) Actin
(D) Myosin (D) Tropomyosin

186. **The joint that allows the movements in several directions is called: (2013)**
(A) Hinge joint (B) Gliding joint
(C) Ball and socket joint (D) Fibrous joint

187. **Where can we find H-zone in the figure of fine structure for skeletal muscles myofibrils: (2013)**
(A) In the mid of "A-band".
(B) Besides the "Z-line"
(C) In "I-band".
(D) Along the "I-band".

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188. First vertebra of cervical region of vertebral column is known as: (2013)
(A) Axis (B) Thoracic
(C) Sacral (D) Atlas

189. In a human vertebral column, the number of_____vertebrae is 7: (2014)
(A) Cervical (B) Lumbar
(C) Thoracic (D) Sacrum

190. Which one of the following structures holds the bones together? (2014)
(A) Joints (B) Fibrous capsules
(C) Cartilages (D) Ligaments

191. Which one of the following cartilages is the most abundant in human body? (2014)
(A) Elastic cartilage
(B) Fibrocartilage
(C) Chondrous cartilage
(D) Hyaline cartilage

192. The repeated protein pattern of myofibril is called: (2014)
(A) Sarcomere (B) Sarcolemma
(C) Zyomere (D) Cross bridges

193. When more energy is required in muscle contraction then that energy can also be produced by____as a secondary source: (2014)
(A) Glucose (B) Fructose
(C) Phosphocreatine (D) Lactic acid

194. The total number of cervical and thoracic vertebrae in human vertebral column is: (2015)
(A) 7 (B) 14
(C) 19 (D) 33

195. A sarcomere is the region of a myofibril between two successive: (2015)
(A) M-lines (B) I-bands
(C) Z-lines (D) T-tubules

196. The sarcolemma of muscle fiber folds inwards and forms a system of tubes which runs through the sarcoplasm called: (2015)
(A) Myofilament
(B) Z-lines
(C) Sarcoplasmic reticulum
(D) Transverse tubules

197. According to sliding filament theory, when muscle fibers are stimulated by nervous system, which of the following changes occurs? (2015)
(A) I-bands shorten
(B) Z-lines move further apart
(C) H-zone becomes more visible
(D) A-bands broaden

198. If lactic acid builds up in thigh muscles, it causes muscle tiredness and pain. This condition is called: (2015)
(A) Muscle fatigue
(B) Cramps
(C) Tetany
(D) Oxygen debt in muscles

199. Longest bone in the human skeleton is: (2016)
(A) Ulna (B) Tibia
(C) Fibula (D) Femur

200. Hip and shoulder joints are examples of: (2016)
(A) Hinge joints
(B) Synovial joints
(C) Ball and socket joints
(D) Cartilaginous joints

201. In pelvic region of human body, sacrum is formed by the fusion of: (2016)
(A) 4 vertebrae (B) 6 vertebrae
(C) 5 vertebrae (D) 3 vertebrae

202. Each muscle fibre is surrounded by a modified cell membrane called: (2016)
(A) Sarcolemma (B) Myosin filament
(C) Sarcomere (D) Myofilament

203. Spongy bone is always surrounded by: (2017)
(A) Compact bone (B) Osteoblast cells
(C) Cartilage (D) Osteoclast cells

204. Bone matrix is hardened by the: (2017)
(A) Haversian canals
(B) Bone marrow tissue
(C) Canaliculi
(D) Calcium phosphate

205. The number of bones forming skull in man is: (2017)
(A) 8 (B) 29
(C) 14 (D) 22

206. The spine consists of a linear series of: (2017)
(A) 33 bones (B) 26 bones
(C) 24 bones (D) 07 bones

207. Which one of the following changes occurs when skeletal muscle contracts? (2017)
(A) I-band shortens only
(B) A-band shortens and Z line moves farther apart
(C) I-band shortens and Z lines get closer
(D) Actin filament contracts

208. Connective tissues which join muscles to bone are: (2017-Retake)
(A) Ligaments (B) RBC

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(C) Tendons (D) Osteocytes

209. Clavicle is the part of: (2017-Retake)
(A) Pectoral Girdle (B) Rib cage
(C) Pelvic Girdle (D) Vertebrae

210. Second vertebrae of Human vertebral column is called: (2017-Retake)
(A) Atlas (B) Phalanges
(B) Axis (D) Tibia

211. Over lapping of thick filament occurs in: (2017-Retake)
(A) A Band (B) M line
(C) I Band (D) Z line

212. Pectoral Girdle is the part of: (2017-Retake)
(A) Appendicular skeleton
(B) Axial skeleton
(C) Skull
(D) Ribs

213. Coccyx vertebrae are located in: (2018)
(A) Cervical region (B) Lumber region
(C) Pelvic region (D) Thoracic region

214. Skull, vertebral column, ribs and sternum forms: (2018)
(A) Appendicular skeleton
(B) Hydrostatic skeleton
(C) Exoskeleton
(D) Axial skeleton

215. Scapula is a: (2018)
(A) Tail bone (B) Hip bone
(C) Skull bone (D) Shoulder bone

216. Which combination is the example of ball and socket joints: (2018)
(A) Hip and shoulder joints
(B) Hip and knee joints
(C) Shoulder and knee joints
(D) Hip and elbow joints

217. The thick filaments in a myofibril of muscles are made of _____: (2019)
(A) Haemoglobin (B) Actin
(C) Myoglobin (D) Myosin

218. Thin filaments of muscles contain ___ chains of actin molecules: (2019)
(A) Four (B) Three
(C) One (D) Two

219. The function of calcium ions is muscle contraction to: (2019)
(A) Bind to troponin and cause them to move
(B) Aid in transmission of never impulse
(C) Polarize visible light
(D) Bind to tropomyosin molecules and cause them to form cross bridges

220. Which of the following muscles are considered as 'Voluntary Muscles'? (2020)
(A) Smooth muscles (B) Cardiac muscles
(C) Skeletal muscles (D) Glandular muscles

221. Which one of the following "myogenic" types of muscle? (2020)
(A) Glandular muscles (B) Cardiac muscles
(C) Skeletal muscles (D) Smooth muscles

222. What do we call the cell surface membrane of a muscle fiber? (2020)
(A) Sarcolemma (B) Plasma membrane
(C) Sarcoplasm (D) Myofibrils

223. Which of the following neurotransmitter's function, both as neurotransmitter and hormones, decreasing our perception of pain? (2020)
(A) Epinephrine (B) Serotonin
(C) Dopamine (D) Endorphins

224. What is false about cartilage? (2022)
(A) There are many blood vessels in cartilage
(B) It is a form of connective tissue
(C) It covers ends of the bones at joints
(D) It is much softer than bone

225. Which of the following is a muscle component that acts as store for energy? (2022)
(A) ATP (B) Creatine - PO4
(C) Myoglobin (D) Creatinine - PO4

226. Which of the following is NOT found in skeletal muscle fibers in human: (2022)
(A) Multiple nuclei
(B) Multiple mitochondria
(C) Large amount of myoglobin
(D) Large amount of hemoglobin

227. Hinge joint is present between which of the following bones: (2022)
(A) Humerus and radio- ulna
(B) Femur and acetabulum
(C) Femur and pectoral girdle
(D) Humerus and pectoral girdle

228. During sliding of actin filaments, ATP is used for: (2023)
(A) Cross bridge formation
(B) Cross bridge breaking
(C) Dragging filaments
(D) Shortening of filaments

229. The cell membrane of muscle cell is: (2023)
(A) Sarcoplasm (B) Sarcolemma

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(C) Sarcomere (D) Myofibrils

230. **Irregular striations and involuntary control is related to: (2023)**
(A) Cardiac muscle cells
(B) Fibroelastic cartilage cell
(C) Skeletal muscle cells
(D) Smooth muscle cells

231. **Cartilage is a type of which tissue? (2023)**
(A) Connective tissues
(B) Epithelial tissues
(C) Muscular tissues
(D) Nervous tissues

232. **Smooth muscles are found in all mentioned below except: (2023)**
(A) Trachea (B) Bronchi
(C) Bronchioles (D) Alveoli

233. **Which of the following is included in paired cranial bones: (UHS 2024)**
(A) Temporal (B) Frontal
(C) Occipital (D) Vomer

234. **Which of the following skeletal disorder is an example of autoimmune disorder: (UHS 2024)**
(A) Sciatica (B) Spondylosis
(C) Rheumatoid arthritis (D) Rickets

235. **Which feature is possessed by smooth muscles: (UHS 2024)**
(A) Voluntary (B) Branched
(C) Striated appearance (D) Uni-nucleate

236. **The accumulation of lactic acid in muscles results in: (UHS 2024)**
(A) Extreme fatigue (B) Paralysis
(C) Muscle contraction (D) Convulsion

237. **Thick filaments in skeletal muscles are composed of: (UHS 2024)**
(A) Actin (B) Tropomyosin
(C) Myosin (D) Troponin

238. **Sarcomere is part of myofibril between: (UHS 2024)**
(A) Two I bands (B) Two A bands
(C) Two M lines (D) Two Z lines

239. **Which of the following is NOT a bone of upper limb: (UHS 2024)**
(A) Humerus (B) Ulna
(C) Femur (D) Radius

240. **Bone forming cells are: (UHS 2024)**
(A) Osteoblast (B) Osteocytes
(C) Osteoclast (D) Osteon

241. **The cells contained in the lacunae of the bone are called: (ETEA 2024)**
(A) Chondrocytes (B) Osteoblast
(C) Osteocytes (D) Osteoclast

242. **The _____ surrounds the muscle fibre of the skeletal muscle: (ETEA 2024)**
(A) Perimysium (B) Lacunae
(C) Epimysium (D) Endomysium

243. **What happens to calcium when skeletal muscles recover from contraction: (ETEA 2024)**
(A) Released from the sarcoplasmic reticulum
(B) Released from the myosin head
(C) Pumped into the sarcoplasmic reticulum
(D) Exchanged for sodium ions

244. **Which of the following does NOT relate to smooth muscles: (ETEA 2024)**
(A) Controlled by the autonomic nervous system
(B) Have spindle shaped cells
(C) Line the wall of heart
(D) Lack striations

245. **You have often heard about the hamstring injury of players. Which of the following is correct about hamstring muscles: (NUMS 2024)**
(A) It is an extensor muscle
(B) Its insertion is on tibia
(C) Originate from pelvic gridle and top of femur
(D) Originate from ilium and femur

246. **Choose the correct, for muscle in relaxed position: (NUMS 2024)**
(A) Exposed binding sites on actin
(B) Broad H-zone in sarcomere
(C) Formation of cross bridges
(D) Ca^{++} released in cytosol

247. **The living cells of cartilage are called: (SZABMU 2024)**
(A) Chondroblast (B) Chondroclasts
(C) Chondrocytes (D) Osteocytes

248. **Which of the following bone is not the part of eye orbit: (SZABMU 2024)**
(A) Ethmoid (B) Occipital
(C) Lacrimal (D) Zygomatic

249. **In skeletal muscles, which tube runs perpendicularly and is connected with the sarcoplasmic reticulum: (BUMHS 2024)**
(A) Troponin (B) T-tubules
(C) Monochondrion (D) Myosin

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Answer Key

1. A	2. A	3. D	4. B	5. D	6. B	7. D	8. D	9. D	10. C
11. C	12. A	13. C	14. D	15. B	16. B	17. A	18. B	19. A	20. C
21. C	22. D	23. C	24. B	25. D	26. B	27. C	28. B	29. A	30. D
31. A	32. D	33. A	34. D	35. A	36. C	37. B	38. C	39. B	40. B
41. A	42. C	43. B	44. C	45. C	46. D	47. B	48. A	49. B	50. C
51. C	52. D	53. B	54. D	55. C	56. C	57. A	58. A	59. C	60. B
61. A	62. A	63. A	64. D	65. C	66. A	67. B	68. B	69. D	70. C
71. C	72. A	73. A	74. C	75. D	76. D	77. C	78. B	79. A	80. C
81. A	82. C	83. A	84. B	85. A	86. A	87. C	88. D	89. B	90. C
91. D	92. A	93. B	94. D	95. A	96. D	97. C	98. A	99. A	100. B
101. D	102. B	103. B	104. B	105. D	106. D	107. A	108. B	109. D	110. B
111. A	112. A	113. D	114. B	115. C	116. A	117. D	118. D	119. B	120. C
121. C	122. D	123. D	124. A	125. B	126. D	127. A	128. D	129. A	130. C
131. C	132. C	133. C	134. A	135. C	136. C	137. A	138. A	139. C	140. D
141. A	142. C	143. C	144. C	145. A	146. A	147. A	148. A	149. C	150. C
151. C	152. B	153. A	154. B	155. A	156. B	157. C	158. C	159. D	160. A
161. B	162. A	163. B	164. C	165. B	166. A	167. B	168. C	169. A	170. B
171. A	172. B	173. C	174. B	175. D	176. A	177. D	178. C	179. C	180. C
181. D	182. A	183. D	184. D	185. A	186. C	187. A	188. D	189. A	190. D
191. D	192. A	193. C	194. C	195. C	196. D	197. A	198. A	199. D	200. C
201. C	202. A	203. A	204. D	205. D	206. B	207. C	208. C	209. A	210. B
211. A	212. A	213. C	214. D	215. D	216. A	217. D	218. B	219. A	220. C
221. B	222. A	223. D	224. A	225. B	226. D	227. A	228. B	229. B	230. A
231. A	232. D	233. A	234. C	235. D	236. A	237. C	238. D	239. C	240. A
241. C	242. D	243. C	244. C	245. C	246. B	247. C	248. B	249. B	

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UNIT # 13

VARIATION & GENETICS
(INHERITANCE)

High Yield Content:

- Mendelian Inheritance
- Law of Segregation/Inheritance of Single Trait
- Law of Independent Assortment/Inheritance of Two Traits
- Dominance Relations
- Multiple Alleles and ABO Blood Group System
- Rh Blood Group System and Erythroblastosis Feotalis
- Gene Linkage and Crossing Over
- Sex Linkage in Drosophila
- Sex Linkage in Humans (Hemophilia & Color Blindness)

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"Variation & Genetics"

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VARIATION & GENETICS / INHERITANCE: KEY CONCEPTS

- Similar characters that pass from parents to their offsprings are collectively called **heredity.**
- The resemblance, however, is not complete and offsprings differ from each other and their parents in many respects. These differences are known as **variations.**
- The science which deals with the mechanism of heredity and variations is called **genetics.**

Classification of Genetics

Aspect	Classical Genetics	Molecular Genetics	Population Genetics
Focus	Inheritance patterns and traits based on **Mendelian laws.**	Structure, function, and regulation of genes at the molecular level.	Genetic variation and evolution in populations over time.
Key Concepts	Mendel's laws Phenotype-genotype relationship Dominance, segregation, independent assortment	DNA, RNA, and protein synthesis Gene expression Mutations	Allele frequencies Hardy-Weinberg equilibrium Genetic drift, selection, migration

Gene

- It is the **basic unit** of biological information. In fact, the DNA stores all sort of biological information coded in the sequence of its bases in a linear order, and **genes** are actually **parts of DNA** comprising its base sequences.
- Gene can also be defined as 'the **sequence of nucleotides** that specifies sequence of amino acids in a polypeptide chain/protein molecule.
- **Hereditary characteristics** pass from parents to offspring through genes in their **gametes.**
- When genes pass in the form of intact parental combination between generations, **inherited similarities are conserved**; but when these shuffle, mutate or juggle with each other, variations emerge.

Locus

- The **position of a gene** on the chromosome is called its locus.

Allele

- Genes form pairs on pairs of homologous chromosomes. One member of a gene pair is located on one homologue and the other member on the other homologue.
- **Partners of a gene / Copy of a gene** pair are called alleles.
- Each allele of a gene pair occupies the **same gene locus** on its respective homologue. Both alleles on one locus may be identical or different from each other.

Dominant Allele

- Such an allele that **masks the effect of other allele** in a pair is called dominant allele and such trait is called dominant trait.
- **For example**, in pea plant, round (R) is dominant over wrinkled (r).

Recessive Allele

- Such an allele that is **masked by another allele** in a gene pair is called recessive allele and such trait is called recessive trait.
- **For example**, in pea plant, green (y) is recessive while yellow (Y) is dominant.

Gene Pool

- **All the genes/alleles** found in a **breeding population** at a given time are collectively called the gene pool.
- It consists of all the alleles at all genes loci in all individuals of the population.
- For a diploid species, each locus is represented twice in a genome of the individual who may be either homozygous or heterozygous.

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Phenotype

- Physical appearance of a trait is called phenotype.
- For example, round and wrinkled are phenotypes of seed shape as the shape is a trait.

Genotype

- Genotype is the **genetic complement** i.e. the genes in an individual for a particular trait.
- For example, genotype of AB blood group is I^AI^B.

Homozygous

- When both alleles of a gene pair in an organism are same, the organism is homozygous for that gene pair.
- An individual with homozygous genotype is called **homozygote or true breeding.**
- For example, RR is genotype of homozygous round seeded pea plant.

Heterozygous

- If both alleles of a gene pair are different from each other, the organism is heterozygous for that gene pair.
- An individual with heterozygous genotype is called **heterozygote or hybrid.**
- For example, Rr is genotype of heterozygous round seeded pea plant.

MENDELIAN INHERITANCE

- In 1860's, Mendel discovered mechanism of inheritance based on his experimental work with pea plants. The first step of his experimental work was to **develop true or pure breed** varieties.
- A plant that produces all the offsprings of its own phenotype upon **self-fertilization** is called true/pure breeding plants. These plants can be developed by repeated self- fertilization through successive generations until pure breed is achieved.
- Mendel studied **seven pairs** of contrasting traits for each contrasting phenotype; he developed a pure breeding plant.
- In second step, he performed hybridization, a cross fertilization between two individuals having contrasting phenotypes.

Selection of Pea Plant

- Mendel performed series of breeding experiments on **garden pea (Pisum sativum)** in his monastery garden for eleven years. He **selected pea plant** for experiments due to **following reasons:**
- Pea plants were easy to cultivate.
- Its flowers were hermaphrodite. It was normally self-fertilized but could be cross- fertilized.
- It has short generation time.
- It has many sharply distinct traits, and each trait had two clear cut alternative forms or varieties.

Seven Contrasting pair of Traits

Trait	Dominant Phenotype	Recessive Phenotype	Chromosome
Seed Shape	Round (R)	Wrinkled (r)	7
Seed Color	Yellow (Y)	Green (y)	1
Flower Color	Purple (P)	White (p)	1
Pod Shape	Inflated (I)	Constricted (i)	4
Pod Color	Green (G)	Yellow (g)	5
Flower Position	Axial (A)	Terminal (a)	4
Plant Height	Tall (T)	Dwarf (t)	4

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Mendelian Laws

Law	Statement
Law of Dominance	In a heterozygous condition, one allele masks the effect of the other. The allele that is expressed is dominant, while the masked allele is recessive.
Law of Segregation	During gamete formation, the two alleles of a gene separate (segregate) so that each gamete carries only one allele for each gene. The extension of Mendel's Law of Segregation is the Law of Purity of Gametes.
Law of Independent Assortment	Alleles of different genes assort independently of one another during gamete formation, provided the genes are not linked.

LAW OF SEGREGATION / INHERITANCE OF SINGLE TRAIT

- The two co-existing alleles for each trait in an individual segregate (separate) from each other at meiosis, so that each gamete receives only one of the two alleles.
- Alleles unite again at random fertilization of gametes when zygote is formed.

Monohybrid Cross

- Mendel studied inheritance of single trait in monohybrid cross in which two plants are crossed that differ on single trait.
- For the study of single trait of inheritance, he crossed a pure breeding yellow seed colored plants with a pure breeding green seed colored plants. He observed that F_1 generation was comprised entirely of individuals exhibiting only one parental phenotype (1:0 ratio) i.e., yellow seed colored.
- When F_1 generation was interbred/self-fertilized, its offsprings (F_2 generation) showed a 3:1 ratio for yellow and green seed colors.
- Mendel got similar results and the same 3:1 ratio in offspring of monohybrid crosses for all the seven contrasting pairs of traits.
- Mendel proceeded a step ahead. He self-fertilized F_2 plants to get the F_3 generation. He observed that 1/3 of F_2 round produced only round (appeared true of pure breeding like P_1 round), while 2/3 of F_2 round produced both round and wrinkled in 3:1 (appeared non- pure breeding like F_1 round); but F_2 wrinkled produced only wrinkled (pure breeding).

Interpretations of Results

- Based upon these observations, Mendel concluded that each contrasting form (phenotype) of a trait, e.g., yellow or green colors of seed was determined by particulate hereditary factors, which he called "elementens" (now called genes). The term gene was used by Johansen in 1902.
- These factors carrying hereditary information were transmitted from parents to offspring.
- Each pea plant had a pair of these factors (now called alleles, the alternative form of gene on the same locus). One derived from the male parent and other from the female parent.
- Yellow is dominant over green.

Key Concepts of Mendel Law of Segregation

Concepts	Explanation
Key Example	Monohybrid cross (e.g., Rr × Rr): Alleles for seed shape (R/r) segregate to produce gametes with either R or r.
Observed Phenotypic Ratio	3:1 in the F2 generation: 3 Round seed plant (dominant) : 1 wrinkled seed plant (recessive).
Observed Genotypic Ratio	1:2:1 in the F2 generation: 1 homozygous dominant (RR) : 2 heterozygous (Rr) : 1 homozygous recessive (rr).
Gamete Formation	Each gamete receives only one allele from the pair of alleles (e.g., R or r).
Significance	Explains why offspring inherit traits as distinct units and not as a blend.

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TEST CROSS

- It is a mating in which an individual showing a dominant phenotype (unknown genotype) is crossed with an individual showing its recessive phenotype (Known genotype).

Significance

- This cross is used to find out the homozygous or heterozygous nature of the genotype of those individuals showing dominant phenotype.

Details

- A phenotypically yellow colored seed could be homozygous (YY) or heterozygous (Yy).
- If the seed is homozygous yellow (YY), it will grow into a pea plant that forms all gametes with only 'Y' alleles. Green seed plants are always homozygous recessive and form all gametes with 'y' alleles. Fertilization will result in 100% yellow colored seed progeny (1:0 ratio) and showed that the tested phenotypically dominant individual is homozygous.
- If the seed is heterozygous yellow (Yy), it will grow into a plant that forms half the gametes with 'Y' and half with 'y'. Green seed plants will form only 'y' type of gametes. Fertilization will result in 50% yellow and 50% green seed progeny (1:1 ratio) and show that tested phenotypically dominant individual is heterozygous.

Summary of Test Cross

Test Cross Scenario	Cross	Offspring Phenotype	Conclusion
1. Unknown is Homozygous Dominant	YY × yy	All Yellow (100%) (1:0 ratio)	The unknown individual is homozygous dominant (YY).
2. Unknown is Heterozygous	Yy × yy	1 Yellow : 1 Green (50% each) (1:1 ratio)	The unknown individual is heterozygous (Yy).

LAW OF INDEPENDENT ASSORTMENT / INHERITANCE OF TWO TRAITS

- When two contrasting pairs of traits are followed in the same cross, their alleles assort independently into gametes.
- The distribution of alleles of one trait into gametes has no influence on the distribution of alleles of the other trait.

Dihybrid Cross

- The inheritance of two traits simultaneously can be studied in dihybrid cross i.e., a cross between two individuals, which are different on two traits.
- The two of the seven characters Mendel studied were seed color and shape. Seed shape may be either round (dominant) or wrinkled (recessive) and color of these seeds may be either yellow (dominant) or green (recessive).

Phenotypic & Genotypic expression

- When he crossed homozygous round yellow (RRYY) plants with homozygous wrinkled green (rryy) plants, all the offsprings were with both dominant phenotypes in F_1 generation.
- In order to analyze the genotypes of F_1 plants, Mendel self-fertilized them and produced F_2 generation. He was expecting that dominant and recessive combinations could be produced in 3:1 in F_2 generation as he had obtained in monohybrid cross, but he observed that offspring were produced in four phenotypic combinations i.e., round yellow, round green, wrinkled yellow and wrinkled green in the ratio of 9:3:3:1.

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Punnett Square

Parent 2 \ Parent 1	RY	Ry	rY	ry
RY	RRYY (Round, Yellow)	RRYy (Round, Yellow)	RrYY (Round, Yellow)	RrYy (Round, Yellow)
Ry	RRYy (Round, Yellow)	RRyy (Round, Green)	RrYy (Round, Yellow)	Rryy (Round, Green)
rY	RrYY (Round, Yellow)	RrYy (Round, Yellow)	rrYY (Wrinkled, Yellow)	rrYy (Wrinkled, Yellow)
ry	RrYy (Round, Yellow)	Rryy (Round, Green)	rrYy (Wrinkled, Yellow)	rryy (Wrinkled, Green)

Interpretation of the Results

- Based upon these observations, Mendel concluded that the **F_1 offspring were dihybrid** i.e., heterozygous (RrYy) for both traits.
- F_1 can produce **four classes of gametes**, e.g., **RY, Ry, rY ry**, in **equal quantities.** If the sperms of the four classes are crossed with eggs of the four types, there will be **16 equally probable** ways in which the alleles can combine in F_2 generation as shown in the Punnett square in the above figure. These combinations make up four phenotypic categories with a **ratio of 9:3:3:1.**

Limitations of Law of Independent Assortment

- Genes are **located** on chromosomes at **specific loci.** Independent assortment of genes depends upon independent assortment of their chromosomes.
- All the genes present on a homologous pair of chromosomes are linked to each other in the form of a **linkage group.** These **cannot assort** independently.
- Those **alleles assort independently** whose alleles are **riding non-homologous** chromosomes **or** were **so far away** from each other on the **same chromosomes** that they appeared to be assort independently due to **crossing over.**

Usefulness of Law of Independent Assortment

- Mendel's law of independent assortment explains that if **two parents** have **unique set of traits** which are desired to express in one individual, it is possible only because of **independent assortment.**
- Furthermore, if two parents have such traits which they do not want to be expressed in their offspring. This is also possible only because of independent assortment.

Scope of Independent Assortment in Variation

- Besides mutation and crossing over (which are sources of variation), **independent assortment of traits** is also a **major source of variations** in successive generations.
- It is only due to the crossing over and independent assortment of the traits that the characteristics may appear in new combination in next generation which often seems necessary for adaptations in varying environment.

Probability and Product Rule

- Probability is the **chance of an event to occur** e.g. in F_2 offspring of a monohybrid cross the independent chance for a seed to be round is 3/4 and wrinkled 1/4.
- When **two independent events** are occurring simultaneously like in **dihybrid cross**, the ratio of each joint phenotypic combination can be obtained by **multiplying the probabilities** of individual phenotypes. It is called **product rule.**

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Event No.1	Event No.2	Both Events at a Time
Seed Shape	Seed Colour	Seed Shape & Colour
Independent Probability	Independent Probability	Joint Probability
Round = 3/4	Yellow = 3/4	Round Yellow = 3/4 x 3/4 = 9/16
Round = 3/4	Green = 1/4	Round Green = 3/4 x 1/4 = 3/16
Wrinkled = 1/4	Yellow = 3/4	Wrinkled Yellow = 1/4 x 3/4 = 3/16
Wrinkled = 1/4	Green = 1/4	Wrinkled Green = 1/4 x 1/4 = 1/16

Key Concepts of Mendel Law of Independent Assortment	
Concepts	Explanation
Key Example	Dihybrid cross (e.g., RrYy × RrYy): Traits for seed shape (R/r) and seed color (Y/y) are inherited independently.
Observed Phenotypic Ratio	9:3:3:1 in the F2 generation: 9 Round-Yellow, 3 Round-Green, 3 Wrinkled-Yellow, 1 Wrinkled-Green.
Condition	Applies to genes located on different chromosomes or far apart on the same chromosome (unlinked).
Gamete Formation	Each parent produces all possible combinations of alleles for the two traits (e.g., RY, Ry, rY, ry).
Significance	Explains the genetic diversity in gametes and the independent inheritance of traits.
Limitation	Gene Linkage

DOMINANCE RELATIONS

- Dominance is a **physiological effect of an allele** over its **partner allele** on the **same gene locus.**
- The relationships between the contrasting alleles at the same locus in heterozygous state are called dominance relations.
- Although **Mendel** had **observed only complete dominance,** later on **many geneticists** became able to explain several exceptions to the Mendelian inheritance that could not be explained on the basis of complete dominance.
- These exceptions are said to be **non-Mendelian inheritance** patterns and include incomplete/partial dominance, co-dominance and over dominance, each indicating a different style of their functional effect upon each other. These relations are summarized in the following table:

Feature	Complete Dominance	Incomplete Dominance	Co-dominance	Over Dominance
Alleles in Heterozygote	One allele completely masks the effect of other	Both alleles are expressed partially	Both alleles are expressed fully	One allele boosts effect of other allele
Phenotype of Heterozygote	Resembles with one homozygote	Intermediate between both homozygotes	Distinct from Both homozygotes	Exceeds in quantity from homozygote
Expression of Alleles	Capital letter for dominant and small letter for recessive	Different expression e.g. R_1 and R_2	Different expression e.g. M and N blood group antigens	Different expression for dominant and recessive e.g. W^+ and w^+

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Phenotype & Genotype Ratios	Different	Same	Same	Same
Need of Test Cross	Correct	x	x	x
Examples	All seven traits studied by Mendel	Flower colour in 4 O'clock plant	AB and MN blood groups	Fluorescent pigments in eyes of Drosophila

MULTIPLE ALLELES AND ABO BLOOD GROUP SYSTEM

Multiple Alleles

- All such altered alternative forms of a gene, whose number is **more than two** are called *multiple alleles*.
- Gene mutations may produce many different alleles of a gene. Some genes may have as many as 300 alleles.
- Any two of these multiple alleles can be present in the genome of a diploid organism, but a haploid organism or a gamete has just one of them in its genome.

ABO Blood Group System

- A well-known example of multiple alleles is the ABO blood group system in humans, which was discovered by **K. Landsteiner in 1901.**
- This system has **four different phenotypes** which are distinct from each other on the basis of specific antigens on the **surface of RBCs.**
- **Bernstein (1925)** explained the genetic basis of ABO blood group system. This blood group system is encoded by a **single polymorphic gene 'I'** (which stands for **isohaemagglutinogen**) which is located on **chromosome 9.** It has three alleles **'I^A', 'I^B' and 'i'.**
- Allele 'I^A' specifies the production of antigen 'A', allele 'I^B' specifies the production of antigen 'B', and allele 'i' does not specify any antigen.
- Their dominance relations are interesting too. **Alleles 'I^A' and 'I^B'** are **co-dominant** to each other because each expresses equally in **I^AI^B heterozygote** to produce **'AB' phenotype.** But allele **'i'** is **recessive** to both 'I^A' and 'I^B'.

Phenotype/Blood Group	Genotype	Antigen on the surface of RBCs	Antibodies in blood plasma
A	I^AI^A, I^Ai	A	Anti-B antibody
B	I^BI^B, I^Bi	B	Anti-A antibody
AB	$I^A I^B$	Both the antigen "A" and "B"	Neither anti-A nor anti-B antibodies
O	ii	Neither antigen A nor antigen B	Both Anti-A and anti-B antibodies

- The **blood group** alleles start their **expression** at **early embryonic stage** and keep on expressing themselves till death. Therefore, the **blood group phenotype** of a person **never changes** throughout life.
- On the other hand, **anti-A and anti-B antibodies** appear in blood plasma during the first **few months after birth.** They are naturally occurring in the absence of corresponding antigens.

Transfusion Principle

- When **transfusions** are carried out between **two incompatible (different) blood groups**, antigens of donor react with the antibodies (also called **agglutinins**) of the recipient, then the red blood **cells clump** with one another.
- The clumping of red blood cells is known as **agglutination.** Therefore, the transfusions are carried out on the basis of donor's antigens and recipient's antibodies.

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- Agglutination leads to serious results because clumped cells cannot pass through the fine capillaries. The blood samples of donor and recipient are cross-matched for compatibility before giving transfusion.

Blood Transfusion

Blood Group	Donated To	Receives from
A	A, AB	A,O
B	B, AB	B,O
AB (Universal recipient)	AB	A, B, AB, O
O (Universal donor)	A, B, AB, O	O

Rh BLOOD GROUP SYSTEM / ERYTHROBLASTOSIS FOETALIS

Rh Blood Group System

- **ABO blood type** is further differentiated by a **positive (+) or negative (-) sign.** This positive or negative sign refers to the **presence or absence** of another blood group system antigen called **Rh factor**, which is present on the surface of **RBCs.**
- The **Rh blood group** system is **clinically the most important** blood group system after **ABO.** The name of this system is derived from **Rhesus monkey,** because its antigen was first discovered in it by **Landsteiner in 1930s.**
- **Rh blood group** system is **encoded** by **three genes** e.g., **C, D, E,** which occupy **two tightly linked** loci.
- Alleles for 'gene D' occupy one locus called 'locus D' while 'gene C' and 'gene E' alternatively occupy the other locus.
- The **'locus D'** is of **prime importance** because it determines the formation of 'D antigen/Rh factor', while its alternative 'allele d' inhibits the formation of Rh factor.
- **'Allele D'** is **completely dominant** over **'allele d',** therefore, persons having genotypes 'DD' or 'Dd' have D antigen on their RBCs and are Rh positive. Persons with genotype 'dd' do not have Rh factor and are Rh negative.

Phenotype/Blood Group	Rh-Factor/Antigen D	Genotype	Anti Rh Antibodies	Can Donate To	Can Receive From
Rh^{+ve}	Present	DD, Dd	Not produced	Rh^{+ve}	Rh^{+ve}, Rh^{-ve}
Rh^{-ve}	Absent	Dd	Produced (If stimulated)	Rh^{+ve}	Rh^{-ve}

Erythroblastosis Feotalis

- This is **materanal-foetal Rh incompatibility** results when as Rh^{-ve} woman, married to Rh^{+ve} man conceives a child who is Rh^{+ve}.
- If the **RBCs of Rh^{+ve} foetus** cross the placental barrier and enter into **Rh^{-ve} mother's blood stream,** then the mother's immune system reacts to the foetal Rh-antigen stimulus by producing large number of anti **Rh antibodies.**
- The **first Rh incompatible** pregnancy may **not face much problems.** But when placenta detaches at birth, a large number of foetal cells enter mother's blood stream and stimulate production of large amount of **anti-Rh antibodies by the mother.** These anti-Rh antibodies persist in mother's blood for a long time and are persistent risk for the next Rh^{+} foetus.
- When **mother's anti-Rh antibodies seep through placenta** into the circulation of foetus, they start **hemolysis of RBCs** of the foetus, which results in **anemia.** This anemia may lead to **abortion** or still birth.
- Even if the pregnancy continues, the liver and spleen of the foetus swell as they rapidly produce RBCs. The breakdown product of RBC called **bilirubin** also accumulates in the foetus.
- Bilirubin damages his brain cells and turns skin and whites of the eye yellow of the foetus. This condition is **jaundice.**

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Control of Rh Incompatibility

- Rh sensitization of Rh mother is avoided by simple therapy. She is given an **injection of Rh-antiserum** during early pregnancy and immediately after birth.
- The **Rh-antibodies** in the Rh-antiserum will **destroy Rh⁺ Red blood cells** of the foetus before they stimulate production of maternal anti-Rh antibodies. The injected antiserum disappears before the next pregnancy.

GENE LINKAGE & CROSSING OVER

Gene Linkage

- Phenomenon of **staying together** of all the genes of a chromosome is called gene linkage. Gene linkage is **a physical relationship** between genes.
- The number of genes in a cell is far greater than the number of chromosomes. In fact, each chromosome has **hundreds and thousands of genes**. So, a chromosome carries its linked genes **en block** (altogether) in the form of linkage group.
- The number of linkage groups corresponds to the number of homologous pairs of chromosomes. For example, man has **23 linkage groups.**
- Gene linkage is a limitation for Mendelian law of independent assortment.

Types of Gene Linkage

i. **Autosomal linkage**
- If genes are linked on autosomes, their linkage is called autosomal linkage.

ii. **Sex Linkage**
- If genes are linked on sex chromosome, their linkage is called sex linkage.

Detection of Gene Linkage

- Gene linkage can easily be detected by performing a **test cross between two gene pairs** (dihybrid test cross). In such type of test cross, a heterozygous individual for two traits (F_1) is back crossed with its recessive parent (P_1).

Conclusion

1) If all four phenotypic combinations (parental and recombinants) are produced in equal **1:1:1:1** ratio, then there would be **no linkage** between the genes.
2) If this ratio is deviated i.e., **more parental types** and less recombinant types, this indicates the **incomplete or partial linkage.**
3) But if **only parental types** are produced, **complete or tight linkage** is believed. In a typical dihybrid cross, the complete or tight linkage inhibits the outcome of recombinant types and disturbs 9:3:3:1 ratio of independent assortment, as a result, only parental combinations are produced in 3:1.

Examples

- Genes for **color blindness, haemophilia,** and **gout** etc. form one **linkage group** on human **X-chromosome** (23).
- Gene for **sickle cell anemia, leukemia** and **albinism** etc. form linkage group on human **chromosome 11.**

Crossing Over

- Crossing over is an **exchange of segments** between **non-sister chromatids** of homologous chromosomes during meiosis.
- **Linked genes** can be **separated** by crossing over. Closer the two gene loci, more strongly their genes linked. The farther apart two genes lie; greater are chances of their separation through crossing over.
- **Crossing over minimizes the chances of gene linkage.**

Recombination Frequency

- Cross over or recombination frequency is the proportion of recombinant types between two gene pairs as compared to the sum of all combinations.
- The **recombination frequencies** between **two linked genes** can be **calculated** by **backcrossing** the heterozygote to a homozygote double recessive.

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- Its value is directly proportional to distance between the linked gene loci.
- Genes can be mapped on a chromosome on the basis of their recombination frequencies.

SEX LINKAGE IN DROSOPHILA

- T. H. Morgan (1910) provided experimental evidence in support of chromosomal theory of heredity through discovery of sex linkage in Drosophila.

Reasons for Selection of Drosophila

- Drosophila is a very useful organism for genetic studies for many reasons. For example;
  i. Easy collection & culturing
  ii. Sexual dimorphism
  iii. Short generation time
  iv. Excellent for genetic studies
  v. Fairly large number of distinct contrasting traits e.g., 85 traits identified by Morgan and his colleagues.
  vi. Part of human genome project

Morgan's Experiments and Crosses

- Morgan raised cultures of Drosophila flies to study different traits, such as colour of the eye.
- Normal fruit flies, the wild type, have bright red eyes. One of his coworkers Calvin Bridges, observed an unusual white eye mutant male fly.

Step 1: Normal Cross

- Morgan mated white eyed male with a wild type red eyed female. All 1237 offsprings of this cross had red eyes. Morgan concluded that red eye is dominant trait.

Step 2: Normal Cross

- Morgan allowed males and females of F_1 generation to mate and produce F_2 generation. He counted 2459 red eyed females, 1011 red eyed males and 782 white eye males among F_2.

Observations

- Offspring produced due to this cross were red-eyed females, red-eyed males and white- eyed males.
- The proportion of 3470 red eyed to 782 white eyed flies did not perfectly fit into Mendelian 3:1 ratio.
- The number of recessive phenotype individuals were too small.
- All the white-eye flies were only males. There was no white eye female in F_2.

Conclusion

- The inheritance of eye color somehow seemed to be related to sex of offspring. Morgan proposed that:
  i. The gene for eye color is located on X-chromosome.
  ii. The alleles for eye color are present only on X-chromosome. There is no corresponding allele for this trait on Y-chromosome.
  iii. Single recessive allele on X-chromosome can express itself in males because Y- chromosome is empty for that gene.
- Now we can relate these crosses with genotype. The genotype of the parents of P_1 cross were $X^{w+}X^{w+}$ for red eye female and $X^{w}Y$ for white eye male.

Step 3: Test Cross

- Morgan wanted to test his hypothesis. He crossed the P_1 white eyed male (XY) with one of its own daughters (the red-eyed heterozygous female from F_1 generation).
- Out of total offspring of this cross, half female offspring had red eyes and half had white. Similarly, half the males had red eyes and half had white.

Step 4: Reciprocal Cross / Confirmatory Test

- Appearance of white-eyed female provided an opportunity for a further confirmatory test.
- Morgan mated a white-eyed female with a red-eyed male. All female offspring had red eyes and all male offspring had white eyes.

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- When F_1 red-eyed females and white-eyed males were mated to produce F_2, then half of the F_2 females had red eyes and half white eyes.
- Similarly, half of the F_2 males had red eyes & half white. This $F_1 \times F_1$ cross was exactly like step 3 test cross.

SEX LINKAGE IN HUMANS

- A trait whose gene is present on **X chromosome** is called **X-linked trait**. X-linked traits are commonly referred as sex-linked traits.
- X-linked recessive traits are common in male while X-linked dominant traits are common in female.
- **X-linked recessive** traits follow **zigzag path** while Y-linked traits are transmitted in **straight way.**
- Genes located on the homologous region of Y- chromosomes are called **Y-linked genes** and their traits are called Y- linked traits or **holandric traits.**
- Such traits whose genes are located on both 'X' and 'Y' chromosomes are called 'X' and 'Y' linked or **pseudoautosomal traits.**
- Experimental mating is practically not possible in humans. Mode of inheritance of human traits can be traced **through pedigree.**

HAEMOPHILIA

- It is a rare **X-linked recessive** trait.
- Hemophiliac's blood **fails to clot** properly after an injury, because it has either reduction or malfunction or complete absence of blood clotting factors.
- It is a serious heredity disease because a haemophilic may bleed to death even from minor cuts.

Types of Haemophilia

Type	Occurrence	Factor	Genetics
A	80%	VIII	X-Linked recessive
B	20%	IX	X-Linked recessive
C	Less than 1%	XI	Autosomal recessive

- **Haemophilia 'A' and 'B'** are **non-allelic** recessive sex-linked, but **haemophilia 'C'** is an **autosomal recessive** trait (autosome 4).
- **Haemophilia 'A' and 'B'** have **more chances** in male as compared to female while **haemophilia 'C'** has **equal chances** in both male and female.

Genetics of Haemophilia A

- A woman can suffer from **haemophilia 'A'** only when she is **homozygous** for the recessive allele.
- A man with just one recessive allele will display the trait.
- **Haemophilia 'A' zigzags** from maternal grandfather through a carrier daughter to a grandson. It never passes directly from father to son.
- Gene for **normal** is 'H' and gene for **haemophilia 'A'** is 'h'.

Conditions of Haemophilia

Gender	Genotype	Phenotype
Female	X^HX^H	Normal
	X^HX^h	Normal but carrier
	X^hX^h	Haemophilic
Male	X^HY	Normal
	X^hY	Haemophilic

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COLOR BLINDNESS

- It is a hereditary disease in which a person cannot differentiate between different colors.
- Normal trichromatic color vision is based on three different kinds of cone cells in the retina, each sensitive to one of the three primary colors, red, green, and blue.
- Each type of cone cell has specific light absorbing proteins called opsins.

Genetics

- The genes for red and green opsins are present on X-chromosome while the gene for blue opsin is present on autosome 7.

Types of Color Blindness

- Dichromacy can perceive two primary colors but is unable to perceive one whose opsins are missing.

Type of Dichromacy		
Type	Blindness	Perception
Protanopia	Red blindness	Green, Blue
Deuteranopia	Green Blindness	Red, Blue
Tritanopia	Blue blindness	Red, Green

Protanomalous

- Some people can detect red and green but with altered perception of the relative shades of these colors. They have abnormal but still partially functional opsins.
- They are protanomalous and deuteranomalous for red and green blindness, respectively.

Monochromacy

- A monochromat can perceive only one color. Monochromacy is true color-blindness.
- Blue cone monochromacy is an X-linked recessive trait in which red and green cone cells are absent. It is also called red-green blindness.
- Like any sex-linked recessive traits, it also zigzags from maternal grandfather through a carrier daughter to a grandson. It never passes directly from father to son.
- This type of color blindness is more common in men than women, because chances for a male to be affected by it are much more than a female.

TESTICULAR FEMINIZATION SYNDROME

- Testicular feminization syndrome/androgen insensitivity syndrome is a rare X-linked recessive trait in which a person has 'X' and 'Y' chromosomes yet tfm genes on their X- chromosome develops them physically into female.
- They have breast, female genitalia, a blind vagina, no uterus, and degenerated testes are present in abdomen. Such individuals are happily married as females but are sterile.

SEX-LIMITED TRAITS

- A sex-limited trait is a type of sex related trait which is confined to only sex due to anatomical differences e.g. beard growth in human male and milk yield in cows.

SEX- INFLUENCED TRAITS

- Sex influenced traits are also a type of sex related traits.
- These occur in both males and females, but they are more common in one sex.
- Such traits are controlled by an allele that is expressed as dominant in one but recessive in the other.
- This difference is expression is due to hormonal difference between the sexes. e.g. pattern baldness which is inherited as an autosomal dominant trait in males but as an autosomal recessive trait in females
- A heterozygous male can be bald, but a heterozygous female is not. A woman can be bald only when she is homozygous recessive.

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Traits and Examples

Trait	Example
X-Linked Recessive	Haemophilia (A & B), Colour blindness (Red & Green), Testicular feminization syndrome, Duchenne muscular dystrophy, Lesch-Nyhan syndrome
X-Linked Dominant	Hypophosphatemic or vitamin 'D' resistant rickets, Fragile X-syndrome, Rette syndrome
Y-Linked Trait	Maleness, Webbing of toe, Testis Determination (SRY gene), Hypertrichosis (Hairy pinna), Porcupine male.
Pseudo autosomal trait	Bobbing in insects
Autosomal Dominant Traits	Blue Colour Blindness, Huntington's Disease, Achondroplasia, Familial Hypercholesterolemia, Tongue Rolling
Autosomal Recessive Traits	Haemophilia 'C', Cystic Fibrosis, Sickle Cell Anemia, Tay-Sachs Disease, Phenylketonuria (PKU), Albinism, Thalassemia
Sex limited trait	Milk yield in cow, Beard in man
Sex influenced trait	Baldness, Gout, Height and Muscle Mass

CHROMOSOMAL ABERRATION / NON-DISJUNCTION

- Failure of chromosomes to separate properly during meiosis (Anaphase), leading to gametes with an abnormal chromosome number.

Disorder	Affected Chromosome(s)	Karyotype	Symptoms/Features
Down Syndrome	Trisomy 21	47, XX/XY, +21	Intellectual disability, flat facial profile, short stature, heart defects, single palm crease.
Klinefelter Syndrome	Extra X chromosome in males	47, XXY	Tall stature, reduced testosterone levels, gynecomastia, infertility.
Turner Syndrome	Monosomy X	45, X	Short stature, webbed neck, lack of secondary sexual characteristics, infertility.
Edward Syndrome	Trisomy 18	47, XX/XY, +18	Severe intellectual disability, clenched fists, low birth weight, organ abnormalities.
Patau Syndrome	Trisomy 13	47, XX/XY, +13	Severe intellectual disability, cleft lip/palate, polydactyly, heart defects.
Jacobs Syndrome (XYY Syndrome)	Extra Y chromosome in males	47, XYY	Tall stature, normal fertility, mild learning disabilities, sometimes behavioral issues.
Metafemales (XXX Syndrome)	Extra X chromosome in females	47, XXX	Tall stature, normal fertility, mild learning difficulties, delayed speech/motor skills, usually no severe physical abnormalities.

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1. Genes keeps on hopping on different loci on the same chromosome or other chromosomes called:
(A) Polygene
(B) Jumping gene
(C) Multiple gene
(D) Jumping gene and Multiple gene
2. Partner of a gene pair occupying the same gene locus is called:
(A) Nucleosome (B) Allele
(C) Genome (D) Gene
3. A gene at one locus interacts with another gene at another locus, the interaction is known as:
(A) Multiple alleles (B) Dominance
(C) Pleiotropy (D) Epistasis
4. Genotype and phenotype ratio are different in:
(A) Over dominance
(B) Co-dominance
(C) Complete dominance
(D) Incomplete dominance
5. ABO blood group system is an example of:
(A) Polygenes (B) Multiple genes
(C) Multiple alleles (D) Multiple mutation
6. It is a physiological effect of an allele over its partner allele at same gene locus called:
(A) Epistasis (B) Pleiotropy
(C) Dominance (D) Mutation
7. The position of gene on the chromosome called:
(A) Location (B) Locus
(C) Place (D) Habitat
8. A permanent change in the cell's DNA include changes in nucleotide sequence, alternation of gene position, gene loss or duplication and insertion of foreign sequences:
(A) Amplification (B) Transposition
(C) Inheritance (D) Mutation
9. During monohybrid cross how much true breed round are produced in F_2 generation:
(A) 2/4 (B) 1/4
(C) 3/4 (D) 4/4
10. Alleles of two or more gene pairs at different loci influencing the same trait in an additive way:
(A) Epistasis (B) Polygenes
(C) Pleiotropy (D) Mutation
11. A character determined by three alleles is:
(A) Human skin color
(B) Human blood group
(C) Human eye color
(D) Human Rh factor
12. A measurable or observable trait or characteristics is called a:
(A) Phenotype
(B) Genotype
(C) Single nucleotide polymorphism (SNP)
(D) Genome
13. X-linked dominant traits are common in:
(A) Males
(B) Females
(C) Insects
(D) Males and females
14. X-linked follow _____ while Y-linked traits are transmitted in _____:
(A) Straight path, straight path
(B) Zigzag path, Crisscross path
(C) Zigzag path, straight path
(D) Straight path, Zigzag path
15. It is an example of X-linked dominant trait:
(A) Maleness
(B) Baldness
(C) Hypophosphatemic resistant rickets
(D) Hemophilia
16. Human skin color is a good example of:
(A) Sex linked inheritance
(B) Polygenic inheritance
(C) X-linked inheritance
(D) Y-linked Inheritance
17. If father of a child is hemophilic and mother is a carrier the chances of the baby inheriting the disease will be:
(A) 25% (B) 0%
(C) 75% (D) 50%
18. Heamophilia A is due to abnormality of factor:
(A) X (B) VII
(C) IX (D) VIII
19. Genes that are located at the same position on homologous chromosome are called:
(A) Recessive (B) Dominant
(C) Allele (D) Genome
20. When a gene suppresses the effect of a gene at another locus, this is called:
(A) Over dominance (B) Pleiotropy
(C) Codominance (D) Epistasis
21. It is an example of autosomal recessive trait:
(A) Haemophilia C (B) Haemophilia A
(C) Tritanopia (D) Protanopia

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22. When the phenotype of a heterozygote is intermediate between phenotypes of two homozygotes, it is called:
(A) Complete dominance
(B) Incomplete dominance
(C) Over dominance
(D) Co-dominance

23. Different alleles of a gene that are both expressed in heterozygous condition are called:
(A) Over dominant
(B) Incompletely dominant
(C) Codominant
(D) completely dominant

24. Rh blood group system is encoded by gene/s:
(A) C (B) D
(C) E (D) C, D and E

25. A person with genotype "I^A-I^B. dd" & will have a blood group:
(A) AB^{+ve} (B) AB^{-ve}
(C) O^{+ve} (D) O^{-ve}

26. Pick up the linked genes:
(A) Leukemia, color blindness
(B) Sickle cell Anemia, Gout
(C) Albinism, Gout
(D) Leukemia, Albinism

27. Linked genes can be separated by:
(A) Crossing over
(B) Independent assortment
(C) Segregation
(D) Reshuffling of genetic make up

28. Greater is the distance between gene loci:
(A) Lesser will be the chance of crossing over
(B) Greater will be the chance of crossing over
(C) Stronger will be the gene linkage
(D) Negligible will be the chances of crossing over

29. A dihybrid cross is a:
(A) Self-fertilization among dihybrids
(B) Cross fertilization with a dihybrid
(C) A back cross of a dihybrid
(D) A test cross of dihybrid

30. As a result of dihybrid cross made by Mendel the number of individuals with double homozygous recessive traits was:
(A) 9/16 (B) 3/16
(C) 1/16 (D) 6/16

31. Jumping genes keep on hopping on different loci:
(A) On the same chromosome
(B) On different chromosome
(C) On the same or different chromosome
(D) On different genomes

32. Pick up the heterozygous gene:
(A) RR (B) Rr
(C) rr (D) YY

33. The genotype of a round shaped pea seed which does not produce wrinkled seeds on self-cross will be:
(A) RR (B) Rr
(C) rr (D) YY

34. When both alleles of a gene pair in an organism are same it is called:
(A) Homozygous (B) Hemizygous
(C) Heterozygous (D) Homologous

35. The human male differs from human female in lacking:
(A) X chromosome (B) Y chromosome
(C) XX chromosome (D) Autosomes

36. Twenty third pair of chromosomes in human male is:
(A) Homologous (B) Isomorphic
(C) Heteromorphic (D) Autosomal

37. SRY is located on the:
(A) Tip of long arm of Y chromosome
(B) Tip of short arm of X chromosome
(C) Tip of short arm of Y chromosome
(D) Tip of long arm of X chromosome

38. What kind of sex-determining pattern is found in human being:
(A) ZZ-ZW system (B) XO-XX system
(C) XY-XX system (D) XX-XY system

39. In human sex of the offspring is determined by the:
(A) Type of egg (B) Type of sperm
(C) Number of eggs (D) Number of sperms

40. Chances for son or daughter in human birth are:
(A) Indeterminate (B) Variable
(C) Never equal (D) Equal

41. Only those genes can assort independently whose loci are on:
(A) Same chromatid
(B) Non-homologous chromosomes
(C) Same chromosome
(D) Homologous

42. Which of the following does not follow Mendel's law of independents assortment?

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(A) Alleles (B) Multiple alleles
(C) Linked genes (D) Non- linked genes

43. **The actual purpose of test cross is to know the:**
(A) Genotype of dominant phenotypic trait
(B) Phenotype of any individual
(C) Genotype of recessive phenotypic
(D) Genotype of any individual

44. **Dominance is physiological effect of an allele over its partner allele occupying:**
(A) Same locus on same chromosome
(B) Same locus on respective homologue
(C) Different locus on same chromosome
(D) Different locus on respective homologue

45. **Which one is non-allelic interaction?**
(A) AB blood group
(B) Seed color in pea plant
(C) Hemophilia C
(D) Bombay phenotype

46. **What is true about occurrence of erythroblastosis foetalis?**
(A) Occurs when both father and mother are Rh + ive
(B) Occurs when both father and mother are Rh-ive
(C) Occurs when mother is Rh + ive and father is Rh –ive
(D) Occurs when mother is Rh – ive and father Rh + ive

47. **When both alleles are expressed partially in phenotype of an organism, it is:**
(A) Over dominance
(B) Incomplete dominance
(C) Co-dominance
(D) Complete dominance

48. **Which of the following is a case of co-dominance?**
(A) I^AI^A (B) I^Ai
(C) I^AI^B (D) ii

49. **If there is cross between round and yellow with wrinkled and green, the F2 gives _____ wrinkled green:**
(A) 9/16 (B) 3/16
(C) 1/16 (D) 2/16

50. **When two or more genes interact in a way that their effect is additive expression, it is?**
(A) Dominance relation (B) Epistasis
(C) Polygenic inheritance (D) Pleiotropy

51. **When a phenotype of heterozygotes appears distinct/ different than those of homozygotes, the relation is called:**
(A) Complete dominance
(B) Co-dominance
(C) Incomplete dominance
(D) Over dominance

52. **Which type of variation is exhibited by pea seed shape?**
(A) Continuous qualitative variation
(B) Continuous quantitative variation
(C) Discontinuous qualitative variation
(D) Discontinuous quantitative variation

53. **Even a single recessive allele on X chromosome in male can be expressed because:**
(A) All genes on X chromosome can be expressed
(B) Y chromosome has dominant allele for that trait
(C) X chromosome alleles are dominant over Y chromosome
(D) Y chromosome does not have counter part of allele of X chromosome

54. **Genes present on both X and Y chromosomes are known as:**
(A) X-linked (B) Sex linked
(C) Y-linked (D) Pseudoautosomal

55. **Traits which pass direct from father to son:**
(A) Color blindness (B) Maleness
(C) Ichthyosis (D) Hemophilia

56. **_____ gene is male sex switch which triggers developmental process towards maleness:**
(A) Se (B) tfm
(C) SRY (D) H

57. **Sex chromosomes in human female are:**
(A) Pseudo autosomes (B) Heteromorphic
(C) Isomorphic (D) Homozygous

58. **SRY is the maleness-determining gene which trigger developmental process towards maleness after _____ week pregnancy:**
(A) 2 (B) 6
(C) 4 (D) 8

59. **How many chromosomes in humans are similar in both male and female?**
(A) 23 (B) 45
(C) 44 (D) 46

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60. When a tall pea plant (TT) is crossed with a dwarf plant (tt), what will be the F2 generation?
(A) All tall plants (B) 3 tall 1 dwarf
(C) All dwarf plants (D) 3 dwarf 1 tall

61. The allele which is unable to express itself in the presence of another is called:
(A) Co-dominant (B) Supplementary
(C) Complementary (D) Recessive

62. A person having antigen I^A and I^A and "Dd" in his blood cells what will be the blood type of that person?
(A) AB^+ (B) A^-
(C) A^+ (D) B^+

63. Genotype is.
(A) Physical appearance of an organism
(B) The interaction of an organism with its environment
(C) The chromosomal structure of a cell
(D) The genetic makeup of an organism

64. F_2 generation offsprings in a plant showing incomplete dominance exhibits:
(A) Phenotypic ratio of 3:1
(B) Similar genotypic and phenotypic ratio of 1:2:1
(C) Variable genotypic and phenotypic ratios
(D) A genotypic ratio of 1:1

65. A person with blood group A possesses:
(A) Antigen A and no antibody
(B) Antigen B and antibody A
(C) No antigen and no antibody
(D) Antigen A and antibody B

66. B blood group person can donate blood to____ and receive blood from_____:
(A) B, O and B, O (B) B, AB and B, AB
(C) B, AB and B, O (D) A, B and A, B

67. Some of the dominant traits studies by Mendel were:
(A) Terminal flower position, green pod colour and inflated pod shape
(B) Wrinkled seed shape, yellow pod colour, and axial flower position
(C) Axial flower position, green pod colour, round seed shape
(D) Round seed shape, green seed colour and axial flower

68. The form or appearance of a trait is called:
(A) Mutation (B) Genotype
(C) Phenotype (D) Both B & C

69. Which of these is a dominant character of pea plant?
(A) Terminal flower (B) Inflated pod
(C) Green seed colour (D) Yellow colour pod

70. Height of short plant studied by Mendel was:
(A) 3-7 inches (B) 9-18 inches
(C) 7-9 inches (D) 8-19 inches

71. According to Mendel each contrasting form of trait was determined by hereditary factors called:
(A) Genes (B) Elements
(C) Alleles (D) Loci

72. If 50 % round and 50 % wrinkled seeds are obtained in a test cross, then the tested phenotypically dominant individual is:
(A) Homozygous (B) Hemizygous
(C) Heterozygous (D) All of these

73. The distribution of alleles of one trait into gametes:
(A) Effects the distribution of alleles of the other trait
(B) Has no influence on the distribution of alleles of the other trait
(C) Multiply the number of alleles of the other trait
(D) All of these

74. If father of a child is hemophilic and mother is a carrier the chances of the baby inheriting the disease will be:
(A) 25% (B) 0%
(C) 75% (D) 50%

75. Heamophilia A is due to abnormality of factor:
(A) X (B) VII
(C) IX (D) VIII

76. It is an example of autosomal recessive trait:
(A) Haemophilia C (B) Haemophilia A
(C) Tritanopia (D) Protanopia

77. A normal woman whose father was colour blind married a colour blind man. What is the percentage of her first-born child being colour-blind:
(A) 1% (B) 75%
(C) 66% (D) 50%

78. If there is cross between round and yellow with wrinkle and green, the F_2 gives wrinkle green:
(A) 3/16 (B) 9/16
(C) 1/16 (D) 2/16

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79. A mating experiment between two organism that are particularly different from two trait is called:
(A) Monohybrid cross (B) Dihybrid cross
(C) Test Cross (D) Back cross

80. Different alleles of a gene that are both expressed in a heterozygous conditions are called:
(A) Dominance
(B) Co-dominance
(C) Incomplete dominance
(D) Over dominance

81. Which of the following will be haemophilic?
(A) $X^{H}X^{h}$ (B) $X^{h}Y$
(C) $X^{H}X^{H}$ (D) $X^{H}Y$

82. The sex of individuals of next generation always depends on one of the parents, who is:
(A) Heterogametic (B) Isogametic
(C) Homogametic (D) Isomorphic

83. Which trait in humans is an example of multiple alleles?
(A) Eye colour (B) ABO-blood group
(C) Skin colour (D) Rh-Blood group

84. The gene for ABO-blood group system in humans is represented by symbol:
(A) X (B) Y
(C) I (D) O

85. In men sex-determination depends upon the nature of:
(A) Heterogametic male
(B) Heterogametic female
(C) Homogametic female
(D) Homogametic male

86. Which pigment is present in the skin, hair and eyes of a normal individual?
(A) B-carotene (B) Melanin
(B) Xanthophylls (D) Rhodopsin

87. Cross between true breeding 4 O'clock plant producing red flower and true breeding 4 O'clock plant producing white flower is a case of:
(A) Incomplete dominance
(B) Co-dominance
(C) Partial dominance
(D) Both A & C

88. Punnett square for incomplete dominance indicates that:
(A) Phenotypic ratio in same as the genetic ratio
(B) Phenotypic ratio is different from the genetic ratio
(C) There is no need of test cross
(D) Both A & C

89. In 1901, Karl Landsteiner discovered blood group system:
(A) ABO (B) MNSs
(C) MN (D) Rh

90. Any blood transfusion is ideally safe, if it:
(A) Does not cause agglutination in the recipient
(B) Does not undergo hemolytic reaction
(C) Both A & B
(D) Cause agglutination

91. If one parent has type AB blood and the other parent has type O blood, what will be the possible blood group type in their offspring?
(A) Type O (B) Type B
(C) Type AB (D) All possible

92. In the F2 generation of a monohybrid cross, the phenotypic ratio would be:
(A) 1:1:2 (B) 2:1:1
(C) 1:2:1 (D) 3:1

93. Hemophilia is a sex-linked recessive trait in humans. If a father and a son are both hemophiliacs, but the mother is normal, her genotype must be:
(A) $X^{H}X$ (B) $X^{H}X^{h}$
(C) $X^{h}X^{h}$ (D) $X^{H}X^{H}$

94. A normal woman whose father was colour blind is married to a normal man. The sons would be:
(A) All normal (B) 50% colourblind
(C) All colourblind (D) 75% colourblind

95. Hemolytic disease of the newborn is called:
(A) Anemia
(B) Jaundice
(C) Erythroblastosis foetalis
(D) Erythrosis

96. Mendel studied seven contrasting pairs of traits but their gene confined to only _____ chromosomes:
(A) 4 (B) 6
(C) 5 (D) 7

97. An Rh^{-} woman is married to Rh^{+} man whose father was also Rh^{-}. What is the probable risk of erythroblastosis fetalis in their babies:
(A) 50 % (B) 0%
(C) 100% (D) 25%

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98. In humans, maleness is:
(A) X-linked trait
(B) Sex influenced trait
(C) Y-linked trait
(D) Autosomal trait

99. A student learns about ABO blood group system. He knows that he is type O and his father is type AB. He wonders how this blood could be arisen. Suggest how type A and AB parent could produce a child of O:
(A) Student is Bombay phenotypic
(B) Parents are abnormal
(C) Student has more than one antigens
(D) This is impossible

100. Pattern of sex determination in humans is:
(A) XO-XX (B) XX-XY
(C) XY-XX (D) ZZ-ZW

101. Autosomal recessive trait effect both men and women equally:
(A) Hemophilia A (B) Hemophilia B
(C) Hemophilia C (D) Both A & B

102. __ zigzag from maternal grandfather through a carrier daughter to grandson:
(A) Hemophilia A (B) Hemophilia C
(C) Hemophilia B (D) Both A and C

103. A normal man married to carrier women. How much of his offspring would be normal:
(A) 25% (B) 75%
(C) 50% (D)No one is normal

104. Sex ratio in humans is:
(A) 1:1 (B) 2:1
(C) 1:2 (D) 2:2

105. It is a type of heredity disorder that has equal chances in both male and female:
(A) Haemophilia C
(B) Hypophosphatemic rickets
(C) Tritanopia
(D) Pattern baldness

106. The position of the gene on the chromosome is:
(A) allele (B) Gene position
(C) locus (D) chromatid

107. According to _____two co-existing alleles for each trait in an individual separate from each other so that each gamete receives only one of the two alleles:
(A) Law of independent assortment
(B) Law of Segregation
(C) Law of Hardy-Weinberg
(D)Law of Co dominance

108. True breeding round seed plants of P1 generation carried rr alleles. Genotype of organism in this generation is:
(A) Homozygous (B) Heterozygous
(C) Homozygote (D) Heterozygous

109. All the altered alternate forms of a gene, whose number is more than two, are called:
(A) Phenotypic gene (B) Gene pool
(C) Multiple Alleles (D) Dominant Alleles

110. When two contrasting pairs of traits are followed in the same cross their alleles assort independently, this law is stated as:
(A) Law of Independent Assortment
(B) Mendel's Law of Segregation
(C) Mendel's law of evolution
(D)Law of natural selection

111. Polymorphic gene I is present on chromosome:
(A) 16 (B) 9
(C) 12 (D) 6

112. A gamete without any sex chromosome is known as:
(A) Heterogametic (B) Homogametic
(C) Abnormal gamete (D) Nullo Gamete

113. ZZ-ZW pattern is common in:
(A) Birds and butterflies (B) Plants
(C) Drosophila (D) Grasshopper

114. When one gene does not allow the expression of other non-allelic gene, it is referred to as?
(A) Dominance (B) Mutation
(C) Epistasis (D) Pleiotropy

115. Which of the following processes can reduce variations?
(A) Inbreeding (B) Out breeding
(C) Cross pollination (D) Hybridization

116. The phenomenon of staying together of all the genes of chromosomes is called:
(A) Linkage (B) Mutation
(C) Homozygous (D) Histogram

117. An organism with two identical alleles of a gene in a cell is called:
(A) Homozygous (B) Dominant
(C) Heterozygous (D) Hybrid

118. When an allele fails to express itself in F1 generation in the presence of another allele, the former is said to be:
(A) Recessive (B) Co-dominant
(C) Complementary (D) Epistatic

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119. Alleles are:
(A) Homologous chromosomes
(B) Chromosomes that have crossed over
(C) Alternate forms of a gene
(D) Linked genes

120. When an individual is having both the alleles of contrasting characters it is said to be:
(A) Heterozygous (B) Dioecious
(C) Monoecious (D) Hermaphrodite

121. Inheritance of 'ABO' blood group shows:
(A) Polyploidy
(B) Overdominance
(C) Incomplete dominance
(D) Multiple allelism

122. Which of following minimizes the chance of genetic recombination?
(A) Crossing over (B) Epistasis
(C) Gene linkage (D) Pleiotropy

123. Baldness in humans is _____ trait:
(A) Sex limited (B) Sex influenced
(C) Pseudoautosomal (D) Polygenic

124. A single gene with multiple phenotypic effects represents:
(A) Co-dominance (B) Pleiotropy
(C) Epistasis (D) Crossing over

125. If your blood group is AB, you can receive blood from donor with blood group:
(A) A (B) B
(C) AB (D) all of these

126. To prevent erythroblastosisfoetalis mother is given Rh-antiserum:
(A) During early pregnancy
(B) After birth
(C) At both times
(D) Not given

127. Secretors have dominant secretor gene "Se" on chromosome:
(A) 9 (B) 11
(C) 21 (D) 19

128. Most gametes have parental combination of linked genes, but some are different as a result of:
(A) Segregation (B) Independence
(C) Non-disjunction (D) Crossing over

129. Haemophilia is a serious genetic disease in which:
(A) Blood clots vary fast
(B) Blood fails to clot or clots very slowly after an injury
(C) Formation of red blood cells increased
(D) Haemoglobin fails to absorb oxygen

130. A person with blood type AB can donate blood to another one having blood type:
(A) O, A, B, AB (B) AB
(C) B and AB (D) A and AB

131. Colour blindness is more common in men than women because:
(A) Its allele is situated on the 'X' chromosome only
(B) Its allele is recessive
(C) Its allele is recessive and is situated on the 'X' chromosome only
(D) 'X' chromosome only

132. A person having blood type O is universal donor because of:
(A) Absence of antibodies in blood
(B) Presence of antigen a only
(C) Absence of antigens on RBCs
(D) Presence of antigens B only

133. Inheritance of colour of kernel in wheat is an example of:
(A) Monogenic inheritance
(B) Polygenic inheritance
(C) Pleiotropic inheritance
(D) None of these

134. All the following characters are sex related except:
(A) Baldness (B) Haemophilia
(C) Albinism (D) Colour blindness

135. Protanopia are those who can / are:
(A) See red (B) Green blind
(C) Red blind (D) Blue blind

136. Insulin dependent diabetes mellitus is due to:
(A) Obesity (B) Auto immunity
(C) Aging (D) Cancer

137. Genes which don't settle at one place:
(A) Walking genes (B) Running genes
(C) Jumping genes (D) All of these

138. Which one is an example of co-dominance?
(A) MN (B) AB
(C) O (D) Both a & b

139. Which one is universal recipient?
(A) O^+ (B) O^-
(C) AB^+ (D) AB^-

140. Who gave the word of genes?
(A) Fleming (B) Correns
(C) Johannsen (D) Avery

141. Secretors have antigens in their:

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(A) Kidneys (B) Secretions
(C) Interstitium (D) Body cells

142. Which blood group has no antigen?
(A) O (B) A
(C) B (D) AB

143. Which blood group has no antibodies of ABO system?
(A) A (B) B
(C) AB (D) AB

144. Bombay phenotype has _____ blood group phenotype:
(A) A (B) B
(C) AB (D) O

145. If husband and wife have 'O' blood groups they will have no child of:
(A) A (B) B
(C) AB (D) All

146. XO syndrome in drosophila is a:
(A) Sterile male
(B) Fertile male
(C) Sterile female
(D) Fertile female

147. Universal donors are:
(A) Recessive (B) Rare
(C) Both (D) Dominant

148. Which type of hemophilia is due to disturbance in factor XI:
(A) A (B) B
(C) C (D) both a & b

149. Deuteranopia is _____ colour blindness:
(A) Green (B) Red
(C) Blue (D) All

150. Which colour blindness is not sex linked?
(A) Green (B) Red
(C) Blue (D) None

151. X-linked recessive traits are:
(A) More in females (B) More in males
(C) Less in male (D) common in both

152. The chances of which hemophilia is equal in male & females:
(A) A (B) B
(C) C (D) All

153. Man has _____ linkage group:
(A) 23 (B) 21
(C) 25 (D) 46

154. The two linked genes A and B with a 30% recombination frequency must be:
(A) 15 units apart (B) 30 units apart
(C) 60 units apart (D) 90 units apart

155. SRY is located at the tip of:
(A) Short arm of X-chromosome
(B) Short arm of Y-chromosome
(C) Long arm of Y-chromosome
(D) Long arm of X-chromosome

156. Pseudo-autosomal genes are present on:
(A) X-chromosome (B) Y-chromosome
(C) Autosomes (D) Both A & B

157. Diabetes is the leading cause of:
(A) Kidney failure (B) Adult blindness
(C) Heart disease (D) All of these

158. Blood pressure is also an example of _____ trait:
(A) Multifactorial (B) Qualitative
(C) Single genic (D) Both a & b

159. A carrier mother for colour blindness does not have:
(A) A normal boy (B) A carrier boy
(C) A colour blind boy (D) A normal daughter

160. How many kinds of rhodopsins, a blue cone monochromate will have?
(A) 3 (B) 2
(C) 1 (D) no rhodopsins

161. Degenerated testes are present in abdomen in which of these cases:
(A) Down's syndrome
(B) Klinefelter's syndrome
(C) Turner's syndrome
(D) Testicular feminization syndrome

162. Insulin receptors are present in:
(A) Cytoplasm of muscle cells
(B) Cell membrane of liver cells
(C) Cell membrane of muscle and liver cells
(D) Cell membrane of all body cells

163. A blue cone monochormate:
(A) Can perceive two colours
(B) Can't perceive any colour
(C) Can perceive only blue colour
(D) Can perceive only red colour

164. Mendel work was neglected for_____ years:
(A) 34 (B) 10
(C) 16 (D) 20

165. What will be the risk of heamophilia in sons if father is haemophilic and mother is normal?
(A) 0% (B) 20%
(C) 25% (D) 50%

166. Queen Victoria was having which kind of haemophilia:

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(A) A (B) B
(C) C (D) none

167. Genes can be mapped on chromosomes on the basis of:
(A) Sex linkage
(B) Assortment
(C) Recombination frequency
(D) Gene sequencing

168. Who explained the genetic basis of ABO blood group system?
(A) Burnstein (B) Landsteiner
(C) DeVries (D) Corren

169. If the distance of 20 map units is found among two linked loci what would be the percentage of cross over gametes:
(A) 40% (B) 60%
(C) 20% (D) 10%

170. Color blindness, haemophilia and gout form linkage group on:
(A) Chromosome 9 (B) Chromosome 19
(C) X-chromosome (D) Y-chromosome

171. Anti-Rh antibodies appear in plasma:
(A) During first few months
(B) During last months
(C) Only when stimulated
(D) If Rh^+ individual mistakenly receives Rh- blood

172. When father is AB and mother is B, they can't have a body of blood group?
(A) A (B) B
(C) AB (D) O

173. There are _____ total possible genotypes of blood group ABO system:
(A) 3 (B) 4
(C) 6 (D) 7

174. Bilirubin:
(A) Turns skin yellow
(B) Damages brain cells
(C) Causes jaundice
(D) All of these

175. What are chances for having Rh^- baby if one parent is Rh^+ and (homozygous) and other is Rh^-?
(A) 25% (B) 50%
(C) 100% (D) 0%

176. Rh factor is encoded by:
(A) 2 genes which occupy 3 loci
(B) 3 genes which occupy 2 loci
(C) 2 genes which occupy 2 loci
(D) 3 genes which occupy 3 loci

177. What is the probability of having an albino child if father and mother both are carrier(Aa)?
(A) 25% (B) 30%
(C) 50% (D) 75%

178. Two parents of blood group A had a child of blood group O, what will be percentage chances of having such child again:
(A) 25% (B) 50%
(C) 75% (D) none

179. Interaction of two loci:
(A) Pleiotropy (B) Epistasis
(C) Dominance (D) Differentiation

180. A phenotype which can't be expressed in heterozygous state but can only be expressed either in homo or hemi form, would be:
(A) Dominant (B) Bombay
(C) Recessive (D) Ordinary

181. A continuously varying trait is encoded by alleles of two or more different gene pairs found at different loci. all influencing the same trait in an:
(A) Stabilizer way (B) Preservative way
(C) Additive way (D) All of these

182. The amount of wheat grain colour is influenced by environmental factors:
(A) Light (B) water
(C) Nutrients (D) All of these

183. Human height is a more complex:
(A) Epistatic trait (B) Multiple trait
(C) Pleiotropic trait (D) Polygenic trait

184. Human skin colour is also a quantitative trait which is controlled by:
(A) 3 -6 gene pairs (B) 1 -3 gene pairs
(C) 2 -6 gene pairs (D) 3- 9 gene pairs

185. Intelligence is also a case of polygenic inheritance which is strongly influenced by:
(A) Genes (B) Environment
(C) Experience (D) Nature

186. The genetics of wheat grain colour was studied by:
(A) Mendel (B) Nilsson -Ehle
(C) Morgan (D) Correns

187. Morgan and his colleagues studied pattern of inheritance of more than ____ traits of Drosophila:
(A) 200 (B) 300
(C) 85 (D) 400

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188. In _____ T.H. Morgan was awarded a Nobel prize for his contribution to genetics:
(A) 1884 (B) 1911
(C) 1933 (D) 1955

189. A man and woman are both affected by vitamin D resistance rickets, which is a dominant sex-linked allele. All of the female offsprings of this couple are affected with rickets but some of the male offsprings are not. What are the genotypes of the parents?
(A) Both are homozygous for the trait
(B) The woman has two dominant alleles and man has one dominant allele
(C) Both parents have only recessive alleles
(D) Each parent has only one dominant allele

190. In crossing over studies on maize, scientist observed the following % crossing over between genes A, B, C, D –between. A and D 10%, between A and C 3%, between genes C and D 7%, between genes A and B 5%, and between genes C and B 8%. On the basis of above observation find out the correct sequence of genes A, B, C and D on chromosomes:
(A) BCDA (B) ABCD
(C) BACD (D) DACB

191. A man whose father was colour blind marries a woman who had a colour blind mother and normal father. What percentage of male children of this couple will be colour blind:
(A) 25% (B) 0%
(C) 50% (D) 75%

192. Select the correct statement from the ones gives below with respect to dihybrid cross:
(A) Genes loosely linked on the same chromosome show similar recombination as the tightly linked ones
(B) Tightly linked genes on the same chromosome show very few recombination's
(C) Tightly linked genes on the same chromosome show higher recombination
(D) Genes far apart on the same chromosome show very few recombination's

193. The most popularly known blood grouping is the ABO grouping. It is named ABO and not ABC, because "O" in it refers to having:
(A) No antigens A and B on RBCs
(B) Other antigens besides A and B on RBCs
(C) Overdominance of this type on the genes for A and B types
(D) One antibody only - either anti–A or anti–B on the RBCs

194. A human male produces sperms with the genotypes AB, Ab, aB, and ab, in equal proportions. What is the corresponding genotype of this person:
(A) AaBb (B) AaBB
(C) AABb (D) AABB

195. How many different kinds of gametes will be produced by a plant having the genotype AABbCC:
(A) Three (B) Four
(C) Nine (D) Two

196. Family has 9 girls, Probability of son at 10th birth is:
(A) 50 % (B) 100 %
(C) 25 % (D) 0 %

197. Morgan coined the term_____ to describe the physical association of genes on a chromosome & the term_____ to describe the generation of non-parental gene combinations:
(A) Recombination; Linkage
(B) Recombination; Non-recombination
(C) Linkage; Non-recombination
(D) Linkage; Recombination

198. Who postulated the 'Chromosome Theory of Inheritance':
(A) De Vries (B) Mendel
(C) Sutton and Boveri (D) Morgan

199. A phenomenon which works opposite to the linkage is:
(A) Independent assortment
(B) Crossing-over
(C) Segregation
(D) Mutation

200. AABbCc genotype forms how many types of gametes:
(A) 4 (B) 8
(C) 2 (D) 6

201. Who rediscovered the results of Mendel's experiments:
(A) DeVries, Tschermach, Correns
(B) DeVries, Tschermach, Morgan
(C) Tschermach, Morgan, Correns
(D) Tschermach, Bateson, Punnet

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202. Due to the cross between TTRr × ttrr the resultant progenies showed how many percent plants would be, tall, red flowered:
(A) 50% (B) 75%
(C) 25% (D) 100%

203. A gene said to be dominant if:
(A) It express it's effect only in homozygous stage
(B) It expressed only in heterozygous condition
(C) It expressed both in homozygous and heterozygous condition
(D) It never expressed in any condition.

204. Mendel does not select which character in his experiment:
(A) Plant height (B) Plant colour
(C) Pod shape (D) Pod colour

205. The phenomenon of incomplete dominance was observed by:
(A) De varies (B) Correns
(C) Tschermak (D) Mendel

206. A man of A blood group marries a woman of AB blood group. which type of progeny would indicate that man is heterozygous A:
(A) AB (B) A
(C) O (D) B

207. Mendel worked in:
(A) 17th century (B) 18th century
(C) 19th century (D) 20th century

208. Gregor Mendel was born in:
(A) Austria (B) Russia
(C) United Kingdom (D) Czechoslovakia

209. Mendel published the results of his experiments in the year:
(A) 1568 (B) 1773
(C) 1866 (D) 1921

210. The genetic controlling of the seven pea characteristics studied by Mendel is known to be located on how many different chromosomes:
(A) 4 (B) 5
(C) 6 (D) 7

211. Which of the following characters is not chosen by Mendel:
(A) Pod shape (B) Pod color
(C) Location of flower (D) Location of pod

212. Pure breed lines refer to:
(A) Homozygosity only
(B) Heterozygosity only
(C) Heterozygosity and linkage
(D) Homozygosity and independent assortment

213. The characters which appear in F1 generation is:
(A) Recessive
(B) Dominant
(C) Both dominant and recessive
(D) Either dominate or receive

214. A gene is said to be dominant if:
(A) It never expresses in any condition
(B) It expresses only in heterozygous condition
(C) It expresses its effect only in homozygous condition
(D) It expresses both in heterozygous and homozygous condition

215. Mendel formulated the law of purity of gametes on the basis of:
(A) Test cross (B) Dihybrid cross
(C) Monohybrid cross (D) Backcross

216. Percentage of heterozygous individual obtained from self-fertilization in Rr individual is:
(A) 25 (B) 50
(C) 75 (D) 100

217. A heterozygous round seeded (Rr) is crossed to recessive wrinkled (rr) seeded plant. The progeny would be:
(A) 20 round : 99 wrinkled
(B) 99 round : 301 wrinkled
(C) 301 round : 100 wrinkled
(D) 303 round : 301 wrinkled

218. Which of the following crosses and resultant phenotypic ratios are mismatched:

Cross	Phenotypic ratio
(A) Tt × Tt	3:1
(B) Tt × tt	2:1
(C) TtYy × ttyy	1:1:1:1
(D) TtYy × TtYy	9:3:3:1

219. In mendelism, linkage was not observed due to:
(A) Synapsis
(B) Crossing over
(C) Mutation
(D) Independent assortment

220. The allele which is unable to express its effect in the presence of another is called:
(A) Co-dominant (B) Supplementary
(C) Complementary (D) Recessive

221. How many types of gametes are expected from the organism with genotype AABBCC:

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(A) One (B) Two
(C) Four (D) Eight

222. A test cross is performed:
(A) By selfing of F_2-generation plants
(B) By selfing of F_1-generation plants
(C) To determine whether F_1-plant dominant is homozygous or heterozygous
(D) Between a homozygous dominant and homozygous recessive plant

223. The blood group alleles start their expression at?
(A) Late embryonic stage (B) Adult stage
(C) Early embryonic stage (D) Teenage

224. Which of the following is exception to Mendel's laws:
(A) Linkage
(B) Incomplete dominance
(C) Co-dominance
(D) All of the above

225. In case of incomplete dominance the monohybrid ratio of phenotypes in F2 generation is:
(A) 1:2:1 (B) 3:1:1
(C) 9:3:3:1 (D) 2:3:1

226. A child of O blood group, has B-blood group father, the genotype of father would be:
(A) ii (B) $I^B I^B$
(C) $I^A I^B$ (D) I^B i

227. A child is blood group is 'O'. His parents blood group cannot be:
(A) B & O (B) A & O
(C) AB (D) A & B

228. A gene that shows it's effect on more than one character is:
(A) Polygene (B) Pleotropic gene
(C) Multifactor gene (D) Multiple gene

229. Which of the following is true for epistasis:
(A) In epistasis one gene pair mask suppress the expression of another pair of genes.
(B) Epistasis is an allelic interaction
(C) Many genes collectively control a particular quantitative character
(D) In epistasis genes are always present on same chromosome.

230. The three different alleles of human ABO blood types will produce how many genotypes & phenotypes respectively:
(A) 4 & 6 (B) 6 & 4
(C) 6 & 6 (D) 4 & 4

231. A polygenic inheritance in human beings is:
(A) Skin colour (B) Sickle cell anemia
(C) Colour blindness (D) Phenylketonuria

232. A colourblind daughter is born when:
(A) Father is colourblind, mother is normal
(B) Mother is colourblind, father is normal
(C) Mother is carrier, father is normal
(D) Mother is carrier, father is colourblind

233. Hypertrichosis is:
(A) Holandric character
(B) X-Linked character
(C) Digenic character
(D) Sex-influenced character

234. A colourblind man marries a normal lady whose father was colour blind. If it produces two sons & two daughters, how many of them would be suffer:
(A) Both sons
(B) Both daughters
(C) One son & one daughter
(D) Both sons & both daughters

235. There are three genes a, b, c. The percentage of crossing over between a and b is 20%, b and c is 28% and a and c is 8%. What is the sequence of genes on chromosome:
(A) b, a, c (B) a, b, c
(C) a, c, b (D) None

236. Mammary glands in female, moustaches and beard in human males are examples of:
(A) Sex linked traits
(B) Sex limited traits
(C) Sex differentiating traits
(D) Sex-determining traits

237. If father shows normal genotype and mother shows a carrier trait for haemophilia:
(A) All the female children will be carrier
(B) A male child has 50% chances of active disease
(C) Female child has probability of 50% to active disease
(D) All the female children will be colorblind

238. Haemophilia is more commonly seen in human males than in human females because:
(A) This disease is due to a Y–linked recessive mutation
(B) This disease is due to an X–linked recessive mutation
(C) This disease is due to an X–linked dominant mutation

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(D) A greater proportion of girls die in infancy

239. **Drosophila melanogaster has:**
(A) 2 pairs of autosomes and 1 pair of sex chromosomes
(B) 3 pairs of autosomes and 3 pairs of sex chromosomes
(C) 1 pairs of autosomes and 3 pairs of sex chromosomes
(D) 3 pairs of autosomes and 1 pairs of sex chromosomes

240. **Morgan and his group found that when genes were grouped on the same chromosome, some genes were very tightly linked and showed:**
(A) Very low recombination
(B) Higher recombination
(C) No recombination
(D) 100% parental combination

241. **Which of the following symbols are used for representing sex chromosome of birds:**
(A) ZZ – ZW (B) XX – XY
(C) XO – XX (D) ZZ – WW

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242. **The sex of individual of the next generation always depends on one of the parents, who is: (2011)**
(A) Heterogametic (B) Isogametic
(C) Homogametic (D) Isomorphic

243. **Which of the following will be hemophilic? (2011)**
(A) X^hX^h (B) X^hY
(C) X^HX^H (D) X^HY

244. **Which of the following is an example of X-linked recessive trait in humans? (2011)**
(A) Hypophosphatemic rickets
(B) Baldness
(C) Colour blindness
(D) Beard growth

245. **Which trait in humans is an example of multiple alleles? (2011)**
(A) Eye colour (B) ABO-blood group
(C) Skin colour (D) Rh-Blood group

246. **When a gene pair at one locus interacts with another gene at another locus, the interaction is called: (2011)**
(A) Epistasis (B) Dominance
(C) Pleiotropy (D) Polygenes

247. **When a single trait is controlled by many gene, it is termed as: (2011)**
(A) Dominance (B) Pleiotropy
(C) Multiple alleles (D) Polygene

248. **Mental retardation, short stature, broad face and squint eyes are symptoms of: (2011)**
(A) Down's syndrome (B) Turner's syndrome
(C) Klinefelter's syndrome (D) XYY syndrome

249. **Which one of the following is main cause of cancer? (2011)**
(A) Mutations
(B) Regulated mitosis
(C) Controlled cell division
(D) Haploid division

250. **When the presence of a gene at one locus suppresses the effect of a gene at another locus phenomenon is called: (2012)**
(A) Hypostasis (B) Epistasis
(C) Pleiotropy (D) Dominance

251. **The gene for ABO-blood group system in humans is represented by symbol: (2012)**
(A) X (B) Y
(C) I (D) O

252. **When a single gene affects two or more traits, the phenomenon is called: (2012)**
(A) Epistasis (B) Dominance
(C) Pleiotropy (D) Over dominance

253. **In men sex-determination depends upon the nature of: (2012)**
(A) Heterogametic male
(B) Heterogametic female
(C) Homogametic female
(D) Homogametic male

254. **If a person has 44 autosomes + XXY, he will suffer from: (2012)**
(A) Klinefelter's syndrome
(B) Turner's syndrome
(C) Down's syndrome
(D) Edward's syndrome

255. **In Downs syndrome which one of the following pair of chromosomes fail to segregate? (2012)**
(A) 7 (B) 21
(C) 18 (D) 19

256. **When a gene suppresses the effect of another gene at another locus, the phenomenonis termed as: (2013)**
(A) Over-mutation (B) Pleiotropy
(C) Epistasis (D) Co-dominance

257. **Phenylketonuria is example of: (2013)**
(A) Point mutation (B) Translocation
(C) Polyploidy (D) Inversion

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258. A situation in which one gene affects two or more unrelated characteristics is called: (2013)
(A) Epistasis (B) Pleiotropy
(C) Dominance relation (D) Polygenes

259. The mutation which causes change in sequence of DNA is called: (2013)
(A) Chromosomal mutation
(B) Inversion
(C) Deletion
(D) Point mutation

260. Down's syndrome is a result of non-disjunction of pair of chromosomesthat fails to segregate: (2013)
(A) 22nd (B) 14th
(C) 18th (D) 21st

261. When a gene suppresses the effect of a gene at another locus, this is called: (2014)
(A) Epistasis
(B) Complete dominance
(C) Co-dominance
(D) Mutation

262. In male, the sex determining gene is: (2014)
(A) XY (B) SXY
(C) SRY (D) SXX

263. A gene which affects two or more unrelated characteristics is called: (2014)
(A) Pleiotropic (B) Dominant
(C) Epistatic (D) Mutated

264. Position of an allele within a DNA molecule is:(2014)
(A) Locus (B) Amplicon
(C) Origin (D) Filial

265. Sickle cell anemia is a type of: (2014)
(A) Insertion (B) Deletion
(C) Transposition (D) Base substitution

266. Non-disjunction of 21st pair of chromosome in one of the gametes leads to 47 chromosomes in new individual. This condition is called: (2014)
(A) Turner's syndrome (B) Down's syndrome
(C) Klinefelter's syndrome (D) Jacob's syndrome

267. X-linked recessive trait is: (2015)
(A) Hypophosphatemia
(B) Haemophilia
(C) Vitamin-D resistant rickets
(D) Diabetes mellitus

268. Human skin color is a good example of: (2015)
(A) Sex linked inheritance
(B) x-linked inheritance
(C) Polygenic inheritance
(D) y linked inheritance

269. From an evolutionary point of view, which respiratory protein is common in many organisms? (2015)
(A) Cytochrome a (B) Cytochrome c
(C) Cytochrome b (D) Cytochrome d

270. Number of pairs of autosomes in humans is: (2015)
(A) 23 (B) 21
(C) 24 (D) 22

271. ABO blood system is an example of: (2015)
(A) Polygenes (B) Multiple alleles
(C) Multiple genes (D) Multiple mutation

272. During maternal meiosis, non-disjunction of autosomal chromosomal pair results inthe formation of an egg having 24 chromosomes in: (2015)
(A) Klinefelter's syndrome
(B) Turner' syndrome
(C) Down's syndrome
(D) Jacob's syndrome

273. Typical syndrome like enlarged breast and small testis in males are attributed to: (2015)
(A) Down's syndrome
(B) Klinefelter's syndrome
(C) Turner' syndrome
(D) Phenylketonuria

274. Turner's syndrome is characterized by having: (2015)
(A) Trisomy 21 (B) Trisomy 18
(C) 44+XXY (D) 44+XO

275. The disease in which an individual has extra sex chromosome (44+XXY) is known as: (2015)
(A) Down's syndrome
(B) Klinefelter's syndrome
(C) Turner's syndrome
(D) Jacob's syndrome

276. Which one of the following is considered as strong evidence of evolution? (2016)
(A) Embryology record
(B) Biochemical record
(C) Molecular record
(D) Fossil record

277. Structures found in different species which are believed to have a common evolutionary origin are: (2016)
(A) Homologous (B) Vestigial

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(C) Analogous (D) Fossilized

278. **Which one of the following is X-linked trait? (2016)**
(A) Male pattern baldness
(B) Haemophilia
(C) Diabetes mellitus
(D) Erythroblastosis foetalis

279. **A character determined by three alleles is:(2016)**
(A) Human skin color (B) Human eye color
(C) Human blood group (D) Human Rh factor

280. **The total number of genes in a population is called: (2016)**
(A) Gene pool (B) Genome
(C) Allele pool (D) Genomic library

281. **Infertility, short height, webbed neck and low hairline at back are symptoms of_____syndrome: (2016)**
(A) Down's (B) Edward's
(C) Turner's (D) Patau's

282. **Down's syndrome is characterized by_____at chromosome 21: (2016)**
(A) Monosomy (B) Polysomy
(C) Trisomy (D) Disomy

283. **Which one of the following is an example of autosomal non-disjunction? (2016)**
(A) Turner's syndrome (B) Down's syndrome
(C) Jacob's syndrome (D) Metafemales

284. **Pure breeding lines of Pea were taken regarding seed shape – Round and Wrinkled and were crossed with no intermediate between parents. All offsprings were foundto be round. These results show: (2017)**
(A) Co-dominance
(B) Dominant – recessive relationship of alleles
(C) Incomplete dominance
(D) Over dominance relationship

285. **Base substitution, deletion and insertion are examples of: (2017)**
(A) Chromosomal aberrations
(B) Aneuploidy
(C) Point mutation
(D) Euploidy

286. **The condition in which heterozygote has a phenotype intermediate betweencontrasting homozygous parents is called: (2017)**
(A) Dominance
(B) Over dominance
(C) Co-dominance
(D) Incomplete dominance

287. **The interaction between different genes occupying different loci is: (2017)**
(A) Dominance (B) Pleiotropy
(C) Co-dominance (D) Epistasis

288. **Locus stands for: (2017)**
(A) Position of gene on homologous chromosomes
(B) Regions of chromosomes
(C) Position of an allele within a DNA molecule
(D) Close regions of same chromosomes

289. **Self-fertilization of F1 dihybrids, following independent assortment of alleles will result in: (2017)**
(A) 3/16 Tall, round: 3/16 Dwarf, wrinkled
(B) 9/16 Tall, wrinkled : 1/16 Dwarf, round
(C) 9/16 Tall, round: 1/16 Dwarf, round
(D) 3/16 Tall, wrinkled: 3/16 Dwarf, round

290. **As a result of cross-fertilization of true breeding pea plant having purple colored flowers with that of white colored flowers, the offsprings will have flower with:**
(A) ¾ purple and ¾ white
(B) All white
(C) ¾ white and ¾ purple
(D) All purple

291. **Identify the true breeder plant: (2015)**
(A) RR (B) Yy
(C) Rr (D) Tt

292. **The gene for red-green color blindness is present on: (2017)**
(A) Y–chromosome (B) Autosome No. 7
(C) X–chromosome (D) Autosome No.9

293. **If one were to unzip the molecule, one would need only to assemble the appropriate complementary nucleotides on the exposed single strand to form two daughter complexes with the same sequence" is the definition of: (2017-Retake)**
(A) Semi-conservative model
(B) Dispersive model
(C) Conservative model
(D) Destruction model

294. **Formation of RNA from DNA is called: (2017-Retake)**
(A) Translation
(B) Replication
(C) Transcription
(D) Reverse transcription

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295. XO-XX is the sex determing pattern present in: (2017-Retake)
(A) Grasshopper (B) Butterfly
(C) Drosophila (D) Man

296. Different alleles of a gene that are both expressed in a heterozygous condition are called: (2017-Retake)
(A) Complete dominance
(B) Co-dominance
(C) Incomplete dominance
(D) Over dominance

297. Effect cause by a gene or gene pair at a locus interferes with or hides the effect caused by another gene or gene pair ay another locus, such a phenomenon of gene interaction is called: (2017-Retake)
(A) Epistasis (B) Dominance
(C) Pleiotropy (D) Co-dominance

298. When two or more alleles do not show complete dominance or both the alleles are expressing independently in heterozygotic condition. Such a condition called:(2018)
(A) Complete dominance
(B) Over dominance
(C) Codominance
(D) Incomplete dominance

299. Which one of the following is multiple allelic character? (2018)
(A) Colour of flower in pea paint
(B) Blood group of the human being
(C) Shape of seed in pea plant
(D) Length of stem in pea plant

300. A person was married to his cousin and both are heterozygous for sickle cell anemia. Among their kids, what will be proportion of affected homozygotes? (2019)
(A) 50% (B) 75%
(C) 25% (D) 100%

301. Homozygous means: (2019)
(A) having two identical alleles of a gene.
(B) hiving two identical gens
(C) Alleles in an organism
(D) two different alleles of a gene.

302. In genetics, the term locus refers to the _____ of the gene on the chromosome: (2019)
(A) Frequency (B) Position
(C) Copy (D) Inversion

303. Change in frequency of alleles that occurs by chance is called as: (2019)
(A) Natural selection (B) Mutation
(C) Migration (D) Genetic drift

304. In which situation genes are not assorted independently during meiosis in a chromosome? (2019)
(A) When genes are not linked and their loci are far apart.
(B) When some genes have mutated on the chromosome.
(C) When there are too many genes of a chromosome
(D) When genes are linked and their loci are close to each other.

305. If carrier haemophilic female (X^hX^h) is married to a haemophilic male (X^hY). What will be the ratio of presence of haemophilia in the children? Select best answer for the given condition: (2019)

X^hX^h x X^hY

(A) 100% All females and males will be haemophilic
(B) Carrier female 25% haemophilic female 25%, 25% normal male and 25% haemophilic male.
(C) Females and males both have 50% chances of getting haemophilia
(D) Females have 50% chances of getting haemophilia and males will be 100% haemophilic

306. Haemophillia A and B, color blindness and testicular feminization are example of: (2020)
(A) X-linked dominant trait
(B) Y-linked recessive trait
(C) Y-linked inheritance
(D) Pseudosutosomal trait

307. Which traits are most likely to affect men than women? (2020)
(A) X linked recessive
(B) Autosomal dominant
(C) X linked dominant
(D) Autosomal recessive

308. Alleles both have an effect on the phenotype of heterozygotic organism: (2020)
(A) Dominant (B) Multiple
(C) Recessive (D) Co-dominant

309. When both the allele of a genes are same, the organism is said to be: (2020)
(A) Heterozygous (B) Homozygous
(C) Genotype (D) Phenotype

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310. "Law of independent assortment" states: (2020)
(A) The each pair of alleles assort independent of other pairs of alleles during gamete formation
(B) That allele of each pair of contrasting trait have unequal probability to assort with the alleles of other pairs
(C) That that coexisting alleles for each trait
(D) That pertain to inheritance of single trait (monohybrid cross)

311. Phenotype is: (2020)
(A) The genetic complement i.e., the genes in an individual for a particular trait
(B) Partner of gene pair
(C) The form of appearance of a trait
(D) The position of a gene on the chromosome

312. In complete dominance: (2020)
(A) Different alleles of a gene are both expressed in heterozygous condition
(B) One allele (R) is completely dominant over the other (r) and the presence of recessive allele is functionally hidden the heterozygote (Rr) has the same sound phenotype (RR) heterozygote
(C) The phenotype of the heterozygote is intermediate between phenotypes of the homozygotes
(D) Gene mutation may produce many different alleles of a gene.

313. ABO blood group is controlled by more than two alleles in a population. This shows that ABO blood group is an example of: (2023)
(A) Polygenic Inheritance
(B) Multiple Alleles
(C) Operons
(D) Allelic interaction

314. According to Mendel Law of Segregation, the one individual out of four in F2 generation had phenotype that failed to express in generation: (2023)
(A) F1 (B) F2
(C) F3 (D) P1

315. Test cross is made to check the genotype of a trait. Which of the following crosses is a test cross: (2023)
(A) Unknown x At (B) Unknown x tt
(C) Unknown x AB (D) Unknown x TT

316. Which one of the following is X Linked Dominant disorder? (2023)
(A) Haemophilia
(B) Color blindness
(C) Hypophosphatemic rickets
(D) Hypertrichosis

317. Only those genes can assort independently whose loci are on: (2023)
(A) Same chromatids
(B) Same chromosomes
(C) Non-homologous chromosomes
(D) Homologous chromosomes

318. Chromosomal abnormality in Turner syndrome is represented by: (UHS 2024)
(A) XXX (B) XYY
(C) XO (D) XXY

319. The chromosomes were first observed by: (UHS 2024)
(A) T. H. Morgan (B) Walther
(C) Griffth (D) Mendel

320. Which of the following blood groups has anti-A and anti-B antibodies in the serum: (ETEA 2024)
(A) A (B) AB
(C) B (D) O

321. What is the primary outcome of crossing over during prophase of meiosis: (ETEA 2024)
(A) Chromosomes duplicate without any exchange of parts
(B) Homologous chromosomes exchange different pairs leading to recombinant chromatids and increased genetic variation
(C) Homologous chromosomes exchange identical parts, resulting in no genetic variation
(D) Non-homologous chromosomes exchange parts

322. The genetic makeup that your parents have transferred to you for your hair colour, makes up your: (ETEA 2024)
(A) Genotype (B) Karyotype
(C) Phenotype (D) None of these

323. Which is true for an X linked dominant trait: (ETEA 2024)
(A) All female offspring of the affected father will be affected
(B) Half of the female offspring of the affected father will be affected
(C) No male offspring of an affected mother will be affected

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(D) No female offspring of the affected father will be affected

324. Which term best describes an organism's physical characteristics: (ETEA 2024)
(A) Allele (B) Genetic code
(C) Genotype (D) Trait

325. What will happen with the addition of salt to Water: (ETEA 2024)
(A) Water potential will increase
(B) Water potential will remain same
(C) Osmotic potential will increase
(D) Osmotic potential will remain same

326. What will be the probability of purple and terminal flower in Pea plant in F_2 generation, if we cross true breeding purple axial flower plant with white terminal flower plant: (NUMS 2024)
(A) 1/16 (B) 3/16
(C) 9/16 (D) 1/2

327. A carrier female for haemophilia is married to an affected male. What would be the probable percentage for their sons to be affected: (NUMS 2024)
(A) 100% (B) 50%
(C) 25% (D) 0%

328. Which of the following is not related to ABO blood group system: (NUMS 2024)
(A) It is an example of multiple alleles
(B) I^A and I^B are codominant
(C) I doesn't code for any antigen
(D) It obeys Mendel's laws of inheritance

329. Which of the following option is correct for pattern baldness: (NUMS 2024)
(A) It is sex linked trait
(B) occurs due to hormonal differences between sexed
(C) Heterozygous male is normal
(D) Heterozygous female is affect

330. It is a condition of blindness where a person cannot distinguish blue color: (DUHS 2024)
(A) Protanopia (B) Monochromacy
(C) Deuteranopia (D) Tritanopia

331. It is a condition of blindness where a person cannot distinguish blue color: (DUHS 2024)
(A) Protanopia (B) Monochromacy
(C) Deuteranopia (D) Tritanopia

332. In Drosophila, Heterozygous exceed in quantity of fluorescent pigment in eyes than wild or white eyed. This kind of dominance is: (SZABMU 2024)
(A) Complete (B) Co-Dominance
(C) Incomplete (D) Over Dominance

333. In which of the following dominance genotypic and phenotypic ration is same in F_2 generation: (SZABMU 2024)
(A) Complete (B) Co-Dominance
(C) Incomplete (D) Over Dominance

334. Which type of antibodies are present in the serum of AB Blood type: (SZABMU 2024)
(A) Anti-A, Anti-B Antibodies
(B) Anti-A Antibodies
(C) Anti-B Antibodies
(D) No Antibodies at all

335. At which of the following phase of prophase-I, crossing over take place: (SZABMU 2024)
(A) Diplotene (B) Leptotene
(C) Pachytene (D) Zygotene

336. Which of the following condition produce a sterile female with Turnor syndrome in human but sterile male in drosophila: (SZABMU 2024)
(A) XO (B) XXO
(C) XXX (D) XXY

337. Haemophilia type A and B zig zag from _____ grandfather through a carrier daughter to a _____: (SZABMU 2024)
(A) Maternal, Grand daughter
(B) Maternal, Grand son
(C) Paternal, Granddaughter
(D) Paternal, Gran son

338. Which trait is most likely to affect men than women: (BUMHS 2024)
(A) X linked recessive
(B) X linked dominant
(C) Autosomal recessive
(D) Autosomal dominant

339. There is situation in which hemophilia effects both gender equally. What is the reason behind it: (BUMHS 2024)
(A) X linked (B) Y linked
(C) Co-dominant (D) Autosomal

340. What is the principal of blood transfusion in donor and receipt respectively: (BUMHS 2024)
(A) Antibodies of both
(B) Antibodies: Antigen of recipient
(C) Antigen of both
(D) Antigen of donor: Antibodies of recipient

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Answer Key

1. B	2. B	3. D	4. C	5. C	6. C	7. B	8. D	9. B	10. B
11. B	12. A	13. B	14. C	15. C	16. B	17. D	18. D	19. C	20. D
21. A	22. B	23. C	24. D	25. B	26. D	27. A	28. B	29. A	30. C
31. C	32. B	33. A	34. A	35. A	36. C	37. C	38. C	39. B	40. D
41. B	42. C	43. A	44. B	45. D	46. D	47. B	48. C	49. C	50. C
51. B	52. C	53. D	54. D	55. B	56. C	57. C	58. B	59. B	60. B
61. D	62. C	63. D	64. B	65. D	66. C	67. C	68. C	69. B	70. B
71. B	72. C	73. B	74. D	75. D	76. A	77. D	78. C	79. B	80. B
81. B	82. A	83. B	84. C	85. A	86. B	87. D	88. D	89. A	90. C
91. B	92. D	93. B	94. B	95. C	96. A	97. A	98. C	99. A	100. C
101. C	102. D	103. B	104. A	105. A	106. C	107. B	108. A	109. C	110. A
111. B	112. D	113. A	114. C	115. A	116. A	117. A	118. A	119. C	120. A
121. D	122. C	123. B	124. B	125. D	126. C	127. D	128. D	129. B	130. B
131. C	132. C	133. B	134. C	135. C	136. B	137. C	138. D	139. C	140. C
141. B	142. A	143. D	144. D	145. D	146. A	147. B	148. C	149. A	150. C
151. B	152. C	153. A	154. B	155. B	156. D	157. D	158. A	159. B	160. B
161. D	162. C	163. C	164. A	165. A	166. A	167. C	168. A	169. C	170. C
171. C	172. D	173. C	174. D	175. D	176. B	177. A	178. A	179. B	180. C
181. C	182. D	183. D	184. A	185. B	186. B	187. C	188. C	189. D	190. C
191. C	192. B	193. A	194. A	195. D	196. A	197. D	198. C	199. B	200. A
201. A	202. A	203. C	204. B	205. B	206. D	207. C	208. A	209. C	210. A
211. D	212. A	213. B	214. D	215. C	216. B	217. D	218. B	219. D	220. D
221. A	222. C	223. C	224. D	225. A	226. D	227. C	228. B	229. A	230. B
231. A	232. D	233. A	234. C	235. A	236. B	237. B	238. B	239. D	240. A
241. A	242. A	243. B	244. C	245. B	246. A	247. D	248. A	249. A	250. B
251. C	252. C	253. A	254. A	255. B	256. C	257. A	258. B	259. D	260. D
261. A	262. C	263. A	264. A	265. D	266. B	267. B	268. C	269. B	270. D
271. B	272. C	273. B	274. D	275. B	276. C	277. A	278. B	279. C	280. A
281. C	282. C	283. B	284. B	285. C	286. D	287. D	288. A	289. D	290. D
291. A	292. C	293. A	294. C	295. A	296. B	297. A	298. C	299. B	300. B
301. A	302. B	303. D	304. D	305. B	306. B	307. A	308. D	309. B	310. A
311. C	312. C	313. B	314. A	315. B	316. C	317. C	318. C	319. B	320. D
321. B	322. A	323. A	324. D	325. C	326. B	327. B	328. C	329. B	330. D
331. D	332. D	333. C	334. D	335. C	336. A	337. B	338. A	339. D	340. D

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