केन्द्रीय विद्यालय संगठन

Kendriya Vidyalaya Sangathan

जीव विज्ञान

BIOLOGY

कक्षा/Class: XI

2024-25

विद्यार्थी सहायक सामग्री

Student Support Material

<u>संदेश</u>

विद्यालयी शिक्षा में शैक्षिक उत्कृष्टता प्राप्त करना केन्द्रीय विद्यालय संगठन की सर्वोच्च वरीयता है। हमारे विद्यार्थी, शिक्षक एवं शैक्षिक नेतृत्व कर्ता निरंतर उन्नति हेतु प्रयासरत रहते हैं। राष्ट्रीय शिक्षा नीति 2020 के संदर्भ में योग्यता आधारित अधिगम एवं मूल्यांकन संबन्धित उद्देश्यों को प्राप्त करना तथा सीबीएसई के दिशा निर्देशों का पालन, वर्तमान में इस प्रयास को और भी चुनौतीपूर्ण बनाता है।

केन्द्रीय विद्यालय संगठन के पांचों **आंचलिक शिक्षा एवं प्रशिक्षण संस्थान** द्वारा संकलित यह 'विद्यार्थी सहायक सामाग्री' इसी दिशा में एक आवश्यक कदम है । यह सहायक सामग्री कक्षा 9 से 12 के विद्यार्थियों के लिए सभी महत्वपूर्ण विषयों पर तैयार की गयी है । केन्द्रीय विद्यालय संगठन की 'विद्यार्थी सहायक सामग्री' अपनी गुणवत्ता एवं परीक्षा संबंधी सामाग्री-संकलन की विशेषज्ञता के लिए जानी जाती है और अन्य शिक्षण संस्थान भी इसका उपयोग परीक्षा संबंधी पठन सामग्री की तरह करते रहे हैं । शुभ-आशा एवं विश्वास है कि यह सहायक सामग्री विद्यार्थियों की सहयोगी बनकर सतत मार्गदर्शन करते हुए उन्हें सफलता के लक्ष्य तक पहुंचाएगी ।

शुभाकांक्षा सहित ।

निधि पांडे
आयुक्त, केन्द्रीय विद्यालय संगठन

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CLASS XI BIOLOGY

INDEX

CBSE CURRICULUM:2024-25
BIOLOGY (Code No. 044)
COURSE STRUCTURE
CLASS XI (2024 -25)
(THEORY)

Time: 03 Hours **Max. Marks: 70**

UNIT	TITLE	MARKS
I	Diversity of Living Organism	15
II	Structural Organization in Plants and Animals	10
III	Cell: Structure and Function	15
IV	Plant Physiology	12
V	Human Physiology	18
	TOTAL	70

Unit-I Diversity of Living Organisms

Chapter-1: The Living World

Biodiversity; Need for classification; three domains of life; taxonomy and systematics; concept of species and taxonomical hierarchy; binomial nomenclature

Chapter-2: Biological Classification

Five kingdom classification; Salient features and classification of Monera, Protista and Fungi into major groups; Lichens, Viruses and Viroids.

Chapter-3: Plant Kingdom

Classification of plants into major groups; Salient and distinguishing features and a few examples of Algae, Bryophyta, Pteridophyta, Gymnospermae (Topics excluded – Angiosperms, Plant Life Cycle and Alternation of Generations)

Chapter-4: Animal Kingdom

Salient features and classification of animals, non-chordates up to phyla level and chordates up to class level (salient features and at a few examples of each category).
(No live animals or specimen should be displayed.)

Unit-II Structural Organization in Plants and Animals

Chapter-5: Morphology of Flowering Plants

Morphology of different parts of flowering plants: root, stem, leaf,

inflorescence, flower, fruit and seed. Description of family Solanaceae

Chapter-6: Anatomy of Flowering Plants

Anatomy and functions of tissue systems in dicots and monocots.

Chapter-7: Structural Organisation in Animals

Morphology, Anatomy and functions of different systems (digestive, circulatory, respiratory, nervous and reproductive) of frog.

Unit-III Cell: Structure and Function

Chapter-8: Cell-The Unit of Life

Cell theory and cell as the basic unit of life, structure of prokaryotic and eukaryotic cells; Plant cell and animal cell; cell envelope; cell membrane, cell wall; cell organelles - structure and function; endomembrane system, endoplasmic reticulum, Golgi bodies, lysosomes, vacuoles, mitochondria, ribosomes, plastids, microbodies; cytoskeleton, cilia, flagella, centrioles (ultrastructure and function); nucleus.

Chapter-9: Biomolecules

Chemical constituents of living cells: biomolecules, structure and function of proteins, carbohydrates, lipids, and nucleic acids; Enzyme - types, properties, enzyme action. (Topics excluded: Nature of Bond Linking Monomers in a Polymer, Dynamic State of Body Constituents Concept of Metabolism, Metabolic Basis of Living, The Living State)

Chapter-10: Cell Cycle and Cell Division

Cell cycle, mitosis, meiosis and their significance

Unit-IV Plant Physiology

Chapter-13: Photosynthesis in Higher Plants

Photosynthesis as a means of autotrophic nutrition; site of photosynthesis, pigments involved in photosynthesis (elementary idea); photochemical and biosynthetic phases of photosynthesis; cyclic and non-cyclic photophosphorylation; chemiosmotic hypothesis; photorespiration; C3 and C4 pathways; factors affecting photosynthesis.

Chapter-14: Respiration in Plants

Exchange of gases; cellular respiration - glycolysis, fermentation (anaerobic), TCA cycle and electron transport system (aerobic); energy relations - number of ATP molecules generated; amphibolic pathways; respiratory quotient.

Chapter-15: Plant - Growth and Development

Seed germination; phases of plant growth and plant growth rate; conditions of growth; differentiation, dedifferentiation and redifferentiation; sequence of developmental processes in a plant cell; plant growth regulators - auxin, gibberellin, cytokinin, ethylene, ABA.

Unit-V Human Physiology

Chapter-17: Breathing and Exchange of Gases

Respiratory organs in animals (recall only); Respiratory system in humans; mechanism of breathing and its regulation in humans - exchange of gases, transport of gases and regulation of respiration, respiratory volume; disorders related to respiration - asthma, emphysema, occupational respiratory disorders.

Chapter-18: Body Fluids and Circulation

Composition of blood, blood groups, coagulation of blood; composition of lymph and its function; human circulatory system - Structure of human heart and blood vessels; cardiac cycle, cardiac output, ECG; double circulation; regulation of cardiac activity; disorders of circulatory system - hypertension, coronary artery disease, angina pectoris, heart failure.

Chapter-19: Excretory Products and their Elimination

Modes of excretion - ammonotelism, ureotelism, uricotelism; human excretory system – structure and function; urine formation, osmoregulation; regulation of kidney function - renin - angiotensin, atrial natriuretic factor, ADH and diabetes insipidus; role of other organs in excretion; disorders - uremia, renal failure, renal calculi, nephritis; dialysis and artificial kidney, kidney transplant.

Chapter-20: Locomotion and Movement

Types of movement - ciliary, flagellar, muscular; skeletal muscle, contractile proteins and muscle contraction; skeletal system and its functions; joints; disorders of muscular and skeletal systems - myasthenia gravis, tetany, muscular dystrophy, arthritis, osteoporosis, gout.

Chapter-21: Neural Control and Coordination

Neuron and nerves; Nervous system in humans - central nervous system; peripheral nervous system and visceral nervous system; generation and conduction of nerve impulse.

Chapter-22: Chemical Coordination and Integration

Endocrine glands and hormones; human endocrine system - hypothalamus, pituitary, pineal, thyroid, parathyroid, adrenal, pancreas, gonads; mechanism of hormone action (elementary idea); role of hormones as messengers and regulators, hypo - and hyperactivity and related disorders; dwarfism, acromegaly, cretinism, goiter, exophthalmic Goitre, diabetes, Addison's disease.

Note: Diseases related to all the human physiological systems to be taught in brief.

Prescribed Books:

1. Biology Class-XI, Published by NCERT
2. Other related books and manuals brought out by NCERT (including multimedia).

UNIT-I

Diversity of Living Organisms

Chapter 1
The Living World
Chapter 2
Biological Classification
Chapter 3
Plant Kingdom
Chapter 4
Animal Kingdom

CHAPTER 1- LIVING WORLD

KEYPOINTS

Non-Defining Characteristics

Growth + Reproduction → Mutually Inclusive Event → Unicellular

Growth + Reproduction → Mutually Exclusive event → Multicellular
Note:

Growth in plant is localised & indefinite (throughout life)

Growth in animal is diffused and definite (up to a limit) Important:

Reproduction is not a characteristic feature of living e.g., mules, worker bees and infertile human.

In living — Growth Irreversible change

Intrinsic (occurs due to increase protoplasm)

Defining Characteristics

(a) Metabolism → Catabolism + Anabolism. It means some of all catabolic and anabolic reactions in our body. In vitro → Not a living thing but is a living reaction. Metabolism is a characteristic feature of living things inside a cell.

(b) Cellular Organisation → Metabolic reaction inside the cell, it means cellular organization strictly require for metabolism to define the feature.

(c) Consciousness → The state of being aware of what is around you and able to sense environment. Consciousness therefore, become the defining property of living organism.

TAXONOMY AND SYSTEMATICS

The number and types of organisms present on earth refer to biodiversity. · Number of species described is 1.7-1.8 million.

Taxonomy- is the study of identification, classification & nomenclature of organisms. Systematics (Latin 'systema' = systematic arrangement) deals with evolutionary relationships among organisms. ·

Systema Naturae is the book written by Carolus Linnaeus.

Basic processes of taxonomy

Characterization: It is the understanding of characters of organisms such as external and internal structure, structure of cell, development process, ecological information etc.

Identification: Correct description of organism so that the naming is possible.

Nomenclature: It is the standardization of names of the organisms such that an organism is known by the same name all over the world. → Binomial nomenclature given by **Carolus Linnaeus**.

Classification: Give a particular position of an organism in a particular taxon.

ICBN → International Code for Botanical Nomenclature.

ICZN → International Code for Zoological Nomenclature.

Binomial nomenclature given by **Carolus Linnaeus**.

Name with two components Generic Name Specific Epithet **System Naturae – written by Carolus Linnaeus.**

TAXONOMIC CATAGORIES

Taxonomic Arrangement- All categories together constitute the taxonomic hierarchy. Each category referred to as a unit of classification, in fact, represent a rank and as commonly called as taxon (Pl. Taxa):

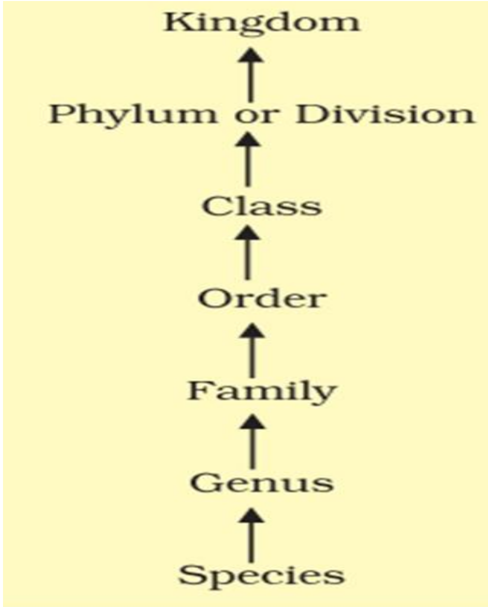
- **(i) Species:** Group of individuals with fundamental similarities e.g., nigrum, tigris.
- **(ii) Genus:** Group of closely related species e.g., Mangifera
- **(iii) Family:** Group of less related genus e.g., Solanaceae.

(iv) Order: The similar characteristics are less in number as compared to different genera. Assemblage of families which exhibit a few similar characteristics e.g., Polymoniale.

(v) Class: Group of related orders e.g., Primata.

(vi) Phylum/Division: In division, related plant classes come in group but in case of animal, related classes became a part of phylum e.g., Chordata.

(vii) Kingdom: Group of similar phylum or division e.g., Animalia and Plantae.



TAXONOMIC HIERARCHY

Organisms with their Taxonomic Categories

Common Name	Biological Name	Genus	Family	Order	Class	Phylum/ Division
Man	*Homo sapiens*	*Homo*	Hominidae	Primata	Mammalia	Chordata
Housefly	*Musca domestica*	*Musca*	Muscidae	Diptera	Insecta	Arthropoda
Mango	*Mangifera indica*	*Mangifera*	Anacardiaceae	Sapindales	Dicotyledonae	Angiospermae
Wheat	*Triticum aestivum*	*Triticum*	Poaceae	Poales	Monocotyledonae	Angiospermae

ASSERTION AND REASON QUESTIONS

These questions consist of two statements each, printed as Assertion and Reason.

While answering these questions you are required to choose any one of the following four responses.

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason are true but the Reason is not a correct explanation of the Assertion.

C. If Assertion is true but the Reason is false.

D. If both Assertion and Reason are false

1. Assertion: Phylogenetic and natural classification are similar.

Reason: The organisms related evolutionarily are usually similar morphologically also.

2. Assertion: Hierarchical system of classification is useful in that it reduces the volume of description in a catalogue of animals and plants.
   Reason: Characters given for a larger category (say a phylum) need not be repeated for smaller categories (say classes, orders, etc.)
3. Assertion: These are only seven obligate categories in taxonomy.
   Reason: Others are called intermediate categories.
4. Assertion: There is no difference between the terms taxon and category.
   Reason: Aves is a taxon that includes the category birds.
5. Assertion: Linnaeus insisted that the scientific names should be Latinised.
   Reason: This gives beauty to the names

1 MARK QUESTIONS

1. A binomial nomenclature consists of _______ and_________.
a) Generic name and Phyla
b) Class and Phyla
c) Generic name and specific epithet
d) Phyla and Kingdom

2. Binomial nomenclature is given by ____________
a) Carolus Linnaeus
b) Charles Darwin
c) Henry Cavendish
d) James Chadwick

3. *Azadirachta indica var. minor* belongs to the genus ________
a) Azadirachta
b) Indica
c) Minor
d) Valeton
4. The scientific name of lion is _________
a) *Panthera Leo*
b) *Panthera Tigress*
c) *Panthera Lion*
d) *Panthera leo*
5. Mangifera Indica is the binomial nomenclature of mango.
a) True
b) False

6. Which among the following statements are correct?
a) All the biological names have their origin in Latin
b) The first word in a biological name represents the genus and the next represents the specific epithet
c) *Canis lupus familaris* is the binomial nomenclature of a dog
d) *Panthera Tigress* is the binomial nomenclature of a tiger

7. The word "Taxa" means a ________
a) Unit of Phyla
b) Genus
c) Unit of Classification
d) Unit of Kingdom

8. Which of the following taxa are in their increasing order of their similarities?
a) Class, Phylum, Kingdom
b) Genus, Kingdom, Phylum
c) Kingdom, Genus, Specific epithet
d) Specific epithet, Phylum, Genus

9. Magnifera indica and *Azadirachta indica* belongs to __________
a) Different species b) Same species c) same genera d)None of the above
10. Classification is the main concept behind taxonomy.
a) True b) False
11. *Magnifera indica* and *Azadirachta indica* belongs to __________
a) Same genus
b) Same species
c) Same phylum
d) Same region

12. Classification is the main concept behind taxonomy.
a) True
b) False

13. The process of grouping organisms based on similarities and evolutionary relationships is known as:
a) Classification
b) Nomenclature
c) Identification
d) Taxonomy

14. Which of the following is the correct hierarchy of taxonomic categories from broadest to most specific?
a) Family - Class - Order - Phylum - Kingdom
b) Kingdom - Phylum - Class - Order - Family

c) Phylum - Kingdom - Order - Family - Class
d) Kingdom - Order - Class - Phylum - Family

15. In multicellular organisms _____refers to the production of progeny possessing features more or less similar to those of parents.
a) growth
b) reproduction
c) metabolism
d) consciousness

2 MARK QUESTIONS

1. Why is the binomial nomenclature system important for the scientific naming of organisms?
2. Explain the concept of taxonomic hierarchy with an example.
3. Distinguish between species and genus.
4. Plants and animals grow by mitotic cell divisions. What differences do they exhibit in their growth?
5. A plant may have different names in different regions of the country or world now and then. How do botanists solve this problem.

3 MARK QUESTIONS

1. Label A, B, C, D, E and F in the given table below.

Common Name	A	Wheat
Biological Name	*Homo sapiens*	*Triticum aestivum*
Species	*sapiens*	*aestivum*
Genus	*Homo*	*Triticum*
Family	B	Poaceae
Order	Primata	C
Class	D	Monocotyledonae
Phylum/Division	Chordata	E
Kingdom	F	Plantae

2. Describe briefly the different levels of organization found in the living things.
3. a) Write the full form of-
   i) ICBN
   ii) ICZN

   b) What are the basic steps involved in taxonomy?

5 MARKS QUESTIONS

1. What are the five objectives of classification? Rectify the biological name – Musca Domestica.
2. a) Who proposed the binomial nomenclature?
   b) State the rules of binomial nomenclature.

c) Why do you think binomial nomenclature is necessary?

CASE BASED QUESTION (4 MARKS)

1. Read the following and answer any four questions from (a) to (b) given below:

Classification is not a single-step process, but involves a hierarchy of steps, in which each step represents a rank or category. Each category, a unit of classification, represents a taxon. Taxonomical studies of all the known organisms have led to the development of certain common categories.

(a) Name and arrange the common categories in proper sequence in a hierarchy, from the lowest to the highest category. (2marks)
(b) Name the following: (2marks)
(i) The family that includes lion, tiger and leopard, all belonging to the genus Panthera.
(ii) The order that includes the plant families Convolvulaceae and Solanaceae.

ANSWERS

ASSERTION AND REASON QUESTIONS

1. A 2. A 3. B 4. D 5. C

1 MARK QUESTIONS

1. A binomial nomenclature consists of _______ and_________.
c) Generic name and specific epithet
2. Binomial nomenclature is given by ____________
a) Carolus Linnaeus
3. *Azadirachta indica var. minor* belongs to the genus ________
a) Azadirachta
4. The scientific name of lion is _________
d) *Panthera leo*
5. Magnifera Indica is the binomial nomenclature of mango.
b) False
6. Which among the following statements are correct?
b) The first word in a biological name represents the genus and the next represents the specific epithet
7. The word "Taxa" means a ________
c) Unit of Classification
8. Which of the following taxa are in their increasing order of their similarities?
c) Kingdom, Genus, Specific epithet
9. Magnifera indica and *Azadirachta indica* belongs to __________
b) Same species

10. Classification is the main concept behind taxonomy.
a) True
11. The process of grouping organisms based on similarities and evolutionary relationships is known as:
a) Classification
12. Classification is the main concept behind taxonomy.
a) True
13. The process of grouping organisms based on similarities and evolutionary relationships is known as:
a) Classification

14. Which of the following is the correct hierarchy of taxonomic categories from broadest to most specific?
b) Kingdom - Phylum - Class - Order - Family
15. In multicellular organisms _____refers to the production of progeny possessing features more or less similar to those of parents.
b) reproduction

2 MARKS QUESTIONS

1. The binomial nomenclature system is important because it provides a **universal** and **standardized** way to name organisms.
It eliminates confusion caused by local names that vary from place to place.
2. Taxonomic hierarchy refers to a ranked system for classifying organisms based on their similarities and differences.
It arranges organisms into progressively broader categories, starting from the most specific (Species) to the most general (Kingdom).
Eg. Species: Mango (Mangifera indica)
Genus: Mangifera (includes other mango varieties)
3.

Species	Genus
1. It is the basic unit of taxonomy.	1. It is the first highest category above the species level.
2. It is a dynamic genetically distinct group of organisms which can interbreed among themselves.	2. It is a group of species which are closely related.

4.

Growth in Plants	Growth in Animals
Growth occurs in certain regions, called meristems	Growth occurs all over the body
Growth occurs throughout their life	Growth stops after a certain period.

4. Botanists assign a scientific name to the plant, based on certain principles and criteria The scientific name ensures that the plants have only one name, in any part of the world i.e. such a name has not been used for any other known plant.

3MARKS QUESTIONS

1. A- Man
   B- Hominidae
   C- Poales
   D- Mammalia
   E- Angiospermae
   F- Animalia

2. Levels (from smallest to largest in the living things)-

Cells: Basic units of life that perform specific functions. (0.5 mark)
Tissues: Groups of similar cells working together for a specific function. (0.5 mark)
Organs: Groups of different tissues working together for a complex function. (0.5 mark)
Organ Systems: Groups of organs working together for a major bodily function. (0.5 mark)
Organisms: Individual living beings.

3. a)
   i) **ICBN** → International Code for Botanical Nomenclature.
   ii) **ICZN** → International Code for Zoological Nomenclature.
   b) The basic steps involved in taxonomy
   Characterization: It is the understanding of characters of organisms such as external and internal structure, structure of cell, development process, ecological information etc.
   Identification: Correct description of organism so that the naming is possible.
   Nomenclature: It is the standardization of names of the organisms such that an organism is known by the same name all over the world. → **Binomial nomenclature given by Linnaeus**.
   Classification: Gives a particular position of an organism in a particular taxon.

5 MARKS QUESTIONS

1. Five objectives of classification are: -
   (i)The creation of a method for quickly recognising a species, whether it is known or unknown. (ii)The description of various species.
   (iii)To distribute qualities at different levels of a hierarchy.
   (iv)The grouping of species in taxonomic classification.

(v)On the grounds of organism resemblances, create a natural relationship board on phylogeny.

2. a) Carolus Linnaeus proposed the binomial nomenclature.
   Biological name - *Musca domestica*

   b) *All the scientific names of organisms are usually Latin. Hence, they are written in italics.
   *There exist two parts of a name. The first word identifies the genus and the second word identifies the species.
   *When the names are handwritten, they are underlined or italicized if typed. This is done to specify its Latin origin.
   *The name of the genus starts with a capital letter and the name of the species starts with a small letter.

CASE BASED QUESTION

1. a) All categories together constitute the taxonomic hierarchy. Each category referred to as a unit of classification, in fact, represent a rank and as commonly called as taxon.
   (i) Species
   (ii) Genus
   (iii) Family
   (iv) Order
   (v) Class:
   (vi) Phylum/Division:
   (vii) Kingdom
   b) (i) The family that includes lion, tiger and leopard, all belonging to the genus Panthera- Felidae
   (ii) The order that includes the plant families Convolvulaceae and Solanaceae- Polymoniales.

CHAPTER 2- BIOLOGICAL CLASSIFICATION

KEYPOINTS

Biological Classification

The process of grouping together various organisms according to their similarities, dissimilarities and phylogenetic descent.

Biological classification of plants and animals was **first proposed by Aristotle** on the basis of simple morphological characters.

He classified animals into two groups, based on the presence and absence of red blood. Enaima (with red blood) and Anaima (without red blood)

He classified plants into **herbs shrubs and trees**.

Linnaeus later gave the **Two Kingdom system of classification** and divided living organisms into a **Plantae and Animalia**

R.H. Whittaker proposed the **five-kingdom system of classification** and classified organisms, based on cellular structure, complexity, mode of nutrition, reproduction and phylogenetic relationship.

Whittaker divided organisms into **Monera, Protista, Fungi, Plantae and Animalia.**

Characteristics of the Five Kingdoms

Characters	Five Kingdoms				
	Monera	**Protista**	**Fungi**	**Plantae**	**Animalia**
Cell type	Prokaryotic	Eukaryotic	Eukaryotic	Eukaryotic	Eukaryotic
Cell wall	Noncellulosic (Polysaccharide + amino acid)	Present in some	Present with chitin	Present (cellulose)	Absent
Nuclear membrane	Absent	Present	Present	Present	Present
Body organisation	Cellular	Cellular	Multiceullar/ loose tissue	Tissue/ organ	Tissue/organ/ organ system
Mode of nutrition	Autotrophic (chemosyn-thetic and photosynthetic) and Hetero-trophic (sapro-phytic/para-sitic)	Autotrophic (Photosyn-thetic) and Hetero-trophic	Heterotrophic (Saprophytic/ Parasitic)	Autotrophic (Photosyn-thetic)	Heterotrophic (Holozoic/ Saprophytic etc.)

MONERA

*This group includes all kinds of bacteria having a prokaryotic cell.
*Cell does not contain a well-defined nucleus.
*There are different shapes of bacteria present, spherical-cocci, rod shaped-bacillus, comma-vibrio and spiral spirilla.
*Mainly reproduce by fission, spore formation under unfavourable conditions and also by DNA transfer.
Mycoplasma lacks the cell wall and is the smallest cell to survive without oxygen.
Archaebacteria are present in the hardest environmental condition.

Methanogens are present in the gut of ruminants produce biogas
Eubacteria are true bacteria and have a rigid cell wall. Bacteria may be autotrophic or heterotrophic in their mode of nutrition.
Halophiles- Salty, marine bacteria
Thermophiles- Present in acidic sulphur springs.

PROTISTA

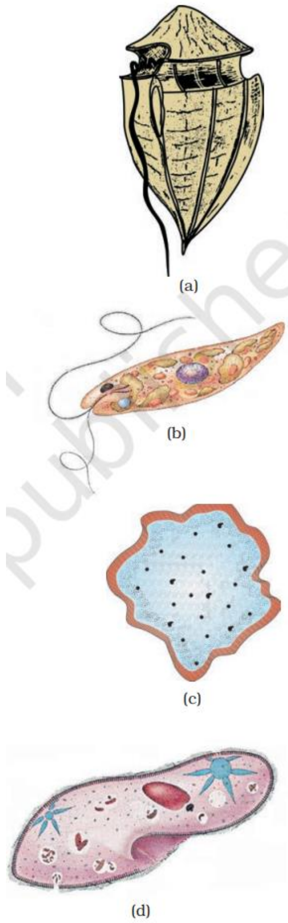


Figure 2.4 (a) *Dinoflagellates* (b) *Euglena* (c) *Slime mould* (d) *Paramoecium*

*The group includes unicellular eukaryotes.
*A photosynthetic protist is a link between plants and animals.
*They contain a well-defined nucleus and other membrane bound cell organelles.
*They include protozoan, slime moulds, chrysophytes, dinoflagellates and euglenoids.

Chrysophytes
Diatoms and golden algae (desmids).
Diatoms have left behind large amount of cell wall deposits in their habitat; this accumulation over billions of years is referred to as **'diatomaceous earth'**.
Being gritty, this soil is used in **polishing, filtration of oils and syrups**.
Diatoms are the **chief 'producers'** in the oceans.

Dinoflagellates

Most of them have two flagella; one lies longitudinally and the other transversely in a furrow between the wall plates.
Very often, red dinoflagellates **(Example: Gonyaulax)** undergo such rapid multiplication that they make the sea appear red (red tides).

Euglenoids

Though they are photosynthetic in the presence of sunlight, when deprived of sunlight, they behave like heterotrophs by predating on other smaller organisms.

Slime Moulds
Slime moulds are saprophytic protists. During unfavourable conditions, the plasmodium differentiates and forms fruiting bodies bearing spores at their tips. The spores possess true walls.

PROTOZOANS

*The group contains all the unicellular eukaryotic heterotrophs which are parasites or predators.

*These are divided into 4 major groups,

a) **Amoeboid**- Amoeba, Entamoeba
b) **Flagellated**- Trypanosoma
c) **Ciliated**- Paramecium
d) **Sporozoans**- Plasmodium

FUNGI

*Fungi are Cosmopolitan and found everywhere.
*They are heterotrophic and get the nutrients by absorption.
*Their cell wall is made up of chitin or fungal cellulose.
*Mode of nutrition is saprophytic, parasitic or symbiotic and the main food reserve is glycogen.
*Vegetative reproduction is by fragmentation budding or fission.
*Asexual reproduction by spore formation.
*Sexual reproduction is by oospore, ascospore or basidiospore formation.
*In sexual reproduction plasmogamy (fusion of protoplasm is followed by karyogamy (fusion of nuclei)
*Fungi are divided into four major classes: **Phycomycetes, Ascomycetes, Basidiomycetes, Deuteromycetes**.
*In basidiomycetes and ascomycetes, **plasmogamy is not immediately followed by karyogamy**, resulting in a distinct **dikaryon (n+n)** cell having two nuclei per cell.

SOME IMPORTANT FUNGI

Yeast - Used in fermentation to make cheese bread beer.
Puccinia -Causes wheat rust
Penicillium -Antibiotic source Symbionts –
Lichens (symbiotic Association of fungi with algae)
Rhizopus -The bread mould

PLANTAE

*Mostly autotropic, chlorophyll containing, eukaryotic organisms.
*Characterised by the presence of rigid cell walls made up of cellulose.
*Some plants are partially heterotrophic such as insectivorous (Venus flytrap, bladderwort) and parasites (Cuscuta)
*Kingdom Plantae include Algae, Bryophytes, Pteridophytes, Gymnosperm and Angiosperm.

ANIMALIA

*All the heterotrophic, eukaryotic and multicellular organisms included in the kingdom Animalia. They lack a cell wall.
*Reproduce mostly by sexual mode.
Some acellular organisms are not included in the five- Kingdom Classification, they are-

VIRUSES

Dmitri Ivanowsky gave the name "**Virus**" to the causal organism of **tobacco mosaic disease (TMV).**

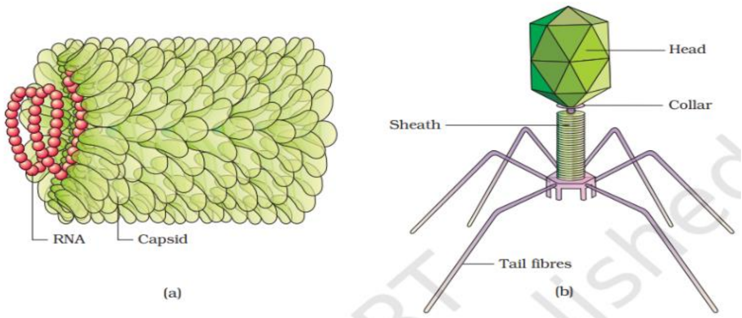


Figure 2.6 (a) Tobacco Mosaic Virus (TMV) (b) Bacteriophage

Beijerinck Called the fluid extracted from diseased plant of tobacco,"**Contagium Vivum Fluidum**" and "observed it as being infectious to healthy plants.
Stanley crystallised TMV for the first time.
*They are acellular containing nucleic acid core (either DNA or RNA), which are surrounded by a protein coat called capsid.
*Viruses use the host machinery to multiply inside the host cell.
*They are non-living outside the host cell.
*They are obligate parasites.
*Some of the diseases caused by virus in animals are: common cold, AIDS, polio, mumps, measles, chickenpox etc In plants: tobacco cucumber, leaf curling, yellowing of veins etc.
*Viruses that infect plants have single-stranded RNA.
*Bacteriophages, viruses infecting bacteria have double-stranded DNA.

VIROIDS

* Smallest Infectious agents. Consist of nucleic acid but lack a protein coat.
***T.O. Diener** discovered viroids as causative agent of potato spindle tuber disease, that was a free RNA.

PRIONS

*Contain abnormally folded protein and have a smaller size than viruses.
*Can change the shape of normal proteins by transmitting their misfolded proteins. *Cause many diseases, e.g. bovine spongiform encephalopathy (BSE) commonly called mad cow disease in cattle and Cr-Jacob disease (CJD) in humans.

LICHENS

*They are a symbiotic, mutually beneficial association of algae (phycoboint) and fungi (mycobiont).

*Algae is autotropic and provides food, whereas the fungus provides protection and shelter.

*Lichens do not grow in polluted areas, thus are good pollution indicators

ASSERTION AND REASON QUESTIONS

These questions consist of two statements each, printed as Assertion and Reason.

While answering these questions you are required to choose any one of the following four responses.

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason are true but the Reason is not a correct explanation of the Assertion.

C. If Assertion is true but the Reason is false.

D. If both Assertion and Reason are false

1. **Assertion:** Phycomycetes are generally called algal fungi
   Reason: It is believed that phycomycetes have evolved from algae.
2. **Assertion:** Viruses are readily killed by antibiotics.
   Reason: Antibiotics are the antigens secreted by the host.
3. **Assertion:** A virus attaching a bacterium is called bacteriophage.
   Reason: A virus attaching a blue green alga is called cyanophage.
4. **Assertion:** There is no change of transmission of malaria to man on the bite of a male Anopheles mosquito.
   Reason: It carries a non-virulent strain of Plasmodium.
5. **Assertion:** Gram-negative bacteria do not retain the stain when washed with alcohol.
   Reason: The outer face of the outer membrane of Gram-negative bacteria contains lipopolysaccharides, a part of which is integrated into the membrane lipids.

1 MARK QUESTIONS

1. In which of the following kingdom are Archaea and Nitrogen-fixing organisms classified?

a) Animalia
b) Plantae
c) Monera
d) Fungi

2. Bentham and Hooker gave which system of classification?

a) Numerical
b) Phylogenetic
c) Artificial
d) Natural

3. What is the main basis of classification in the five-kingdom system?
a) Structure of the nucleus
b) Structure of cell wall
c) Asexual Reproduction
d) Mode of Nutrition

4. Which of the following statements is false about the fungi?
a) They are eukaryotes
b) They are heterotrophs
c) They possess a purely cellulosic cell wall
d) None of the above

5. African Sleeping Sickness is caused by _______.
a) Trypanozoma cruzi
b) T. Tangela
c) T. rhodesiense
d) T. gambiense

6. Linnaeus evolved a system of nomenclature called _______.
a) Vernacular
b) Monomial
c) Polynomial
d) Binomial

7. What is a taxon?
a) A group of related families
b) A type of living organisms
c) A group of related species
d) A group of any ranking

8. Phylogenetic classification is based on _______.
a) Overall similarities
b) Habit of plants
c) Common evolutionary descendants
d) All of these

9. Static concept of species was proposed by _______.
a) Darwin
b) Theophrastus
c) Linnaeus
d) De Candolle

10. The protists have which of the following?
a) Free nucleic acid aggregates
b) Nucleoprotein in direct contact with the rest of the cell substance
c) Membrane-bound nucleoproteins within the cytoplasm
d) Nucleoproteins condensed together in a loose mass

11. Genes of Tobacco Mosaic Virus are _______.

a) Double-stranded RNA
b) Single-stranded RNA
c) Double-stranded DNA
d) Proteinaceous
12. Blue-green algae belong to which group?
a) Protista
b) Prokaryotes
c) Fungi
d) Bryophytes
13. Who wrote the book “Genera Plantarum”?
a) Bessey
b) Benthem and Hooker
c) Linnaeus
d) Hutchinson
14. T.O. Diener discovered _______.
a) Bacteriophage
b) Infectious protein
c) Free infectious DNA
d) Free infectious RNA
15. Formed by the symbiotic association of algae and fungi.
a) Mycorrhiza b) Lichen
c) Viroids d) Prions

2 MARKS QUESTIONS

1. Why are both autotrophic cyanobacteria and heterotrophic bacteria classified under eubacteria of the kingdom Monera?
2. Why is Neurospora extensively used in genetic experiments?
3. Why do polluted water bodies show more numbers of Nostoc and Oscillatoria under the microscope?
4. Differentiate between Virus and Bacteria.
5. Describe some uses of Chrysophytes.

3 MARKS QUESTIONS

1. Apart from chlorophyll, algae have several other pigments in their chloroplast. What pigments are found in blue-green, red, and brown algae responsible for their characteristic colours?
2. Radha during monsoon season went on a trekking to the forest and saw many mushrooms. She asked her teacher after returning whether all mushrooms are edible? Her teacher replied, No.
   Not all mushrooms are edible.
   a) Can you name an edible mushroom?
   b) Mushroom belongs to which phylum of fungus? What is the name of the fruiting body found in this phylum?
   c) Give any other two uses of fungi.
3. What are ‘pearls of the ocean’? What are their deposits?

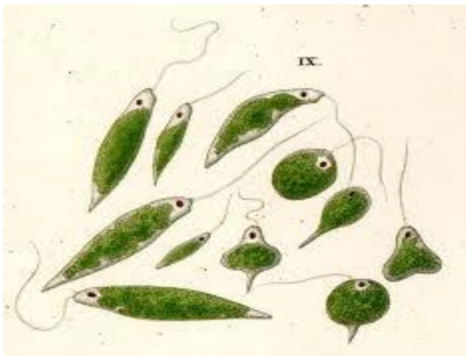
5 MARKS QUESTIONS

1. What are the merits of the five-kingdom classification?
2. **How are bacteria classified?**
3. **What are the different characteristic features of euglenoids?**

CASE BASED QUESTION (4 MARKS)

2. Read the following and answer any four questions from (a) to (b) given below:

The Mysterious Organism
A scientist discovers a single-celled organism in a hot spring. The organism has a nucleus and other membrane-bound organelles, but it also has a cell wall made of cellulose. It can obtain food by absorbing nutrients from the environment, but it can also capture sunlight for energy production.



a) Based on the characteristics described, to which kingdom would this organism most likely belong according to the five-kingdom classification? Briefly explain your answer. (2marks)
b) Name an organism which shows mixotrophic mode of nutrition and how it is significant? (2marks)

ANSWERS

ASSERTION AND REASON QUESTIONS

1. A
2. D
3. B
4. C
5. A

1 MARK QUESTIONS

1. In which of the following kingdom are Archaea and Nitrogen-fixing organisms classified?
c) Monera
2. Bentham and Hooker gave which system of classification?
d) Natural
3. What is the main basis of classification in the five-kingdom system?
d) Mode of Nutrition
4. Which of the following statements is false about the fungi?
c) They possess a purely cellulosic cell wall
5. African Sleeping Sickness is caused by _______.
d) T. gambiense
6. Linnaeus evolved a system of nomenclature called _______.
d) Binomial

7. What is a taxon?
d) A group of any ranking
8. Phylogenetic classification is based on _______.
c) Common evolutionary descendants
9. Static concept of species was proposed by _______.
c) Linnaeus
10. The protists have which of the following?
c) Membrane-bound nucleoproteins within the cytoplasm
11. Genes of Tobacco Mosaic Virus are _______.
b) Single-stranded RNA
12. Blue-green algae belong to which group?
b) Prokaryotes
13. Who wrote the book "Genera Plantarum"?
c) Linnaeus
14. T.O. Diener discovered _______.
d) Free infectious RNA
15. Formed by the symbiotic association of algae and fungi.
b) Lichen

2 MARKS QUESTIONS

1. The similar features of autotrophic cyanobacteria and heterotrophic bacteria are as follows:

They do not have a true nucleus with a nuclear membrane.
DNA is directly present in the cytoplasm without a protein coat.
All the ribosomes are of the 70S type.
All the membranous organelles are absent.

2. Neurospora is used in genetic experiments for three reasons. (Any two)
(1) It can easily be grown in a nutrient medium containing simple organic substances, mineral salts, **vitamins**, and **hormones** in the lab.
(2) Its life cycle is very short.
(3) It is very easy to introduce mutations in Neurospora by using X-rays.

3. A water body suddenly turns green due to the rapid growth of algae. This is called an **algal bloom**. If you collect that water and observe it under the **microscope**, you can find a number of algal species including Nostoc and Oscillatoria.

4. **Cellular Organization**: Viruses are non-cellular entities, while bacteria are single-celled organisms.
   Reproduction: Viruses replicate by hijacking host cells, while bacteria reproduce independently.
   Examples:
   Viral Disease: Common cold (caused by Rhinovirus)
   Bacterial Disease: Cholera (caused by *Vibrio cholerae*)

5. Diatoms have left behind large amount of cell wall deposits in their habitat; this accumulation over billions of years is referred to as '**diatomaceous earth'**.

Being gritty, this soil is used in **polishing, filtration of oils and syrups**. Diatoms are the **chief 'producers'** in the oceans.

3 MARKS QUESTIONS

1. Aside from chlorophyll, algae contain xanthophyll, fucoxanthin and r-phycoerythrin, which impart distinctive colours.
Algae under Chlorophyceae impart green colour, commonly known as green algae.
Phaeophyceae contain fucoxanthin as a major pigment which imparts brown colour.
Similarly, Rhodophyceae imparts red colour with the help of r-phycoerythrin pigment.
2. a) Agaricus
   b) Basidiomycetes. Basidiocarp.
   c) Penicillium- for making antibiotics Penicillin
      Yeast- For making alcohol and bread.
3. Diatoms are nicknamed "pearls of the ocean". They are so-called because of the ornamentations on their **cell walls.** The siliceous cell walls of **diatoms** are called the frustules. They are the chief autotrophs in the surface waters of oceans.
   After death, diatom cells reach the bottom of the ocean and accumulate there for billions of years. These deposits are for the diatomaceous earth. It has a number of applications in different industries.

5 MARKS QUESTIONS

1. The merits of the five-kingdom classification are given below:
The system of classification proposed by RH Whittaker is more scientific, accurate, and natural with evolutionary relationships.
It takes into account the presence of the cell wall, nucleus, mode of nutrition, and reproduction into consideration.
In the five-kingdom classification, the living organisms are classified into different groups based on their similarities and evolutionary relationships. The five-kingdom classification makes us understand the phylogeny and evolutionary origins of organisms.
2. **(i) Bacteria are classified on the basis of the shapes of cells**
A rod-shaped bacterium is called bacillus.
A spiral-shaped bacterium is called the spirillum.
A comma-shaped bacterium is called the vibrio.
The spherical shaped bacterium is called the coccus.
(ii) Bacteria are classified on the basis of the nature of the cell wall
Gram-positive bacteria.
Gram-negative bacteria.
(iii) Bacteria are classified on the basis of the type of respiration
Aerobic bacteria or Aerobes in the presence of oxygen.

Anaerobic bacteria or Anaerobes in the absence of oxygen
(iv) Bacteria are classified on the basis of mode of nutrition
Autotrophic Bacteria: prepare their own food material
Heterotrophic Bacteria: cannot prepare their own food material

3. The characteristic features of euglenoids are given as follows:
They are unicellular organisms with a true nucleus.
They are commonly found in freshwater bodies.
The outer hard and tough cell membrane is called a pellicle.
The anterior part of the cell has two flagella.
There is a photosensitive eyespot near the flagella.
They are autotrophic in nutrition due to the presence of a photosynthetic pigment called chlorophyll.
In the absence of sunlight, euglenoids behave as heterotrophs.

CASE BASED QUESTION (4 MARKS)

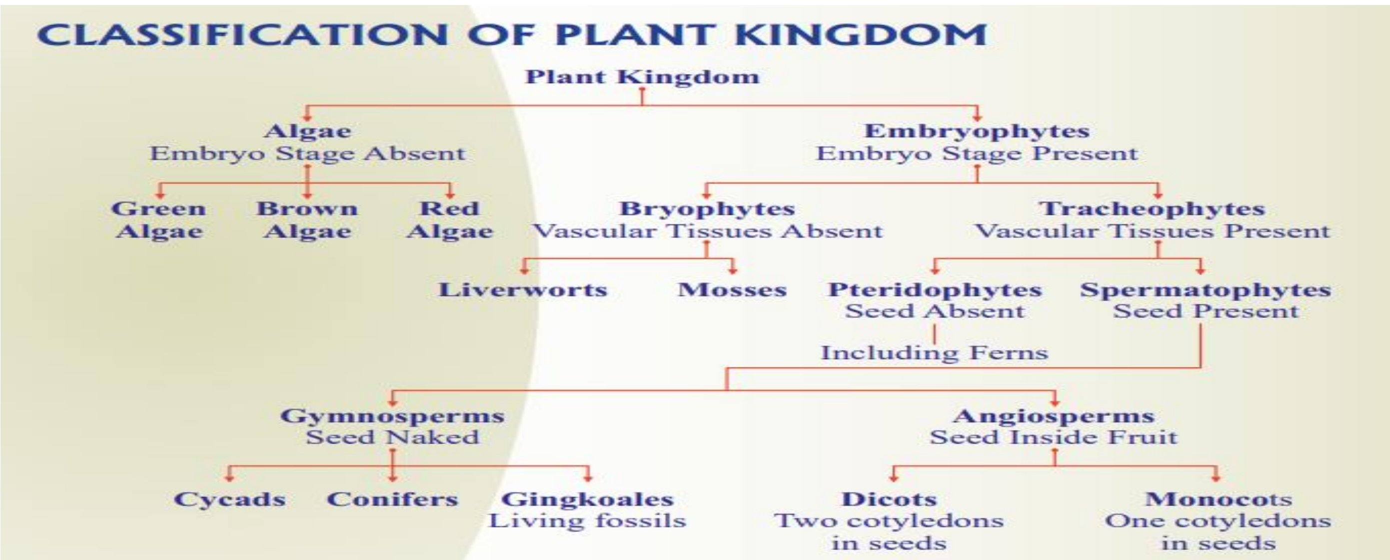
1.

a) The organism is most likely a member of the Protista.

It's single-celled with a nucleus and organelles (eukaryotic).
Protists can have various cell wall compositions, including cellulose.
The ability to absorb nutrients and capture sunlight for energy indicates mixotrophic nutrition, which is common in some protists.
b) Euglena. It shows both autotrophic and heterotrophic mode of nutrition forming a connecting link between plants and animals.

CHAPTER 3- PLANT KINGDOM

KEYPOINTS



ALGAE

TABLE 3.1 Divisions of Algae and their Main Characteristics

Classes	Common Name	Major Pigments	Stored Food	Cell Wall	Flagellar Number and Position of Insertions	Habitat
Chlorophyceae	Green algae	Chlorophyll *a*, *b*	Starch	Cellulose	2-8, equal, apical	Fresh water, brackish water, salt water
Phaeophyceae	Brown algae	Chlorophyll *a*, *c*, fucoxanthin	Mannitol, laminarin	Cellulose and algin	2, unequal, lateral	Fresh water (rare) brackish water, salt water
Rhodophyceae	Red algae	Chlorophyll *a*, *d*, phycoerythrin	Floridean starch	Cellulose, pectin and poly sulphate esters	Absent	Fresh water (some), brackish water, salt water (most)

CHARACTERISTICS

Green Algae (Chlorophyceae)

*Microscopic, eukaryotic, unicellular green algae.
*Generally found in ammonium salt rich habitat.
* Reproduce by both sexual and asexual means.
*Asexual reproduction through Zoospores, Palmella stage, Akinetes, Aplanospores and Hyponospores.
*Sexual reproduction through isogamy, anisogamy or oogamy.
*The holdfast cell is non-photosynthetic and lost the ability to divide.

Brown Algae (Phaeophyceae)

*Sargassum, is a menace to shipping.
*No unicellular brown algae is known.
*Laminaria (20–30 m) due to their giant size are called as giant kelps.
*Alginic acid is obtained from phycocolloids from kelps.

Red Algae (Rhodophyceae)

*In deeper oceans, red algae acquire deeper colour. The pigment r-phycoerythrin in red algae can do this job of capturing light of available wavelength for red algae.
* The common name for brown and red algae is sea weed.
*Polysiphonia, a red alga, has anti-bacterial property.

***Life cycle in green algae is of three types:**
I) Haplontic: Zygotic meiosis e.g., Ulothrix, Spirogyra. **II) Diplontic:** Gametic meiosis e.g., Caulerpa. **III) Diplohaplontic:** Haploid and diploid phases are well developed and multicellular.

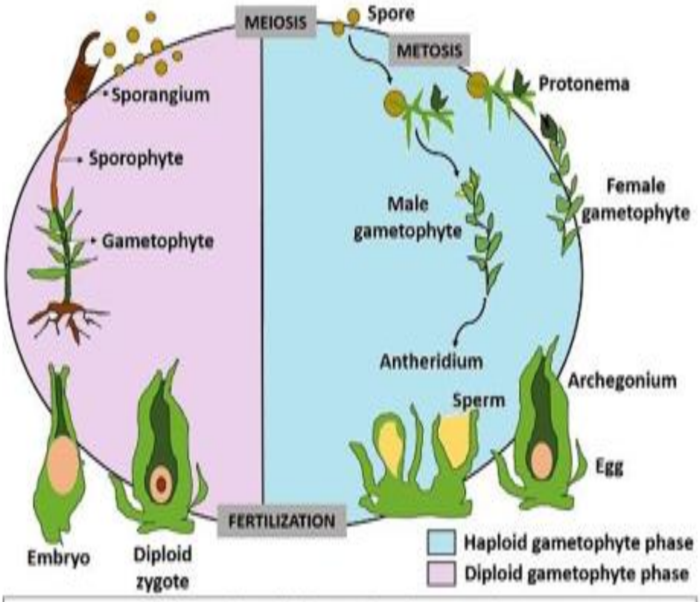
- Economic Importance of Algae:

Cattle food	*Sargassum*, *Fucus*, *Macrocystis* (rich in Vit. A & E).
Human food	*Laminaria*, *Spirulina* (richest in protein), Chlorella (rich in protein & carbohydrates).
Algenic acid	*Laminaria*, *Ascophyllum*, *Macrocystic*.
Carrageenin	*Chondrus crispus* (Irish moss)
Agar	*Gelidium* and *Gracilaria*.
Iodine	*Laminaria digetata*
Nitrogen fixation	*Anabaena*, *Nostoc*
Space algae	*Chlorella*

BRYOPHYTES

CHARACTERISTICS

*Commonly called **as plant amphibian**.
*Alternation of generation is observed.
*Vascular tissues are absent.
*They lack true stem, leaves and roots.
*Gametophyte is anchored (attached) by rhizoids.
*Sporophyte (sporogonium) is dependent on gametophyte for nutrition.
*Spores are produced by the sporophyte in a spore capsule.
*Water is essential for fertilization.



Generalized life cycle of Bryophytes

* Sex organs are multicellular and jacketed. **Male-antheridium, female archegonium**.
*Fertilization produced an embryo inside the archegonium. Embryo grows into a sporophyte.
***Protonema is the juvenile gametophyte**.
*Zygote and spores are the first cell of sporophytic and gametophytic generation respectively.

Liverworts

*They are found in moist, shady regions such as marshy ground, banks of streams, damp soil, bark trees and deep in the woods
*Plant body is thalloid (Marchantia). The thallus is dorsoventrally flattened. The leafy members have small leaf-like appendages on steam-like structures

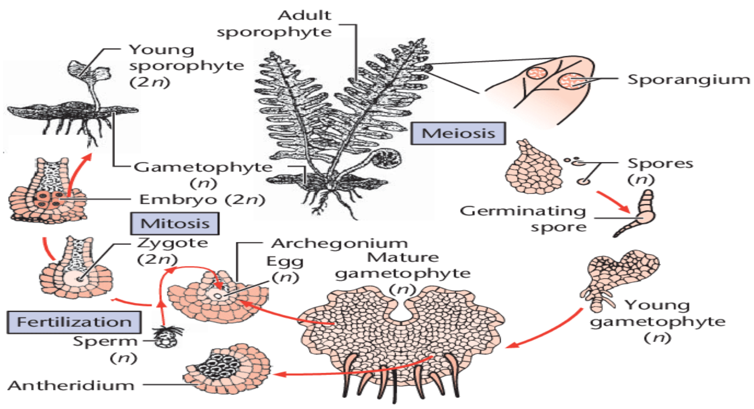
Moss/Funaria.

I) **Gametophyte has 2 stages – protonema stage and the leafy stage.**
*It consists of slender axes, upright arranged leaves spirally. When they are attached to the soil through branched and multicellular rhizoids, the stage bears the sex organs
II) Fragmentation and budding are observed in secondary protonema in the vegetative reproduction while in sexual reproduction, the sex organs are produced at the apex of leafy shoots.
III) Sporophytes in mosses are more elaborate than that in liverworts. Capsules comprise of spores formed after meiosis. Some examples – Funaria, Sphagnum
***Fossilised Sphagnum produces peat which is used as fuel as well as manure**

PTERIDOPHYTES OR FERNS

CHARACTERISTICS

***Commonly called snakes of plant kingdom.**
*First vascular plants without seeds.
*Main plant body is sporophyte and distinguishes into root, stem and leaves.
*The stem is underground **rhizome**.
*Alternation of generation between spore producing diploid sporophyte and gamete forming haploid gametophyte.
*Ornamental leaves are called **fronds**.
*<u>**Reproduction is of vegetative, asexual and sexual type.**</u>
*Sperms are flagellated.
*Sporophytes bear sporangia subtended by sporophylls.
*Sporangia produce spores by meiosis which germinate to produce the prothallus.
*Sporangia occurs on leaves in cluster called sori. Fertile leaves are called sporophylls.
*A sorus is covered by a flap

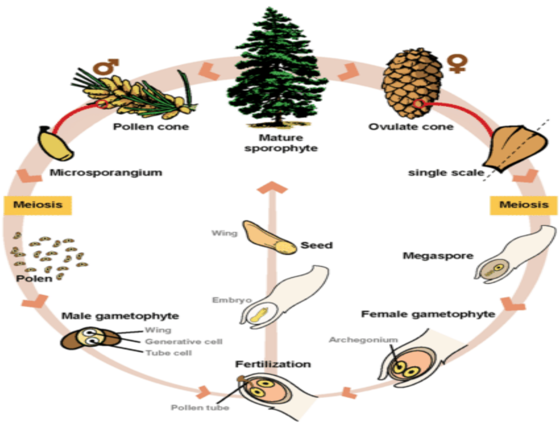


like outgrowth from its surface (true indusium) or turned margin of the sporophyll (false indusium).
*Most of them are homosporous (similar kinds of spores) some others may be heterosporous (macro and microspores)
*Selaginella is **heterosporous** i.e., small male and large female spores.
*Smallest pteridophyte—**Azolla** (a bio-fertilizer).
***Apogamy**—Development of sporophyte (n) from gametophyte without fertilization.
***Apospory**—Development of gametophyte (2n) from sporophyte without meiosis.
***Selaginella** is popularly known as **club moss or spike moss**.
***Dryopteris** is commonly called as **male shield fern**.
*Adiantum is commonly called as walking fern, maiden hair fern.
*Pteridophytes formed dominant flora in carboniferous period, Palaeozoic era.
***Most part of coal is formed from pteridophytes plants**.

GYMNOSPERMS

CHARACTERISTICS

*They include medium-sized trees or tall trees & shrubs. **Ovules are not enclosed by any ovary wall** and remain exposed, before and after fertilisation.

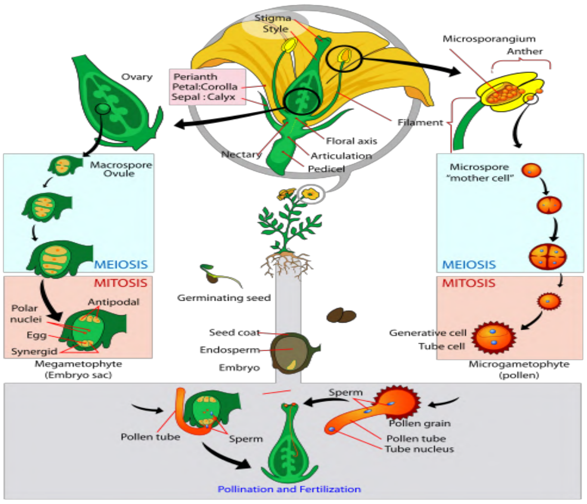


*Vascular plant
*Perennial plant of colder region.
*Leaves may be simple or compound, dimorphic—foliage & scale leaves.
* The leaves in gymnosperms are well-adapted to withstand extremes of temperature, humidity and wind. In conifers, the **needle-like leaves** reduce the surface area. Their thick cuticle and sunken stomata also help to reduce water loss.
* They are **heterosporous**, strobili bear two kinds of spores- **microsporophylls and megasporophylls**. *Sporophyll produces **strobili or cones**.
* Flowers are absent.
*Integument is three layered.
*Each one has a mass of tissue called nucellus (equivalent to megasporangia).
* Unlike earlier forms, in gymnosperms, the male and the female gametophytes **do not have an independent free-living existence.**
*Female gametophyte develops archegonia. Neck canal cell absent.
*Endosperm (2n) gametophytic.
***Gingko and Cycas** are called as the **living fossils**.
****Sequoia gigantica***—Tallest gymnosperm
***Red wood tree—Father of the forest**

*Cycas—Sago palm
***Chilgoza from *Pinus girardiana*.**

ANGIOSPERMS

CHARACTERISTICS



* In angiosperms, the seeds are enclosed in fruits, the pollen grains and ovules are developed in specialized structures called flowers.
* Highly evolved plants group.
* Sporophylls are aggregated to form flowers. Therefore, angiosperms are also called flowering plants.
* Both microsporophylls and megasporophylls are specialised.
* A microsporophyll or stamen consists of a filament and an anther. A megasporophylls or carpel consists of a stigma, style and ovary containing ovules.
* Female gametophyte or embryo sac develops, up to 8-nucleate state prior to fertilization.
* Archegonia are absent. Instead, there is one oosphere surrounded by two specialised synergid cells that attract the pollen tube. The latter brings two naked non-flagellate male gametes

ASSERTION AND REASON QUESTIONS

These questions consist of two statements each, printed as Assertion and Reason.
While answering these questions you are required to choose any one of the following four responses.
A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.
B. If both Assertion and Reason are true but the Reason is not a correct explanation of the Assertion.
C. If Assertion is true but the Reason is false.
D. If both Assertion and Reason are false

1. **Assertion:** Chlorella could be utilised to keep the air pure in space vehicles.
   Reason: The space travellers feed on Chlorella soup.
2. **Assertion:** Red algae contribute in producing coral reef.
   Reason: Some red algae secrete and deposit calcium carbonate on their walls.
3. **Assertion:** Gymnosperms do not produce fruit.
   Reason: Ovules of gymnosperms are enclosed within the ovaries.
4. **Assertion:** Bryophyte has an independent embryo.
   Reason: The zygote of thallophyte is dependent.
5. **Assertion:** All living species of Cycas are dioecious.
   Reason: Cycas contains male and female cones on the separate plant

1 MARK QUESTIONS

1. Which of the plant groups needs both land and water to complete their life cycle?
a) Tracheophyta
b) Pteridophyta
c) Thallophyta
d) Bryophyta
2. A plant that has seeds but no flowers and fruits?
a)) Bryophytes
b) Gymnosperms
c) Mosses
d) Pteridophytes
3. Most primitive vascular plants?
a) Mosses
b) Cycads
c) Kelps
d) Ferns
4. Plants that possess spores and embryo but lack vascular tissues and seeds?
a) Rhodophyta
b) Bryophyta
c) Pteridophyta
d) Phaeophyta
5. Which one is an exception in angiosperms?
a) Double fertilization
b) Secondary growth
c)Presence of vessels
d) Autotrophic nutrition
6. Pteridophytes differ from mosses in ---------------------------.
a) independent gametophyte
b) Dependent gametophyte
c) Flagellate antherozoids
d) Independent and dominant sporophyte
7. Angiosperms are the dominant flora because of
a) Domestication by man
b) Power of adapting in diverse habitats
c) Self-pollination property
d) Property of producing a large number of seeds
8. Plants reproducing by spores are grouped under----------------------.
a) Bryophytes
b) Sporophytes
c) Cryptogams
d) Thallophytes

9. Plants having vascular tissue without seeds -------------------------.
a) Angiosperm
b) Pteridophytes
c) Bryophytes
d) Gymnosperms
10. The plant group that possess the largest ovule, largest gametes, and largest tree --------------------------.
a) Angiosperms
b) Gymnosperms
c) Pteridophytes
d) Bryophytes
11. Zygotic meiosis is the characteristic of ----------------------------------.
a) Fucus
b) Funaria
c) Marchantia
d) Chlamydomonas
12. Pick the mismatched pair
a) Cycas – Dioecious
b) Equisetum – Homosporous
c) Salvinia – Heterosporous
d)Pinus – Dioecious
13. A colonial alga is --------------------------.
a) Volvox
b) Chlorella
c) Ulothrix
d) Spirogyra
R14. Double fertilization is the characteristic of -------------------------.
a) Algae
b) Gymnosperms
c) Fung
d) Angiosperms
15. Conifers can tolerate extreme environments because of -------------.
a) Presence of vessels
b) Thick cuticle
c) Superficial stomata
d) Broad hardy leaves

2 MARK QUESTIONS

1. Explain why Bryophytes are called the "amphibians of the plant kingdom."
2. Mycorrhiza and coralloid roots are found in which plants? What do these terms mean?
3. What features led to the dominance of vascular plants?
4**. Does heterospory have some evolutionary significance in the plant kingdom?**

5. Sphagnum has a lot of economic importance. Justify.

3 MARK QUESTIONS

1. Explain the following terms briefly with suitable examples –

a) Protonema
b) Antheridium
c) Sporophyll
d) Archegonium
e) Diplontic
f) Isogamy

2. Match the following groups of kingdom Plantae with their examples.

a)

Column A	Column B
(a) Bryophyta	(i) Apple
(b) Angiosperm	(ii) Fern
(c) Pteridophyta	(iii) Pine
(d) Gymnosperm	(iv) Funaria

b) Give an example of
i) A gymnosperm whose seeds are edible
ii) A tallest gymnosperm.

3. Arnav once went on a vacation to Darjeeling. He collected a Cycas leaf and showed it to his biology teacher after his return. The biology teacher identified that it had two types of leaves and was narrow and pointed.

a) Can you guess the term used for the plants having two types of leaves.
b) Why the leaves were narrow and pointed? Give any other special feature of such leaves.

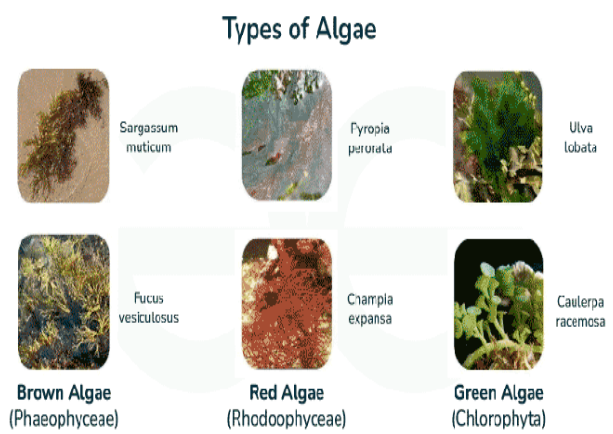
5 MARKS QUESTIONS

1. Explain in brief the structure of the prothallus of the fern?
2. Algae and Bryophytes are different from each other.” Point out the main differences between them?

CASE BASED QUESTION (4 MARKS)

3. Read the following and answer any four questions from (a) to (b) given below:

The biology teacher showed the students some pictures of different types of algae and asked them to collect the information about them. All the students gathered information and made a chart of it.



a) Name the pigment found in Rhodophyceae.
b) Name an alga which is also known as giant kelps.
c) What is the reserve food found in Phaeophyceae?
d) Give one importance of *Spirulina*.

ANSWERS
ASSERTION AND REASON QUESTIONS

1. B
2. A
3. C
4. D
5. A

1 MARK QUESTIONS

1. Which of the plant groups needs both land and water to complete their life cycle?
d) Bryophyta
2. A plant that has seeds but no flowers and fruits?
b) Gymnosperms
3. Most primitive vascular plants?
d) Ferns
4. Plants that possess spores and embryo but lack vascular tissues and seeds?
b) Bryophyta
5. Which one is an exception in angiosperms?
a) Double fertilization
6. Pteridophytes differ from mosses in
d) Independent and dominant sporophyte
7. Angiosperms are the dominant flora because of
b) Power of adapting in diverse habitats
8. Plants reproducing by spores are grouped under
c) Cryptogams
9. Plants having vascular tissue without seeds
b) Pteridophytes
10. The plant group that possess the largest ovule, largest gametes, and largest tree
b) Gymnosperms
11. Zygotic meiosis is the characteristic of
d) Chlamydomonas
12. Pick the mismatched pair
d)Pinus – Dioecious
13. A colonial alga is
a) Volvox
14. Double fertilization is the characteristic of
d) Angiosperms
15. Conifers can tolerate extreme environments because of
b) Thick cuticle

2 MARKS QUESTIONS

1. Bryophytes are called the "amphibians of the plant kingdom" because their sexual reproduction relies on water. They lack vascular tissues and require a moist environment for their sperm, called antherozoids, to swim to the egg located in the archegonium.

2. Mycorrhiza is the symbiotic association between fungus and roots of vascular plants. The mycorrhizal association is present in conifers such as Pinus, Cedrus, etc. Coralloid roots are present in Cycas. Coralloid roots are present in clusters at the base of the stem and protrude over the ground. It is greenish in colour and dichotomously branched.

3. The features which led to the dominance of vascular plants are:

(i) Development of deep roots with the ability to penetrate the soil.

(ii) Development of water-proofing material eg. cutin on aerial surfaces, to reduce water loss through evaporation.

(iii) Development of strong woody material anchor and support above-ground structures.

4. Pteridophytes forms a connecting link between bryophytes and gymnosperms. Primitive pteridophytes are homosporous while the later pteridophytes are heterosporous. Bryophytes are homosporous and gymnosperms are heterosporous.

5. Sphagnum has a lot of economic importance as it provides peat which is used as a fuel. It is also used as packaging material for the transhipment of living material.

3 MARKS QUESTIONS

1. a) Protonema: It is the Juvenile, green, autotrophic filament like haploid, independent, gametophytic stage in the life cycle of mosses. It is produced from the germination of spores and gives rise to new gametophytic plants.

b) Antheridium: It is multicellular, Jacketed male sex organ in bryophytes and pteridophytes. It produces sperms (antherozoids or male gametes).

c) Sporophyll: It is a leaf that bears sporangia or sori. Sporophyll may be microsporophyll or megasporophylls. Sporophylls aggregate to form cones or strobili, e.g., sporophyll of fern; micro and megasporophylls of Selaginella, Pinus; stamen and carpel of Angiosperms.

d) Archegonium: It is multicellular, jacketed, flask shaped female sex organ in bryophytes, pteridophytes and gymnosperms. It has a neck and swollen venter and produces a single female gamete called egg or ovum or oosphere.

e) Diplontic: The diploid stage or sporophyte is the dominant and independent stage of the plant and performs photosynthesis. The haploid phase is represented by single-cell gametes or few celled gametophytes.

(f) Isogamy: It is a type of sexual reproduction in which the fusing gametes are similar in structure and function, e.g., Ulothrix, Chlamydomonas, Ectocarpus.

4. a)

Column A	Column B
(a) Bryophyta	(iv) Funaria
(b) Angiosperm	(i) Apple
(c) Pteridophyta	(ii) Fern
(d) Gymnosperm	(iii) Pine

b) Give an example of
i) Pinus
ii) *Sequoia gigantica*

5. a.Leaves may be **dimorphic** having foliage & scale leaves.
b.The leaves in gymnosperms are well-adapted to withstand extremes of temperature, humidity and wind. In conifers, the **needle-like leaves** reduce the surface area.
c. Their thick cuticle and sunken stomata also help to reduce water loss.

5 MARKS QUESTIONS

1. The structure of the Prothallus of fern has been defined below: (**Any Five**)

(i) Heart-shaped structure.
(ii) Sex organs antheridia and archegonia are present on the lower surface of the prothallus.
(iv) Prothallus is produced from meiospore as a gametophyte of fern.
(v) Below the sex organs are rhizoids
(vi) The sex organs which are Archegonia and antheridia are flask and globose shaped respectively.
(vii) Male and female gametes are produced in the antheridia and the archegonia.

2.

Algae	Bryophytes
They are mostly aquatic	They are mostly terrestrial and found in damp, shady places
Thallus may be single-celled to branched filaments	The thallus is made up of parenchymatous cells
No tissue differentiation is observed	Tissue differentiation is well marked
Stomata is absent	Stomata is present
Rhizoids are absent	Rhizoids are absent

CASE BASED QUESTION

2.
   a) Chlorophyceae a, d, r- phycoerythrin.
   b) Laminaria
   c) Laminarin, Manitol
   d) *Spirulina* is the richest source of protein and taken as food supplement.

CHAPTER 4- ANIMAL KINGDOM

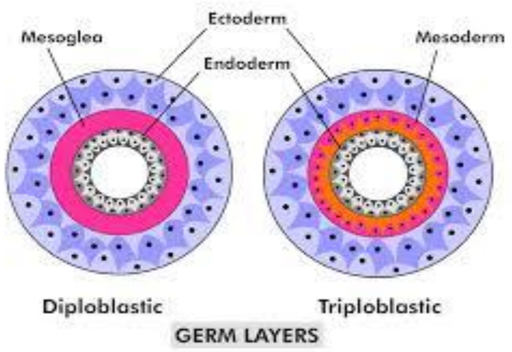
KEYPOINTS

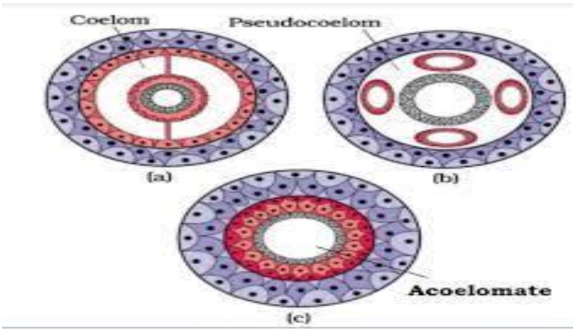
CLASSIFICATION OF ANIMALS

Animals are classified on the following basis-

Levels of Organisation- cellular/ tissue/ body level
Body symmetry- symmetrical/ asymmetrical/radial symmetry
Nature of coelom- coelomate/ acoelomate// pseudocoelomate
Circulatory System- open/ closed
Segmentation
Notochord

Coelom **Germ Layers**





PHYLUM – PORIFERA (Sponges)

Cellular level of organization.
Ostia: Minute pores through which water enters, Spongocoel: central cavity in the body
Osculum: Water goes outside through it, Water transport system helps in food gathering, respiratory exchange and removal of waste. Choanocytes (collar cells): line the Spongocoel and the canals.
Spicules/ Spongins: Skeleton fibres
Hermaphrodite: Sexes are not separate
Asexual Reproduction: Fragmentation, Sexual reproduction by the formation of gametes.

Fertilization: Internal, development is indirect.
Eg-Sycon (Scypha), Spongilla (Freshwater sponge), Euspongia (Bath sponge).

PHYLUM – COELENTERATA (Cnidaria)

Cnidoblasts or Cnidocytes: contain the stinging capsules (nematocysts) on the tentacles and the body.
These are used for anchorage/ defence/ capture of prey.
They have a **central gastro-vascular cavity** with a single opening, mouth on hypostome.
Cnidarians exhibit two basic body forms called **polyp and medusa**.
Polyp: Sessile and cylindrical e.g., Hydra, Adamsia
Medusa: Free swimming and umbrella-shaped e.g., Aurelia or jellyfish.
Metagenesis: Alternation of generation; polyps produce medusa asexually and medusa form the polyps sexually.
Eg- *Adamsia* (sea anemones), *Pennantula* (sea pen), *Physalia* (Portuguese man of war), *Gorgonia* (sea fan) and *Meandrina* (Brain coral)

PHYLUM – CTENOPHORA (Sea Walnuts or Comb Jellies)

Comb plate: eight rows of ciliated plates for locomotion, bioluminescent.
Reproduction: only by sexual means.
Fertilization: external with indirect development.
Eg- *Pleurobrachia* and *Ctenoplana*.

PHYLUM – PLATYHELMINTHES (Flatworms)

Flame cells: osmoregulation and excretion.
Fertilization: internal and development is indirect.
Planaria possess high regeneration capacity.
Eg-*Taenia* (Tapeworm), *Fasciola* (Liver fluke)

PHYLUM – ASCHELMINTHES (Roundworms)

Alimentary canal is complete with a well-developed **muscular pharynx**.
Excretion occurs by excretory tube and the excretory pore.
Often females are longer than males.
Eg-*Ascaris* (round worm), *Wuchereria* (Filarial worm)

PHYLUM – ANNELIDA

They have longitudinal and circular muscles for locomotion.
Aquatic annelids like Nereis possess **lateral appendages**, and **parapodia**, which help in swimming.
Circulatory system- closed type
Nephridia: helps in osmoregulation and excretion.
Ganglia: Neural system consists of paired ganglia.
Dioecious (Nereis) , monoecious (earthworms and leeches)
Reproduction: Sexual.

Eg--*Nereis, Pheretima* (Earthworm), *Hirudinaria*(Blood sucking leech)

PHYLUM – ARTHROPODA

Circulatory system: open type.
Sensory organs: Antennae, eyes (compound and simple), **statocysts** or balancing organs are present.
Excretion: **Malpighian tubules**.
Eg- Economically important- ***Apis*** (Honey bee), ***Bombyx*** (Silkworm), ***Laccifer*** (Lac insect)
Vectors – *Anopheles, Culex and Aedes* (Mosquitoes)
Gregarious pest – ***Locusta*** (Locust)
Living fossil – ***Limulus*** (King crab).

PHYLUM – MOLLUSCA

They are bilaterally symmetrical, triploblastic, coelomate animals with the organ-system level of organization.

Eg- *Pila* (Apple snail), *Pinctada* (Pearl oyster), *Sepia* (Cuttlefish), *Loligo* (Squid), Octopus (Devil fish), *Aplysia* (Seahare), *Dentalium* (Tusk shell) and *Chaetopleura* (Chiton)

PHYLUM – ECHINODERMATA

Spiny body and contains endoskeleton of **calcareous ossicles**.
They are triploblastic and coelomate animals with the organ-system level of organization.
Digestive system: complete with the mouth (ventral side) and anus (dorsal side).
Sexes are separate, Reproduction is sexual.
Eg- *Asterias* (Star fish), Echinus (Sea urchin), *Antedon* (Sea lily), *Cucumaria* (Sea cucumber) and *Ophiura* (Brittle star)

PHYLUM – HEMICHORDATA

Non-Chordata (have a rudimentary structure in the collar region called **stomochord**, a structure similar to notochord).

They are bilaterally symmetrical, triploblastic and coelomate animals with the organ-system level of organization.

Sexes are separate; Fertilization is external; Development is indirect.

Eg- *Balanoglossus* and ***Saccoglossus.***

PHYLUM – CHORDATA

Phylum Chordata is divided into three subphyla:
Protochordates: Urochordata/ Tunicata and Cephalochordates-
Marine Vertebrata: Vertebrata possess notochord during the embryonic period. The notochord is replaced by a cartilaginous or bony vertebral column in the adult.
Vertebrates have a ventral muscular heart with two, three or four chambers, kidneys for excretion and osmoregulation, and paired appendages which may be fins or limbs.

Urochordata, the notochord is present only in the larval tail.
Eg *Ascidia, Salpa, Doliolum*
In Cephalochordate, notochord extends from head to tail region and is persistent throughout their life.
Eg- *Branchiostoma* (Amphioxus or Lancelets).

CLASS – CYCLOSTOMATA (Circular Mouthed Fishes)

They are **Ecto-parasites** on some fishes. They have **sucking and circular mouth** without jaws.
Body devoid of scales, gill slits for respiration, cranium and vertebral column is cartilaginous.
Circulation is closed type. They are marine but migrate to fresh water for spawning and die after few days. Larva return to seas after metamorphosis.
Eg- *Petromyzon* (Lamprey), *Maxine* (Hag fish).

CLASS- CHONDRICHTHYES (Cartilaginous Fish)

They are marine, streamlined body, have cartilaginous endoskeleton, cold blooded, tough skin with minute placoid scales.

Gill slits are separate without operculum.

They have powerful jaw and are predators.

Air bladder is absent, hence to avoid sinking swims constantly. Heart is two chambered, cold blooded **(Poikilothermous).**

Sexes separate. Males have pelvic fins which bear claspers. Internal fertilisation, many are viviparous.

Electric organ is present in Torpedo and Poison sting in Trygon

Eg- *Scoliodon* (Dog fish), *Carcharodron* (Great white shark).

CLASS OSTEICHTHYES (The body fish)

Marine and fresh water both have bony endoskeleton. Streamlined body with four pair of gills covered by operculum.

Skin is covered with scales, air bladder is present, and heart is two chambered, cold blooded.

Sexes are separate, fertilisation external, oviparous and development direct.

Eg- Marine- *Hippocampus* (Sea horse), *Exocoetus* (Flying fish).

Fresh water- *Labeo* (Rohu), Catla, *Clarias* (Magur).

Amphibia	Reptilia	Aves	Mammals
Can live in aquatic as well as terrestrial habitat.	Mostly terrestrial animals.	Presence of feathers for flying.	Mostly terrestrial, a few can fly and live in water.
Two pairs of limbs	Limb two pair if present.	Forelimb is modified into wings.	Two pair of limbs.
Moist skin without scales.	Dry and cornified skin having scale or scute.	Skin is dry without glands. Long bones are hollow with air cavities.	Skin possesses hairs. Mammary gland is present to produce milk.
Respiration by gills, lungs or skin.	Respiration by lungs.	Respiration by lungs.	Respiration by lungs.
Heart three chambered, cold blooded.	Heart three chambered, Crocodile 4-chambered .	Heart is four chambered, warm blooded.	Heart four chambered
Oviparous	Oviparous	Oviparous	Viviparous or Oviparous.
Rana (frog), Salamander, *Hyla*	*Chamelion, Crocodilus, Naja*	*Columba, Pavo*, Ostrich	Platypus(oviparous) Camel, Dog, Blue whale.

ASSERTION AND REASON QUESTIONS

These questions consist of two statements each, printed as Assertion and Reason.
While answering these questions you are required to choose any one of the following four responses.
A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.
B. If both Assertion and Reason are true but the Reason is not a correct explanation of the Assertion.
C. If Assertion is true but the Reason is false.
D. If both Assertion and Reason are false

1. **Assertion:** There is no chance of malaria to a man by the bite of male Anopheles mosquito.
   Reason: It carries a virulent strain of Plasmodium.
2. **Assertion:** Tapeworm, roundworm and pinworm are endo-parasites of human intestine.
   Reason: Improperly cooked food is the source of intestinal infections.
3. **Assertion:** In ctenophores, digestion is chiefly extracellular.
   Reason: Digestive tract is incomplete in ctenophores.
4. **Assertion:** Arthropods are able to survive in adverse conditions.
   Reason: Arthropods have developed sense organs, compound eyes and taste receptors.

5. **Assertion:** Water vascular system is the characteristic of echinoderms.
   Reason: Main function of water vascular system is locomotion.

1 MARK QUESTIONS

1. Body forms present in cnidarians are
a) Cylindrical and umbrella-shaped
b) Corals and coral reefs
c) Polyp and medusa
d) Cnidoblasts and nematocysts
2. Coelenterates belong to which of the following –
a) Acoelomate
b) Coelomate
c) Pseudocoelomate
d) All of these
3. In case of poriferans, the Spongocoel is lined with flagellated cells called
a) Ostia
b) Oscula
c) Choanocytes
d) mesenchymal cells
4. Identifying feature of phylum– Ctenophora is
a) the presence of comb plates and appearance like jellies
b) the presence of comb plates only
c) the presence of tentacles only
d) alternation of generations only
5 Platyhelminthes have hooks and suckers and act as an endo-parasite on other animals.
a) True
b) False
c) Cannot say
d) Partially true or false
6. The animals belonging to phylum–Annelida use the following in locomotion.
a) Nephridia and nephridial pores
b) Longitudinal and circular muscles
c) Organs of bursa
d) Spicules and ostia
7. Malpighian tubules are
a) excretory organs of insects
b) excretory organs of frog
c) respiratory organs of insects
d) endocrine glands of insects
8. Which one of the following features is not present in the phylum–Arthropoda?

a) Metameric segmentation
b) Parapodia
c) Jointed appendages
d) Chitinous exoskeleton
9. The body of organisms belonging to phylum–Mollusca is divided into
a) head, thorax and abdomen
b) head, muscular foot and abdomen
c) head, thorax, visceral hump and muscular foot
d) head, muscular foot and visceral hump
10. A set of features observed in chordates
a) dorsal heart, pharynx perforated by gill slits and dorsal ventral system
b) ventral heart, presence of post-anal tail and presence of gill slits
c) ventral heart, absence of notochord, but presence of post-anal part of the tail
d) dorsal heart, presence of post-anal tail and central nervous system in dorsal
11. Opening on the upper side of spongocoel _________
a) Osculum
b) Cnidoblasts
c) Spicules
d) Ostia
12. The property of not having separate sexes in an organism is called as _________
a) Hermaphrodite
b) Oogamous
c) Homogamous
d) Heterogamous
13. Which among the following statements is incorrect about ctenophores?
a) Ctenophores are radially symmetrical
b) They are diploblastic
c) They reproduce both sexually and asexually
d) They have ciliated comb plates on their body
14. Branchiostoma is an example of Cephalochordata.
a) True
b) False
15. What does the word homoiothermous refer to?
a) Lie in the same temperature
b) Warm blooded animals
c) The animal is in thermal equilibrium with its surrounding
d) The animal lives in isotonic conditions

2 MARKS QUESTIONS

1. How do endo-parasites survive inside the body of the host?
2. Diagrammatically show the difference between diploblastic and triploblastic animals?

3. Write any two specific features of Amphibians.
4. The animal kingdom is full of amazing creatures. This marine organism shows bioluminescence and is transparent in appearance.
a) To which phylum does the above-mentioned organism belongs?
b) Mention any two other characteristics of this phylum.
5. Define
a) Cnidoblasts
b) Nephridia
c) Polyp
d) Operculum

3 MARKS QUESTIONS

1. Provide a technical term for the following:
a) Blood filled cavity in arthropods
b) A stinging organ of jellyfish
c) Free-floating form of Cnidaria
d) Lateral appendages in aquatic annelids
e) Osmoregulation and excretion
f) Cold blooded animals
2. Differentiate between coelomate, acoelomate and pseudocoelomate with examples.
3. Param went to the jungle and identified a reptile which was long and slithering with no limbs. Which organism it may be and what features he must have observed to classify it as a reptile. Write any 3 features of it. Give an example of any other organism belonging to the phylum.

5 MARKS QUESTIONS

1. a) What is the basis of the classification of Animalia?
   b) Mention any two features of Pisces.
2.

Identify the phylum to which it belongs and write any five characteristics of this phylum.

CASE BASED QUESTION (4 MARKS)

6. Read the following and answer any four questions from (a) to (b) given below:

Aadhya, a student of class IX has brought a crab and an apple snail from the beach. She had identified both as members of Phylum Mollusca, as they have a shell. As a senior student of biology, help her to identify the animals correctly.

(a) Name the phylum, crab belongs to and that which apple snail belongs to. (1mark)

(b) Write any four differences between the animals of the two phyla. (2marks)

(c) Name any two economically important arthropods. (1mark)

ANSWERS

ASSERTION AND REASON QUESTIONS

1. C
2. A
3. D
4. B
5. B

1 MARK QUESTIONS

1. Body forms present in cnidarians are
c) Polyp and medusa
2. Coelenterates belong to which of the following –
a) Acoelomate
3. In case of poriferans, the spongocoel is lined with flagellated cells called
c) Choanocytes
4. Identifying feature of phylum– Ctenophora is
a) the presence of comb plates and appearance like jellies
5. Platyhelminthes have hooks and suckers and act as an endo-parasite on other animals.
a) True
6. The animals belonging to phylum–Annelida use the following in locomotion.
b) Longitudinal and circular muscles
7. Malpighian tubules are
a) excretory organs of insects
8. Which one of the following features is not present in the phylum–Arthropoda?
b) Parapodia
9. The body of organisms belonging to phylum–Mollusca is divided into
d) head, muscular foot and visceral hump
10. A set of features observed in chordates
b) ventral heart, presence of post-anal tail and presence of gill slits
11. Opening on the upper side of spongocoel _________
d) Ostia

12. The property of not having separate sexes in an organism is called as __________

a) Hermaphrodite

13. Which among the following statements is incorrect about ctenophores?

c) They reproduce both sexually and asexually

14. Branchiostoma is an example of Cephalochordata.

a) True

15. What does the word homoiothermous refer to?

b) Warm blooded animals

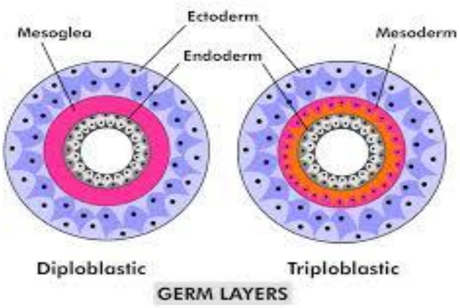
2 MARKS QUESTIONS

1. The endo-parasites have the following features which enables them to survive inside the body of the host:

Anaerobic respiration.

i) Exchange of gases through the body surface.
ii) They possess an additional organ for attachment.
iii) Well-developed reproductive organs.
iv) They have no locomotory organs.

2.



3. The two features of Amphibia:

(i) Moist skin

(ii) Cutaneous and pulmonary respiration.

4. a) Ctenophora

b) **Comb plate:** eight rows of ciliated plates for locomotion.

Reproduction: only by sexual means.

5. a) Cnidoblasts or Nematoblasts are stinging cells found in Cnidaria.

b) Excretory organ found in Annelids

c) Polyp is a fixed, cylindrical structure that symbolizes the asexual stage.

e) Bony covering over the gills found in Osteichthyes.

3 MARKS QUESTIONS

1. a) Haemocoel

b) Nematocytes

c) Medusa

d) Parapodia

e) Flame cells
f) Poikilotherms
2.

Coelomate	**Acoelomate**	**Pseudocoelomate**
The animals that are having true coeloms.	The coelom is absent.	The animals in which the body cavity is present but it is not completely lined by mesoderm, instead it is present as scattered pouches in between the ectoderm and endoderm
The blastocoel is completely replaced by a true coelom.	The blastocoel is completely occupied by mesoderm.	The blastocoel is partly filled by mesodermal cells.
Examples include Annelids, Molluscs, and Arthropods.	Examples include Porifera, Coelenterata, Platyhelminthes (flatworms).	Examples include Aschelminths (roundworms).

3. Param might have observed a snake.
Three characters of reptiles are-
i) These are creeping and burrowing terrestrial animals with scales on their body.
ii) They are cold-blooded animals found in most of the warmer regions of the world.
iii) The body is divided into head, neck, trunk, and tail.
Reptilia- Lizard, Crocodile.

5 MARKS QUESTIONS

1. a) The basis of classification of Animalia are: -
i) Notochord: It is basically a rod-like structure found in the chordates. However, it is not found in non-chordates.
ii) Symmetry: It is basically about the arrangement of the body parts i.e., how they are arranged. The arrangement is of three types, Asymmetrical, radially symmetrical, and bilaterally symmetrical.
iii) Organisation: Animals have a cellular grade of organisation. So, their bodies are made up of cells, while others have tissues, organs, and organ systems.
iv) Embryonic layers: Ectoderm, mesoderm and endoderm are three embryonic layers that provide rise to different organs in the body. These are also called germinal layers. Some animals are diploblastic, for

example-sponges while others are triploblastic having three germinal layers.
b) The two features of Pisces-
a) Streamlined body for swimming.
b) Air bladder for buoyancy.
2. Phylum- Arthropoda
The characteristics of Arthropods are-
a) The body is triploblastic, segmented, and bilaterally symmetrical.
b) Presence of exoskeleton.
c) The body is divided into head, thorax, and abdomen.
d) Their body has jointed appendages which help in locomotion.
e) The coelomic cavity is filled with blood.

CASE BASED QUESTION (4 MARKS)

3.
a. Crab- Arthropoda, Apple Snail- Mollusca.
b. ***Apis*** (Honey bee), ***Bombyx*** (Silkworm)

Arthropoda	Mollusca
Body is segmented into head, thorax, and abdomen	Body is not segmented
Have jointed appendages	Do not have jointed appendages
Have a Chitinous exoskeleton	Have a calcareous exoskeleton (if present)
Respire using gills, book gills, book lungs, and tracheal system.	Respire using ctenidia.

UNIT II

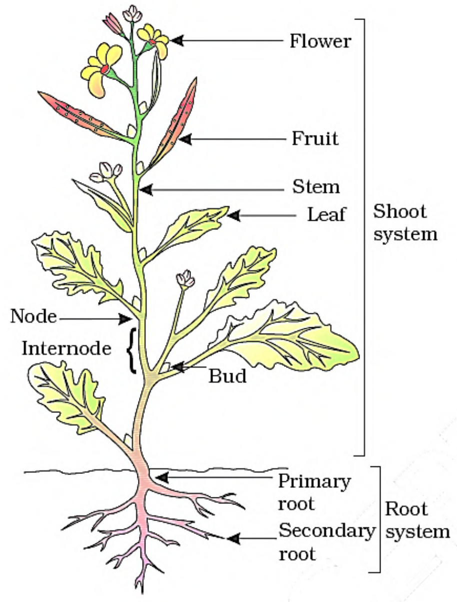
Structural Organisation in Plants & Animals

Chapter 5
Morphology of Flowering Plants
Chapter 6
Anatomy of Flowering Plants
Chapter 7
Structural Organisation in Animals

Chapter-5: Morphology of Flowering Plant

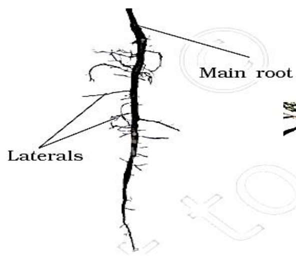
ROOT:

1. In majority of the dicotyledonous plants, the direct elongation of the radicle leads to the formation of **Primary Root** which grows inside the soil.
2. It bears lateral roots of several orders that are referred to as **secondary, tertiary**, etc. roots. The primary roots and its branches constitute the **Tap Root System**, as seen in the mustard plant.
3. In monocotyledonous plants, the primary root is short lived and is replaced by a large number of roots. These roots originate from the base of the stem and constitute the **Fibrous Root System**, as seen in the wheat plant.
4. In some plants, like grass, monstera and the banyan tree, roots arise from parts of the plant other than the radicle and are called **Adventitious Roots**.



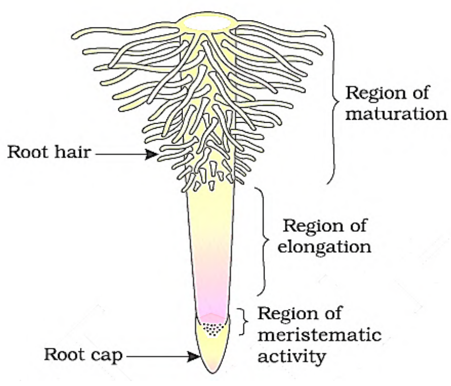
Functions of the Root:

The main functions are absorption of water and minerals from the soil, providing a proper anchorage to the plant parts, storing reserve food material and synthesis of plant growth regulators.



Regions of the Root:

1. The root is covered at the apex by a thimble-like structure called the **Root Cap**. It protects the tender apex of the root as it makes its way through the soil.
2. A few millimetres above the root cap are the region of **Meristematic Activity**. The cells of this region are very small, thin-walled and with dense protoplasm. They divide repeatedly.
3. The cells proximal to this region undergo rapid elongation and enlargement and



are responsible for the growth of the root in length. This region is called the **region of elongation**.

4. The cells of the elongation zone gradually differentiate and mature. Hence, this zone, proximal to region of elongation, is called the **REGION OF MATURATION**.
5. From this region some of the epidermal cells form very fine and delicate, thread-like structures called **Root Hairs**. These root hairs absorb water and minerals from the soil.

THE STEM

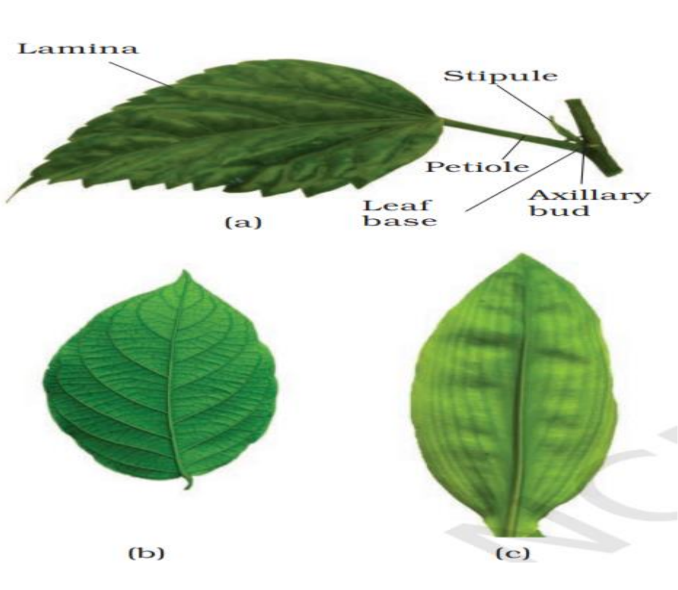
1. The stem is the ascending part of the axis bearing branches, leaves, flowers and fruits.
2. It develops from the plumule of the embryo of a germinating seed.
3. The stem bears nodes and internodes. The region of the stem where leaves are born are called nodes while internodes are the portions between two nodes.
4. The stem bears buds, which may be terminal or axillary.
5. Stem is generally green when young and later often become woody and dark brown.

Functions of the Stem:

a) The main function of the stem is spreading out branches bearing leaves, flowers and fruits.
b) It conducts water, minerals and photosynthates.
c) Some stems perform the function of storage of food, support, protection and of vegetative propagation.

THE LEAF **<u>Parts of a leaf</u>**

1. A leaf develops from shoot apical meristem, flattened, green structure, manufacture the food by photosynthesis.
2. It has bud in axil.
3. A typical leaf has **leaf base, petiole** and **lamina**.
4. **Venation:**The arrangement of veins and veinlets in the lamina of leaf.



Reticulate Venation **Parallel Venation**

Types of Venation:

1. **Reticulate:** Veinlets form a network as in leaves of dicotyledonous plants (China rose, Peepal).
2. **Parallel:** Veins run parallel to each other as in leaves of monocotyledonous plants (grass, maize).

Types of Leaves

Simple ↓ (Single leaf blade)

e.g., mango, peepal

Compound ↓ (Leaf has number of leaflets)

Pinnately Compound e.g. (Neem, rose)

Palmately Compound e.g. (Silk cotton)

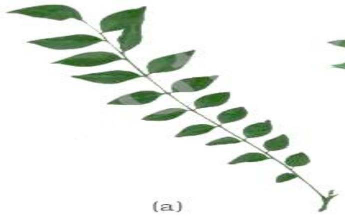
Phyllotaxy: The pattern of arrangement of leaves on the stem or branch.

Types of phyllotaxy

Alternate
(Single leaf on a Node)
e.g., China rose , Mustard

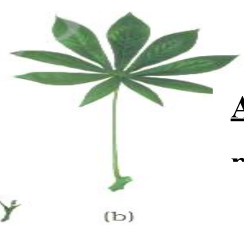
Opposit
(Two leaves on a node)
e.g., Calotropis, Guava

Whorled
(More than two on a node)
e.g., Nerium, Alstonia.



(a)

Pinnately Compound leaf

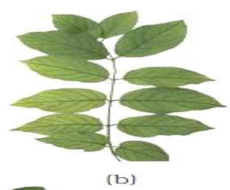


(b)

Palmately Compound leaf

(a)

Alternate phyllotaxy



(b)

~~Opposite~~

(c)

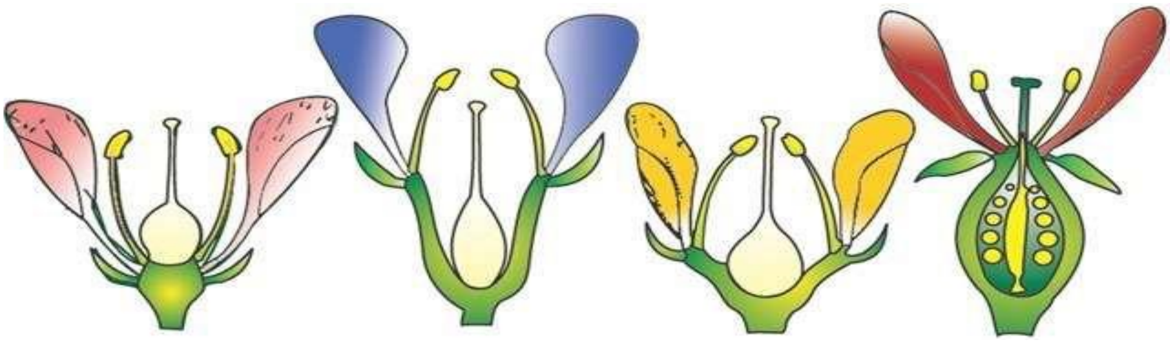
Whorled Phyllotaxy

THE INFLORESCENCE: The arrangement of flowers on the floral axis.
Main types of Inflorescence:

1. **Racemose:** Main axis is **unlimited** in growth-Radish, Mustard, *Amaranthus.*
2. **Cymose:** Main axis is **limited** in growth-Cotton, Jasmine, *Calotropis.*
3. **Special type:** *Ficus*, *Salvia, Euphorbia.*

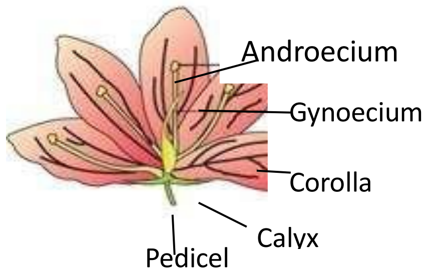
THE FLOWER: Flower is modified shoot and reproductive unit in angiosperms.
Flowers may be **unisexual** or **bisexual**, **bracteate** or **ebracteate**. Some features of flower are:

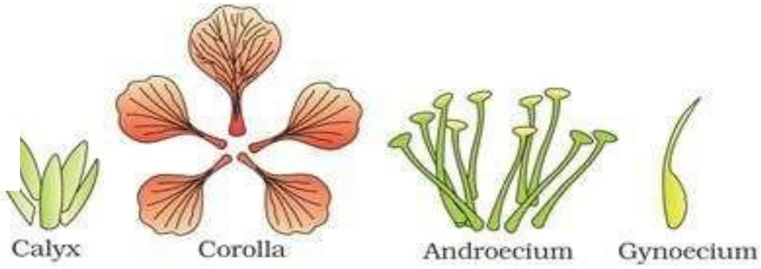
Symmetry of flower	On the basis of no. of floral appendages	On the basis of position of calyx, corolla, androecium with respect to ovary
Actinomorphic (radial symmetry)	Trimerous	Hypogynous (superior ovary)
Zygomorphic (bilateral symmetry)	Tetramerous	Perigynous (half inferior ovary)
Asymmetric (irregular)	Pentamerous	Epigynous (inferior ovary)



Hypogynous Flower **Perigynous flowers** **Epigynous flower**

PARTS OF A FLOWER:

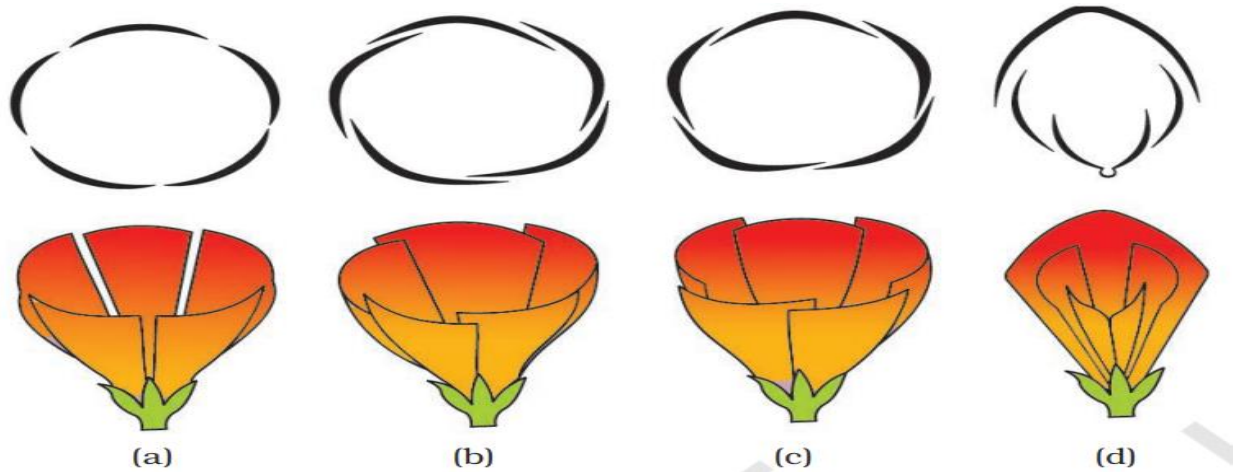




1. Calyx: Sepals, green in colour, leaf like. **Gamosepalous**– (Sepals united) **Polysepalous -** (Sepals free)
2. Corolla: Petals, usually brightly coloured to attract insects for pollination **Gamopetalous** -
(Petals united) **Polypetalous** – (Petals free)

AESTIVATION: The mode of arrangement of sepals or petals in floral bud with respect to other members of the same whore.

Types of aestivations:



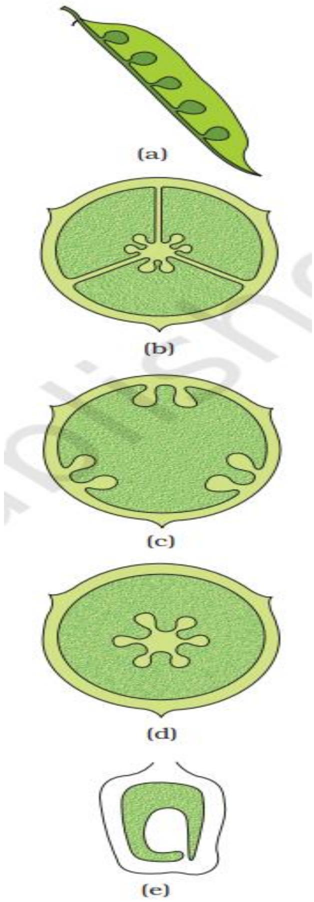
1. **Valvate:** Sepals or petals do not overlap the sepal or petal at margins as in *Calotropis.*
2. **Twisted:** Sepals or petals overlap the next sepal or petal as in China rose.
3. **Imbricate:** The margins of sepals or petals overlap one another but not in any definite direction as in Gulmohar.
4. **Vexillary:** The largest petal overlaps the two lateral petals which in turn overlap two smallest anterior petals as in Pea.

(Papilionaceous)

Perianth: If calyx and corolla are not distinguishable (tepals), they are called perianth

ANDROECIUM: Stamens (filament, anther), **male reproductive organ** and produce pollen grains. Stamens may be **epipetalous** (attach to petals) or **epiphyllous** (attach to perianth). Stamens may be **monoadelphous** (united into one bundle- China rose), **diadelphous** (two bundles pea) or **polyadelphous** (more than two bundles-citrus).

GYNOECIUM: Made up of one or more carpels, **female reproductive part**, consists of **stigma**, **style** and **ovary**, ovary bears one or more **ovules**. Carpels maybe **apocarpous** (free) or **syncarpous** (united). After fertilisation, ovules develop into seeds and ovary into fruit.



PLACENTATION: The arrangement of ovules within the ovary.

Types of Placentation:

(a) Marginal: Placenta forms a ridge along the ventral suture of ovary as in pea.

(b) Axile: Margins of carpels fuse to form central axis as in China rose.

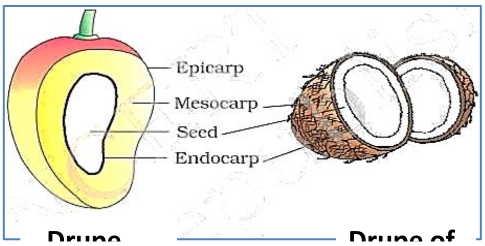
(c) Parietal: Ovules develop on inner wall of ovary as in mustard.

(d) Free central: Ovules borne on central axis, lacking septa as in *Dianthus*.

(e) Basal: Placenta develops at the base of ovary as in sunflower.

THE FRUIT:

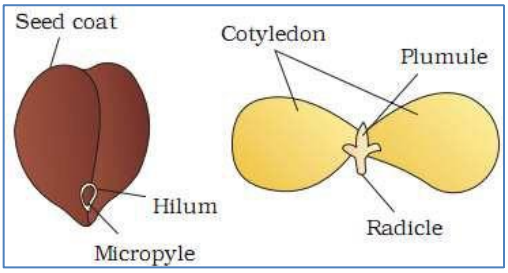
1. After fertilization, the mature ovary develops into fruit.
2. The **parthenocarpic** fruits are formed from ovary without fertilization.



The Fruit

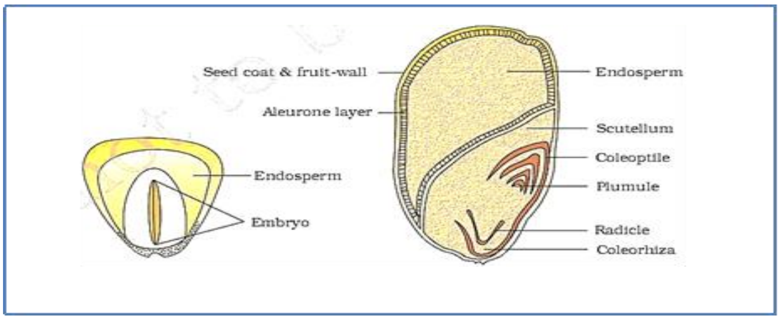
- **Pericarp**
  - Epicarp
  - Mesocarp
  - Endocarp
- **Seed**
  - Seed coat (Testa & tegmen)
  - Embryo
    - Embryonal axis (Plumule + Radicle)
    - Cotyledons (Store food)

Structure of a Dicotyledonous Seed:



1. The outermost covering of a seed is the **seed coat**.
2. The seed coat has two layers, the outer **testa** and the inner **tegmen**.
3. The **hilum** is a scar on the seed coat through which the developing seeds were attached to the fruit.
4. Above the hilum is a small pore called the **micropyle**. Within the seed coat is the embryo, consisting of an embryonal axis and two cotyledons.
5. The **cotyledons** are often fleshy and full of reserve food materials.
6. At the two ends of the embryonal axis are present the **radicle** and the **plumule**

Structure of a Monocotyledonous Seed:

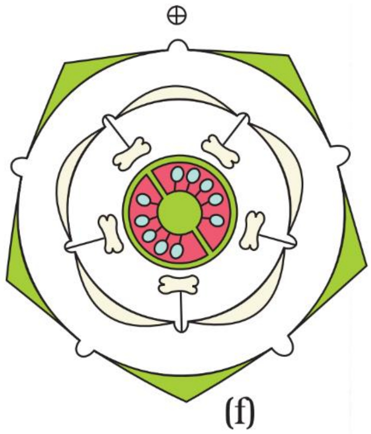


1. Monocotyledonous seeds are **endospermic** but some as in orchids are **non-endospermic**.
2. In the seeds of cereals such as maize the seed coat is membranous and generally fused with the fruit wall.
3. The endosperm is bulky and stores food. The outer covering of endosperm separates the embryo by a proteinaceous layer called **aleurone layer**.

4. The embryo is small and consists of one large and shield shaped cotyledon known as **scutellum** and a short axis with a **plumule** and a **radicle**.
5. The plumule and radicle are enclosed in sheaths which are called **coleoptile** and **coleorhiza** respectively

SOLANACAE (A Family)

It is a large family, commonly called as the '**potato family**'. It is widely distributed in tropics, subtropics and even temperate zones



Vegetative Characters

Plants mostly herbs, shrubs and rarely small trees

Stem: herbaceous rarely woody, aerial; erect, cylindrical, branched, solid or hollow, hairy or glabrous, underground stem in potato (*Solanum tuberosum*)

Leaves: alternate, simple, rarely pinnately compound, exstipulate; reticulate venation

Floral Characters

Inflorescence: Solitary, axillary or cymose as in *Solanum*
Flower: bisexual, actinomorphic
Calyx: sepals five, united, persistent, valvate aestivation
Corolla: petals five, united; valvate aestivation **Androecium:** stamens five, epipetalous
Gynoecium: bicarpellary obligately placed, syncarpous; ovary superior, bilocular, placenta swollen with many ovules, axile placentation.
Fruits: berry or capsule
Seeds: many, endospermous.

Floral Formula: $\oplus ⚥ K_{(5)} \overparen{C_{(5)} A_5} \underline{G}_{(2)}$

Economic Importance:

Several plants belonging to this family are:

a) source of food (tomato, brinjal, potato),

b) spice (chilli); medicine (belladonna, *ashwagandha*);

c) fumigators (tobacco); and

d) ornamentals (petunia).

QUESTIONAIRE

Multiple Choice Questions (MCQ's):

Q1. Which of the following is not a stem modification?
(a) Pitcher of Nepenthes (b) Thorns of citrus
(c) Tendrils of cucumber (d) Flattened structures of Opuntia
Ans: (a)
Q2. Cotyledon of maize grain is called ………………
(a) plumule (b) coleorhiza (c) coleoptile (d) scutellum
Ans: (d)
Q3. Ovary is half-inferior in the flowers of:
(a) Cucumber (b) Guava (c) Plum (d) Brinjal
Ans: (c)
Q4. In unilocular ovary with a single ovule the placentation is:
(a) Axile (b) Marginal (c) Basal (d) Free Central
Ans: (c)
Q5. Pneumatophores are found in-
(a) The vegetation which is found in marshy and saline lake
(b) The vegetation which found in saline soil
(c) Xerophytes
(d) Epiphytes
Ans: (a)
Q6. Inflorescence in Solanaceae is:-
(a) Racemose (b) Cymose (c) Hypanthodium (d) Verticillaster
Ans: (b)
Q7. Stamens attached to petals are :-
(a) Epipetalous (b) Episepalous (c) Epiphyllous (d) All
Ans: (a)

Q8. Androecium is the whorl of :-
(a) Anthers (b) Filaments (c) Stamens (d) Tepals
Ans: (c)
Q9. Syncarpous gynoecium has two or more :-
(a) Free carpels (b) Fused carpels (c) Free Ovaries (d) All
Ans: (b)
Q10. Arrangement of Ovules within the Ovary is known as:-
(a) Aestivation (b) Placentation (c) Both (a)&(b) (d) None
Ans: (b)

ASSERTION AND REASON BASED QUESTIONS

In the following questions a statement of Assertion (A) is followed by a statement of Reason(R) mark the correct choice as:

a. Both A and R are true and R is the correct explanation of A.
b. Both A and R are true but R is NOT the correct explanation of A.
c. A is true but R is false.
d. A is false but R is true.

1. Assertion (A): Apple is a true fruit.
   Reason (R): In apple, thalamus and perianth take part in fruit formation
   Ans. (d)
2. Assertion (A): Mustard and China rose has hypogynous flowers
   Reason (R): In hypogynous flowers, the ovary is said to be inferior.
   Ans: (c)
3. Assertion (A): Maize grain is called a true fruit.
   Reason (R): It develops from ripened ovary, which contains ripened ovule.
   Ans: (a)
4. Assertion (A): Pea has vexillary type of aestivation.
   Reason (R): In this type of aestivation, the posterior petal is the largest and covers almost the two lateral petals, and the latter in their turn, nearly overlap the two anterior or smallest petals.
   Ans. (a)
5. Assertion (A): Flower is complete in Petunia.
   Reason (R): Perianth, androecium and gynoecium is present.
   Ans: (c)
6. Assertion (A): Placenta and pericarp are both edible portions in Tomato.
   Reason (R): Basal placentation is present in marigold.
   Ans: (b)

Short Answer (SA) type Questions (2 Marks)

Q 1.“*Flower is a modified shoot*”. Justify.
Ans: The flower is considered to be a modified shoot because the internodes in flower are highly condensed and the appendages such as sepals, petals,
stamens and carpels(pistil) are at the nodes. These whorls are arranged in a definite sequence.
Q 2.What is the importance of morphology?
Ans: Knowledge of morphology is essential for recognition or identification of plants. It gives information about the range of variations found in a species.
Q 3.Distinguish between fibrous root and adventitious root.
Ans: fibrous root - in monocots (wheat, rice) primary root is short lived hence replaced by several roots arising from base of stem.

Adventitious root -in banyan tree, grass, monstera root arises from parts other than radicle.

Q 4.Differentiate between Monadelphous and diadelphous stamens.

Ans: Monadelphous stamens- stamens may be united into one bunch or one bundle of filaments. eg. in China rose.

Diadelphous stamens - stamens may be united into two bundles eg. in pea.

Short Answer (SA) type Questions (3 Marks)

Q 1.What is the economic importance of plants of the family Solanaceae?

Ans: Food (tomato, brinjal, potato), spice (chilli), medicine (Belladona, ashwagandha); ornamentals(petunia).

Q 2.Potato is a stem and sweet potato is a root. 'Justify the statement on the basis of external features.

Ans: Potato is the swollen tip of an underground stem branch (stolon). It has nodes (eyes) which consist of one or more buds subtended by a leaf scar.

Adventitious roots also arise during sprouting. On the other hand, sweet potato is a swollen adventitious root (tuberous root). It has no nodes, internodes and buds like a stem.

Q 3.Define aestivation. Which type of aestivation is found in China rose, Calotropis Gulmohar and Pea.

Ans: The mode of arrangement of sepals or petals in a floral bud is known as aestivation. China rose – twisted, Calotropis – valvate, Gulmohar – imbricate, Pea – vexillary.

Q 4.Give two examples of each type of phyllotaxy.

Ans: Types of phyllotaxy

(i) Alternate- China rose, mustard (ii) Opposite- Calotropis, guava (iii) Whorled- Nerium, Alstonia.

Q 5.Differentiate between:

(a) Actinomorphic flower and Zygomorphic flower
(b) Apocarpous ovary and Syncarpous ovary
(c) Racemose inflorescence and Cymose inflorescence

Ans: (a) Actinomorphic Flower- (1) Two equal halves are formed by any vertical division passing through the centre. (2) It has a radial symmetry.

Zygomorphic flower- (1) Two equal halves are produced only by one vertical division. (2) It has a bilateral symmetry.

(b) Apocarpous Ovary - (1) The flower has several free carpels (ovary). 2) On maturity it forms fruitlets of aggregate type.

Syncarpous Ovary - (1) The flower has fused carpels (2) On maturity it forms a single fruit.

(c) Racemose inflorescence (1) The main axis has unlimited growth.(2) Flowers are arranged in an acropetal manner. i.e., New flowers are at the apex and older flowers at the base.

Cymose inflorescence- (1) The main axis has a limited growth.(2) Flowers are arranged basipetally i.e., Older flowers at the apex and the younger flowers at the base.

Q 6.How many types of roots are found in plants?

Ans: (i) Tap root: The root which develops from radicles along with its branches is termed as tap root. Secondary root develops from the tap root.

(ii) Fibrous Root:- In monocot plants, the primary root is short lived and is replaced by roots that arise from the stem. These roots constitute the fibrous roots.

(iii) Adventitious root:- Roots which arise from other parts of the plant except radicals, are termed as adventitious roots.

Q 7.Draw the diagram of V.S of maize seed and label any six parts.

Ans: For 6 Correct labels- 1/2 mark each.

Q 8. *"The fruit in mango and coconut is known as drupe yet they are different with respect to the nature of mesocarp"*. Justify the statement with suitable labelled diagrams.

Ans: Both the fruits develop from monocarpellary superior ovaries and have one seed. In mango the pericarp is well differentiated into epicarp and a fleshy edible mesocarp. In coconut the mesocarp is fibrous.

CASE BASED MCQs – (4 marks)

1. Read the following and answer the questions given below:

The important functions of roots are: fixation of plants in the soil i.e., ground, absorption of nutrients and water from soil and conduction of absorbed materials from soil to aerial parts of the plant. In addition to the above functions, some roots perform different function i.e., in *Cuscuta* (a parasitic plant) they absorb food from the host's body; in banyan; the prop roots provide support to the plant, in maize,

Rhizophora, they support the plant; in *Tinospora* the green roots perform the function of photosynthesis; in some plants they get swollen and perform as storage organs for the plant; other perform the function of vegetative reproduction. Some roots perform the functions of storage of food reproduction, climbing, and giving support to plants.

(i) Roots developed from parts other than radicle are called:
(a) Tap roots (b) Fibrous roots (c) Adventitious roots d) Nodular roots

(ii) Tuberous roots are found in —---
(a) *Daucus carota* (b) *Ipomoea batatas* (c) *Beta vulgaris* (d) *Raphanus sativus*

(iii) Tap roots are seen in –
(a) Mustard (b) Fern (c) Moss (d) Algae

(iv) Which is not a product of root?
(a) Sugar beet (b) Carrot (c) Radish (d) Potato
Ans: (i) (c); (ii) (b); (iii) (a); (iv) (d)

2. Read the following to answer any four questions from (i) to (v) given below:

The veins are not only the conducting channels for water, minerals and organic food, they also provide firmness to the lamina and keep it expanded. They give rise to lateral veins, which traverse the entire lamina.

Venation is of two main types: Reticulate and parallel. When the veinlets form a network, the venation is termed as reticulate venation. for e.g., leaves of dicot plants. When the veins arising from mid rib or main veins, run parallel to each other towards the margin or the apex of the lamina, venation is termed as parallel venation, present in the leaves of monocot plants.

(i) Venation is a term used to describe the pattern of arrangement of:
(a) Floral organs. (b) Flower in inflorescence.
(c) Veins and veinlets in a lamina. (d) All of them.
(ii) Pinnately compound leaf is found in
(a) Neem (b) Silk cotton (c) Papaya (d) Cucurbita
(iii) Parallel venation is not a characteristic in:
(a) Hibiscus (b) Grass (c) Rice (d) Maize
(iv) Reticulate venation is found is:
(a) Mango (b) Rice (c) Canna (d) Musa.
Ans: (i) (c); (ii) (a); (iii) (a); (iv) (a)

Long Answer (LA) type Questions (5 Marks)

1. What do you understand by aestivation? How many types of aestivation are found in corolla?

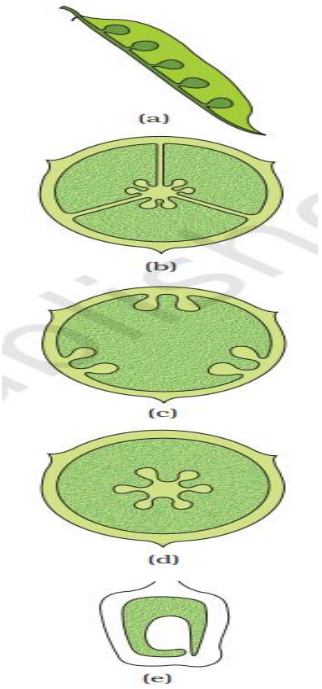
Ans: The mode of arrangement of sepals or petals in floral bud with respect to the other members of the same whorl.
VALVATE- Sepals/petals in a whorl just touch one another at margin without overlapping. Eg- Calotropis
TWISTED- One margin of appendage overlaps that of the next one. Eg.-China Lady's finger, Cotton
IMBRICATE- Margins of appendage overlap one another in any direction. Eg -Cassia, Gulmohur
VEXILLARY- Largest petal(standard) overlaps 2 lateral(wings) which in turn overlaps 2 smallest(keels). Eg- Pea, Bean. It is also called papilionaceous.
Types of aestivations in corolla.

2. Briefly explain the identifying floral features of family Solanaceae.

Ans- Identifying features: - Floral characters-
INFLORESCENCE Solitary, axillary, cymose in Solanum.

FLOWER- bisexual, actinomorphic.
CALYX-5(united sepals), valvate, persistent.
COROLLA-5(united & valvate).
ANDROECIUM-5(epipetalous).
GYNOECIUM- bicarpellary, obligately placed, syncarpus, superior, bilocular, placenta swollen with many ovules, axile placentation.

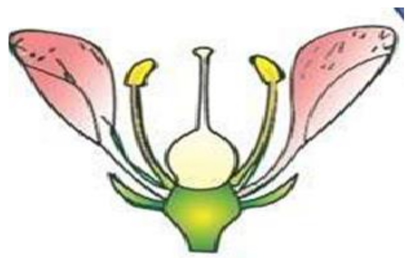
3. Describe the various types of placentation found in flowering plants with diagram.



Ans: MARGINAL- Placenta forms ridge along ventral suture of ovary & ovule are formed on it. Eg. pea
AXILE- Placenta is axial, ovules attached to multilocular ovary
Eg. -China Rose, Tomato, lemon.
PARIETAL- Ovules develop on the inner wall of the ovary or periphery. Ovary becomes 2 chambered due to the formation of false septum. Eg.- Mustard, Argemone.
FREE CENTRAL- Ovules are born on central axis & septum are absent. Eg. Dianthus, Primrose
BASAL- Placenta develops at the base of the ovary and a single ovule is attached. Eg. Sunflower.

4. Describe the arrangement of floral members in relation to their insertion on thalamus. Draw a hypogynous flower.

Ans: Flowers may be of three kinds based on the position of calyx, corolla and the androecium in respect of ovary on the thalamus (i) Hypogynous flower (ii) Perigynous flower (iii) Epigynous flower.



i) Hypogynous flower: Gynoecium located at highest position and rest whorls of flower lies below it e.g. Mustard.
(ii) Perigynous flower: The gynoecium is situated in the center and other parts of flower lie on the rim of thalamus almost at same level. Ovary is half inferior e.g., Rose.
(iii) Epigynous flower: The margins of thalamus grow upwards enclosing the ovary fully and getting united to it, the rest parts of the flower arise above the ovary e.g., Guava

5. a) Draw and label the structure of the most important vegetative organ of photosynthesis.

b) Mention the functions of petiole and veins.

Ans: a) Correct Diagram.

b) Petiole-Helps hold the blade to light. Long thin petioles help leaf blades to flutter in wind, cooling the leaf and bringing fresh air to leaf surface.

Veins– Provide rigidity to the leaf blade, are channels for transport of water, minerals and food materials.

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CHAPTER – 6: ANATOMY OF FLOWERING PLANTS

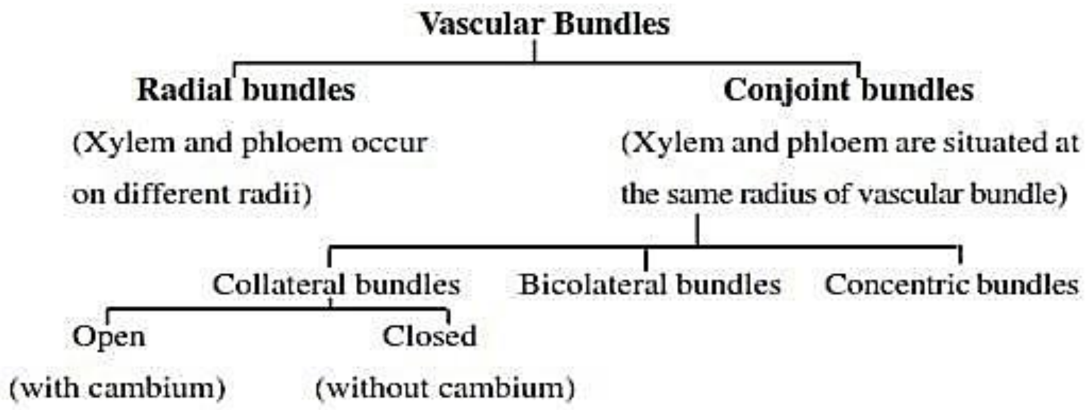
1. **Anatomy:** Anatomy is the study of internal structure of organisms. Plant anatomy includes organization and structure of tissues.
2. **Tissue**: A group of interdependent identical or non-identical cells along with intercellular substance having common origin to perform a specific (definite) function in multicellular organisms is called tissue.
3. **Meristematic tissues**: The meristematic tissue is made up of the cells which have the capability to divide. Meristems in plants are restricted to a specialized region and responsible to the growth of plants.
4. **Axillary bud**: The buds which are present in the axils of leaves and are responsible for forming branches or flowers. Permanent tissues: The permanent tissues are derived from meristematic tissue and are composed of cells, which have lost the ability to divide.
5. **Xylem**: Xylem consists of tracheids, vessels, xylem fibres and xylem parenchyma. It conducts water and minerals from roots to other parts of plant.
6. **Protoxylem**: The first formed primary xylem elements.
7. **Metaxylem**: The later formed primary xylem elements.
8. **Endarch xylem**: Protoxylem lies towards the centre and metaxylem towards the periphery of the organ.
9. **Exarch xylem**: Protoxylem towards periphery and metaxylem towards the centre.
10. **Phloem**: Phloem consists of sieve tube elements, companion cells, phloem fibres and phloem parenchyma. Phloem transports the food material from leaves to various parts of the plant.
11. **Protophloem**: First formed phloem with narrow sieve tubes.
12. **Metaphloem**: Later formed phloem with broader sieve tubes. The Tissue System: 1. Epidermal tissue system: It includes

cuticle, epidermis, epidermal hairs, root hairs, trichomes and stomata.

13. **The ground tissue system**: It is made up of parenchyma, collenchyma, and sclerenchyma. In dicot stems and roots the ground tissue is divided into hypodermis, cortex, endodermis, pericycle, medullary rays and pith.
14. **The vascular tissue system**: It includes vascular bundles which are made up of xylem and phloem.

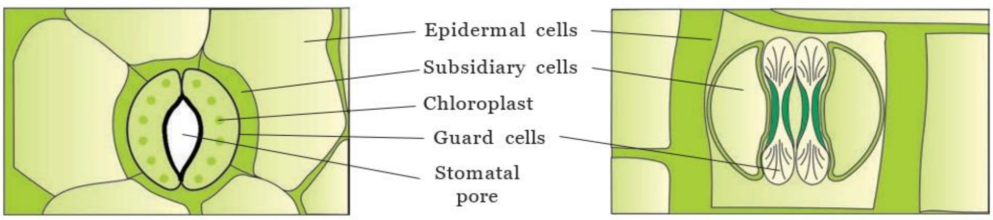
THE TISSUE SYSTEM

Epidermal tissue system: It includes cuticle, epidermis, epidermal hairs, root hairs, trichomes and stomata.
The ground tissue system: It is made up of parenchyma, collenchyma, and sclerenchyma. In dicot stems and roots the ground tissue is divided into hypodermis cortex, endodermis, pericycle, medullary rays and pith.
The vascular tissue system: It includes vascular bundles which are made up of xylem and phloem.



STOMATA:

1. Stomata are minute apertures in the epidermis.



2. Each aperture is bounded by two kidney shaped cells, called **guard cells**.
3. In **xerophytes**, the stomata are sunken in grooves due to which rate of transpiration is greatly reduced (e.g. Nerium).
4. There is a large air cavity below each aperture, it is called **sub stomatal cavity**. Guard cells are surrounded by subsidiary cells

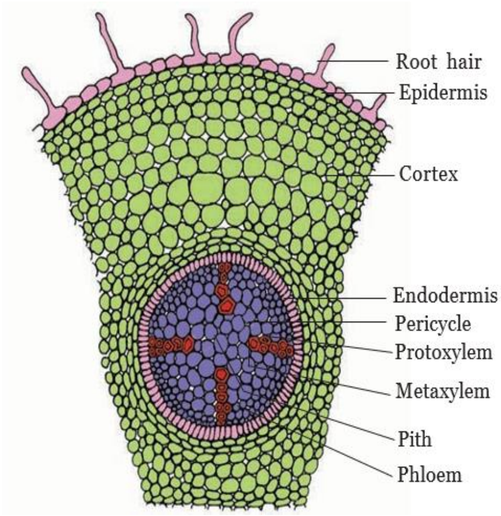
or accessory cells which differ morphologically from the other epidermal cells.

5. In **monocots**, e.g., Doob, Maize; guard cells are dumb bell shape.

T.S. OF DICOT ROOT

The outermost layer is **epiblema.** Many of the cells of epiblema protrude in the form of unicellular root hairs.

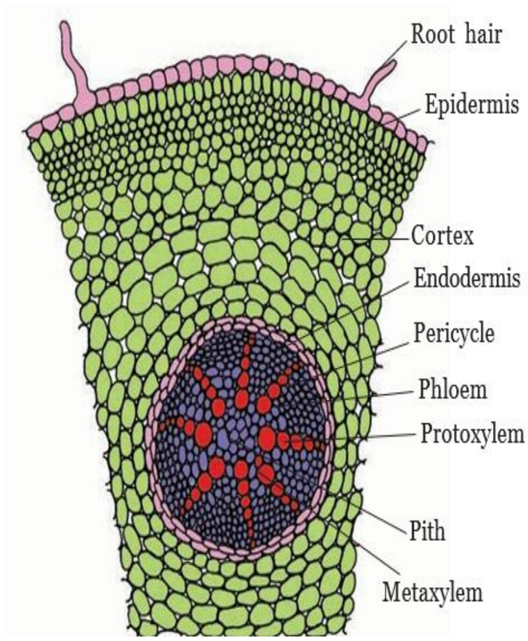
1. The **cortex** consists of several layers of thin-walled parenchyma cells with intercellular spaces.
2. The innermost layer of the cortex is called **endodermis.** It comprises a single layer of barrel- shaped cells without any intercellular spaces. The tangential as well as radial walls of the endodermal cells have a deposition of water-impermeable, waxy material suberin in the form of **casparian strips**.



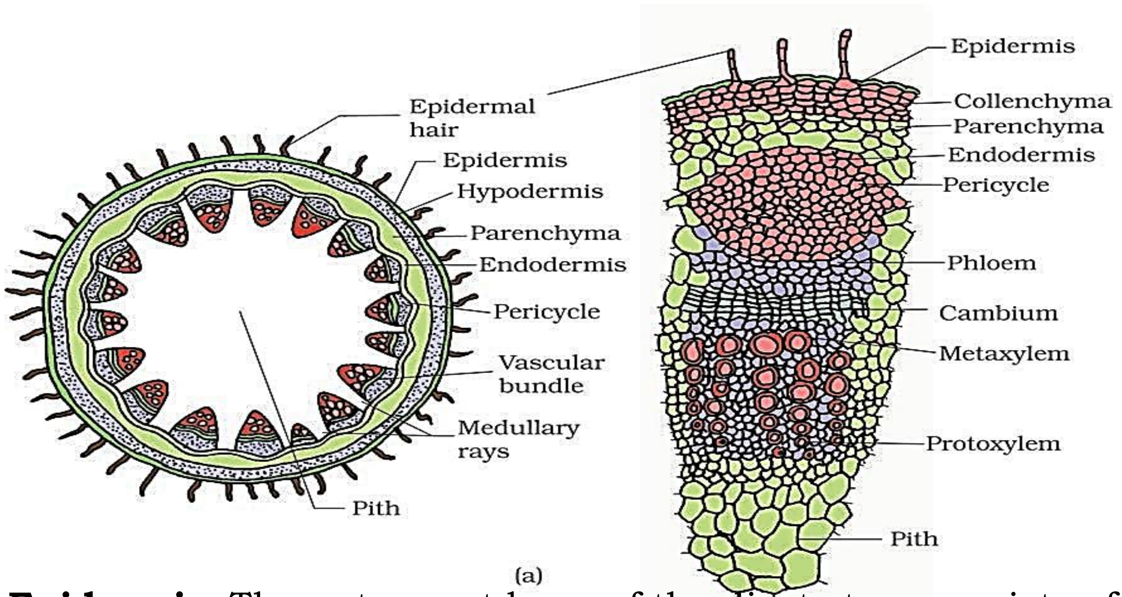
3. After the endodermis lies a few layers of thick-walled parenchyomatous cells referred to as **pericycle**.
4. The pith is small or inconspicuous. The parenchymatous cells which lie between the xylem and the phloem are called **conjuctive tissue**.
5. There are usually two to four xylem and phloem patches. Later, a cambium ring develops between the xylem and phloem.

T.S. OF MONOCOT ROOT

1. The anatomy of the monocot root is **similar to the dicot root** in many respects.
2. It has epidermis, cortex, endodermis, pericycle, vascular bundles and pith.
3. As compared to the dicot root which have **fewer xylem vessels** there are usually more than six (polyarch) xylem bundles in the monocot root.
4. **Pith** is large and well developed.
5. Monocotyledonous roots <u>do not undergo</u> any **secondary growth**.



T.S. OF DICOT STEM



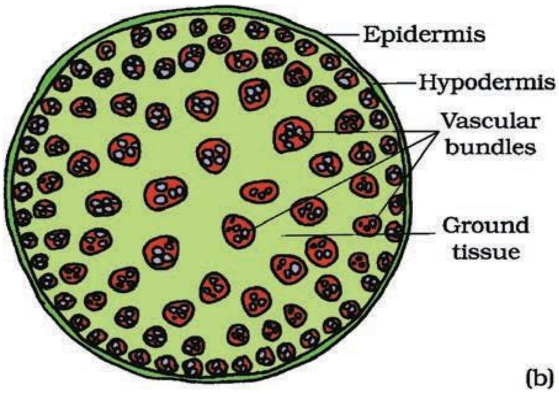
(a)

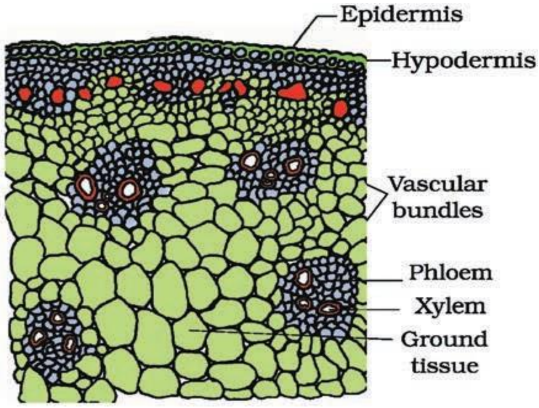
1. **Epidermis**: The outermost layer of the dicot stem consists of a single layer of epidermal cells covered with a waxy cuticle, which helps to reduce water loss.
2. **Cuticle**: A thin, waxy layer on the outer surface of the epidermis that provides protection against water loss and mechanical injury.
3. **Stomata**: Small pores on the epidermis that allow gas exchange (particularly CO_2 uptake for photosynthesis and oxygen release) and water vapor to exit during transpiration.
4. **Cortex**: Below the epidermis lies the cortex, which consists of several layers of parenchyma cells.
Q5. **Endodermis**: The innermost layer of the cortex, characterized by a single layer of tightly packed cells with Casparian strips (bands of suberin in cell walls), which regulate the movement of water and nutrients into the vascular cylinder.

6. **Pericycle**: A layer of cells just inside the endodermis that gives rise to lateral roots and vascular cambium in older stems.
7. **Vascular Bundles**: Arranged in a ring around the central pith, the vascular bundles consist of xylem and phloem tissues:
   - **Xylem**: Located towards the center, xylem tissue consists of vessels, tracheids, fibers, and parenchyma cells. It transports water and minerals from roots to stems and leaves.
     Phloem: Found towards the outside of the vascular bundle, phloem tissue transports sugars produced during photosynthesis from leaves to other parts of the plant.
8. **Pith**: The central region of the dicot stem, consisting of large, parenchyma cells that store food and provide structural support.
9. **Cambium**: In older dicot stems, the vascular cambium appears as a thin layer of meristematic tissue between the xylem and phloem. It is responsible for secondary growth, which increases the girth of the stem.

10. **Secondary Growth**: In some older dicot stems, secondary growth leads to the formation of annual rings.

T.S. OF MONOCOT STEM

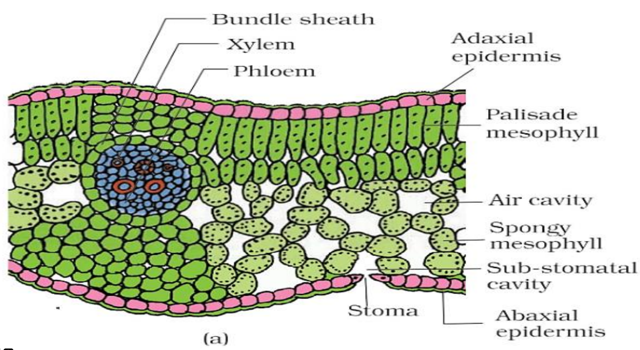




1. **Epidermis**: The outermost layer composed of a single layer of epidermal cells covered with a thin cuticle. It helps in reducing water loss and protection.
2. **Stomata**: Present on the epidermis, these are specialized pores that facilitate gas exchange and water vapor release.
3. **Ground Tissue**:
   Cortex: Consists of several layers of parenchyma cells. It provides storage and support.

   Endodermis: A single layer of cells with Casparian strips that regulate water and nutrient movement.
4. **Vascular Bundles**: Scattered throughout the stem without a specific arrangement. Each bundle is surrounded by sclerenchyma fibers for support.
   Xylem: Located towards the center of the vascular bundle, it transports water and minerals.
   Phloem: Found towards the periphery of the vascular bundle, it transports organic nutrients.
5. **Parenchyma Cells**: Found in the cortex and pith, these cells store starch and support the stem.
6. **No Cambium**: Monocot stems lack a vascular cambium, limiting secondary growth. As a result, they do not form annual rings.
7. **Pith**: Central region composed of large, thin-walled parenchyma cells that store food and provide structural support.

8. T.S. OF DICOT LEAF



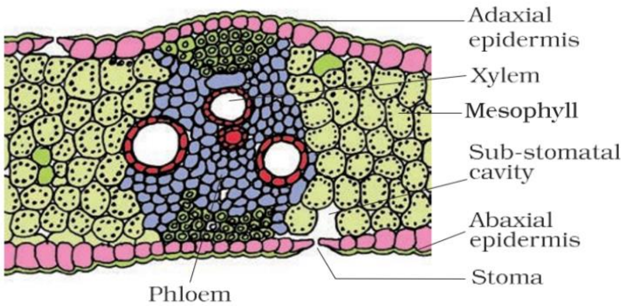
1. The vertical section of a dorsiventral leaf through the lamina shows three main parts, namely, epidermis, mesophyll and

vascular system.
2. The **epidermis** which covers both the upper surface (adaxial epidermis) and lower surface (abaxial epidermis) of the leaf has a conspicuous cuticle.
3. The abaxial epidermis generally bears more **stomata** than the adaxial epidermis.
4. The tissue between the upper and the lower epidermis is called the **mesophyll**. Mesophyll, which possesses chloroplasts and carry out photosynthesis, is made up of parenchyma. It has two types of cells – the **palisade parenchyma** and the **spongy parenchyma**.
5. The adaxially placed palisade parenchyma is made up of elongated cells, which are arranged vertically and parallel to each other.
6. There are numerous large spaces and air cavities between these cells.
7. **Vascular system** includes vascular bundles, which can be seen in the veins and the midrib. The veins vary in thickness in the reticulate venation of the dicot leaves.
8. The vascular bundles are surrounded by a layer of thick-walled **bundle sheath cells**.

T.S. OF MONOCOT LEAF

The anatomy of isobilateral (Monocot) leaf is similar to that of the dorsiventral (Dicot) leaf in many ways. It shows the following characteristic differences:

1. In an isobilateral leaf, the **stomata** are present on both the surfaces of the epidermis; and the mesophyll is not differentiated into palisade and spongy parenchyma.
2. In grasses, certain adaxial epidermal cells along the veins modify themselves into large, empty, colourless cells. These are called **bulliform cells.** When the bulliform cells in the leaves have absorbed water and are turgid, the leaf surface is exposed. When they are flaccid due to water stress, they make the leaves curl inwards to minimise water loss.



3. The **parallel venation** in monocot leaves is reflected in the near similar sizes of vascular bundles (except in main veins) as seen in vertical sections of the leaves.

QUESTIONAIRE

Multiple Choice Questions (MCQ's):

Q1. Which one of the following is absent in root?
a) pericycle b) cuticle c) cortex d) endodermis
Ans. b

Q2. Which one the following is only present in the leaf?
a) epidermis b) xylem c) mesophyll d) phloem
Ans. c

Q3. Root hair is an extension of cells of –
a) endodermis b) pericycle c) epiblema d) cortex
Ans. c

Q4. Which of the following do not constitute ground tissue?
(i) cortex (ii) vascular bundle (iii) pith (iv) medullary rays (v) epidermis
a) (i) & (ii) b) (ii) & (v) c) (iii) & (iv) d) (ii) & (iv)
Ans. b

Q5. The bundle sheath surrounding vascular bundles in monocot stem is –
a) parenchymatous b) collenchymatous
c) chlorenchymatous d) sclerenchymatous
Ans. d

Q6. Stele does not include –
a) pericycle b) endodermis c) pith d) vascular bundle
Ans. b

Q7. Casparian strip is found in –
a) endodermis of stem b) hypodermis of stem
c) endodermis of root d) hypodermis of root
Ans. c

Q8. Which one of the following statements is not true for vascular bundles found in monocot root?
a) These are surrounded by sclerenchymatous bundle sheath
b) Phloem parenchyma absent
c) Peripheral bundles are larger than centrally located ones
d) Water containing cavities present
Ans. c

Q9. Leaves of which of the following plants have dumb-bell shaped stomata?
a) sunflower b) maize c) mango d) *Hibiscus*
Ans. b

Q10. Starch sheath refers to
a) epidermis of stem
b) endodermis of stem
c) epidermis of root

d) endodermis of root

Ans. b

ASSERTION AND REASON BASED QUESTIONS

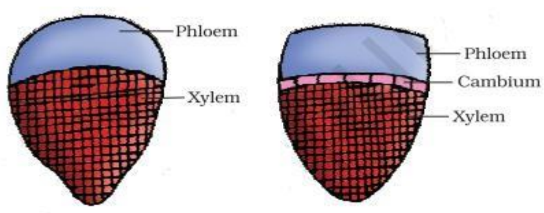
In the following questions a statement of Assertion (A) is followed by a statement of Reason(R) mark the correct choice as:

a. Both A and R are true and R is the correct explanation of A.
b. Both A and R are true but R is NOT the correct explanation of A.
c. A is true but R is false.
d. A is false but R is true.

1. Assertion: Monocot root does not undergo secondary growth.
   Reason: Monocot root does not have cambium.
   Ans. a
2. Assertion: Monocot leaves curl up under water stress conditions.
   Reason: Bulliform cells are turgid due to water loss.
   Ans. c
3. Assertion: The vascular bundles vary in thickness in dicot leaf.
   Reason: Dicot leaves have reticulate venation.
   Ans. a
4. Assertion: The upper surface of dicot leaf is darker green in colour than the lower surface.
   Reason: palisade mesophyll contains more chloroplasts than spongy mesophyll.
   Ans. a
5. Assertion: vascular bundles containing cambium are called closed vascular bundles.
   Reason: Cambium forms secondary xylem and phloem.
   Ans. d

Short Answer (SA) type Questions (2 Marks)

Q 1. The following is a diagram of vascular bundle.

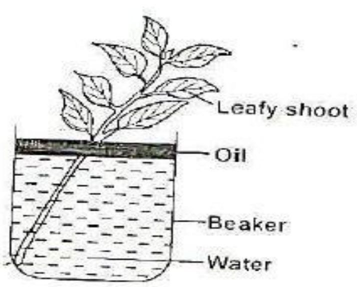


a) Which one of these two types is considered an open vascular bundle? Why?

b) Which type of plant has an open vascular bundle- monocot or dicot?

Ans.- a) Vascular bundle with cambium is considered an open bundle because it leads to secondary growth.

b) Dicot root.



Q 2. Most of the water lost by plants during transpiration is through stomata. You are performing an experiment on stomatal transpiration using dorsiventral leaf. You prepare three similar experimental set up A, B and C as shown in the diagram below and put them in the sun for 2 hr.

Set A No Vaseline applied.
Set B Vaseline applied on lower surfaces of leaves.
Set C Vaseline applied on the upper surfaces of leaves.
In which set up will you find maximum and minimum lowering of water level? Why?

Ans.- Set A maximum lowering. Because stomata on both surfaces participate in transpiration.
Set B Minimum lowering. Because dorsiventral leaf has more stomata on lower surfaces which are blocked by Vaseline, so they don't contribute towards transpiratory loss.

Q 3. Why do monocot leaves curl up during water stress conditions?

Ans.- Monocot leaves have bulliform cells in the upper surface. Under water stress conditions, these cells lose water and become flaccid which make the leaves curl up. This minimises water loss.

Q 4. If you want to study stomata in a dicot leaf,
a) which surface are you going to take the peel from? Why?
b) Distinguish between dicot and monocot stomata on the basis of shape of guard cells.

Ans.- a) Lower surface, because more stomata on the lower surface.

b) Dicot – bean shaped Monocot – dumb-bell shaped

Q 5. a) What are the two types of mesophyll cells found in dicot leaf?

b) Which one has more chloroplast? Is it present towards the adaxial or abaxial side?

Ans.- a) palisade and spongy palisade.

b) palisade, towards adaxial epidermis.

Short Answer (SA) type Questions (3 Marks)

Q 1. a) Desert plants have thick cuticle on the leaves. Give reasons for this.
b) Why is the cuticle absent in roots?

Ans.- a) Cuticles prevent loss of water. A thick cuticle prevents excessive loss of water by transpiration. b) Cuticles will prevent

(i) (ii)

absorption of water and salt from soil by roots.

Q 2. Epidermal peel of maize and Hibiscus leaf showed two types of stomata.

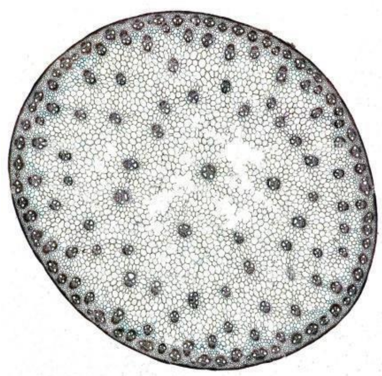
a)Which one of these two types of stomata will be found on maize leaf?

b)On which surface of maize leaf are you likely to find stomata?

c)There are large, empty colourless cells found on the upper surface of maize leaf that help the leaf to curl up. What are they called? What is their function?

Ans.- a) (i)
b) Both surface
c) Bulliform cells, minimise water loss by curling up leaf under water stress condition.

Q 3. Dipak made the following section of a stem. He found the outer layer of tissue a little harder than the inner portion of the stem. The inner portion had dotted appearance.



a) Why was the peripheral part comparatively harder than the rest of the stem?

b) What do the ―dots represent? Draw a magnified view of one such ―dot and label the various parts.

Ans.- a) Because of presence of sclerenchymatous hypodermis while rest of the ground tissue comprises parenchymatous cells.
b) The dots represent vascular bundles.

Q 4. Identify the location and mention one function of each of the following.

a) Cambium ring in root
b) Bulliform cells in leaf
c) Guard cells in leaf

Ans.- a) In between xylem and phloem, secondary growth
b) Upper surface of monocot leaf, curl up leaf and minimise water loss
c) Upper or lower epidermis or both, transpiration/gaseous exchange

Q 5. The function of stomata is to help in gaseous exchange and transpiration. Indian Lotus with floating leaves on water have stomata only on one surface.

a. Which surface is likely to have stomata on it?

b. Can you explain why?

Ans.- a) Upper

b) Lower surface is in contact with water. This will make gaseous exchange difficult.

CASE BASED QUESTION – (4 marks)

1. Read the following and answer the questions given below:

The complex tissues are made of more than one type of cells and these works together as a unit. Xylem and phloem constitute the complex tissues in plants. Xylem functions as a conducting tissue for water and minerals from roots to the stem and leaves. It also provides mechanical strength to the plant parts. It is composed of four different kinds of elements, namely, tracheids, vessels, xylem fibres and xylem parenchyma. Tracheids are elongated or tube like cells with thick and lignified walls and tapering ends. These are dead and are without protoplasm. In flowering plants, tracheids and vessels are the main water transporting elements. Vessel is a long cylindrical tube-like structure made up of many cells called vessel members. Vessel members are interconnected through perforations in their common walls. Primary xylem is of two types – protoxylem and metaxylem. The first formed primary xylem elements are called protoxylem and the later formed primary xylem is called metaxylem. In stems, the protoxylem lies towards the centre (pith) and the metaxylem lies towards the periphery of the organ. This type of primary xylem is called

Phloem transports food materials, usually from leaves to other parts of the plant. Phloem in angiosperms is composed of sieve tube elements, companion cells, and phloem parenchyma and phloem fibres. Sieve tube elements are also long, tube-like structures, arranged longitudinally and are associated with the companion cells. The functions of sieve tubes are controlled by the nucleus of companion cells. The companion cells are specialised parenchymatous cells, which are closely associated with sieve tube elements. The companion cells help in maintaining the pressure gradient in the sieve tubes. Phloem parenchyma is made up of elongated, tapering cylindrical cells which have dense cytoplasm and nucleus. The phloem parenchyma stores food material and other substances like resins, latex and mucilage. Phloem fibres (bast fibres) are made up of sclerenchymatous cells.

These are generally absent in the primary phloem but are found in the secondary phloem. At maturity, these fibres lose their protoplasm and become dead. The first formed primary phloem consists of narrow sieve tubes and is referred to as protophloem and the later formed phloem has bigger sieve tubes and is referred to as metaphloem.

Q 1.Xylem and phloem are examples of

a) Meristematic tissue b) Simple tissue

c) Protective tissue d) Complex tissue

Q 2.The protoxylem lies towards periphery and metaxylem lies towards the centre. Such arrangement of primary xylem is known as

a) Exarch b) Endarch c) Inarch d) None of the above

Q 3.What are the functions of xylem and phloem?

Q 4.Define Protoxylem and Metaxylem?

Answer key

1. d
2. a
3. Functions of xylem and Phloem are as follows;

- Xylem – Xylem functions as a conducting tissue for water and minerals from roots to the stem and leaves. It also provides mechanical strength to the plant parts.
- Phloem – Phloem transports food materials, usually from leaves to other parts of the plant. The phloem parenchyma stores food material and other substances like resins, latex and mucilage.

4. The first formed primary xylem elements are called protoxylem and the later formed primary xylem is called metaxylem.

Long Answer (LA) type Questions (5 Marks)

Q 1. Describe various types of vascular systems observed in flowering plants.

Ans: The vascular system consists of complex tissues, the phloem and the xylem. The xylem and phloem together constitute vascular bundles. Cambium is present in between the xylem and phloem of dicotyledonous stems. On the basis of cambium, the vascular bundles may be-

a. Open type: cambium is present

b. Closed type: cambium is absent e.g. in monocot.

On the basis of the arrangement of the xylem and phloem the vascular bundles may be-

a. Radial: xylem and phloem are arranged in an alternate manner along the different radii. E.g.- roots.

b. Conjoint: xylem and phloem are jointly situated along the same radius of vascular bundles. E.g. - stems and leaves. In these, the phloem is located only on the outer side of the xylem.

Q 2. Explain the following about stomata-

(i) Origin of stomata

(ii) Regulation of opening and closing of stomata

(iii) Structure of stomata

Ans: (i) Stomata are present in the epidermis layer of leaves

(ii)The guard cells possess chloroplasts and regulate the opening and closing of stomata. When guard cells are in the flaccid condition the stomatal pore is closed and when turgid the pores are open.

(iii)Each stoma is composed of two bean-shaped cells known as

guard cells which enclose the stomatal pore. The outer walls of guard cells (away from the stomatal pore) are thin and the inner walls (towards the stomatal pore) are highly thickened. Sometimes, a few epidermal
Cells, in the vicinity of the guard cells, become specialized in their shape and size and are known as subsidiary cells. The stomatal aperture, guard cells, and the surrounding subsidiary cells are together called stomatal apparatus.

Q 3. Diagrammatically compare the anatomy of a Dicot root and b Monocot root.

Ans: Appropriate figures, reflecting suitable differences.

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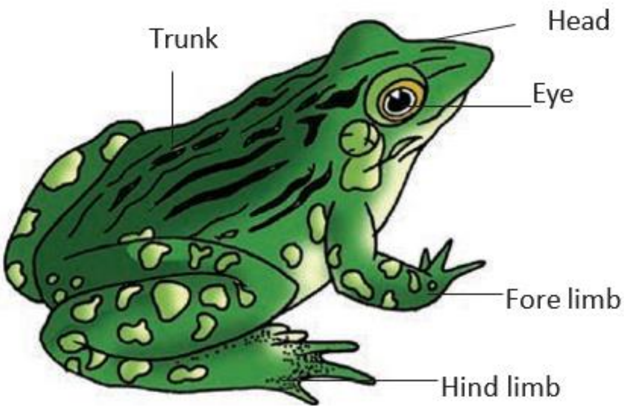
CHAPTER: 7 STRUCTURAL ORGANISATION INANIMALS

FROG – An introduction:

Phylum – Chordata
Subphylum – Gnathostomata
Superclass- Tetrapoda
Class- Amphibia
Order- Anura
Genus- *Rana*
Species- *tigrina*



MORPHOLOGY

1. Cold blooded or poikilotherms- They do not have constant body temperature i.e., their body temperature varies with the temperature of the environment.
2. They have the ability to change the colour to hide them from their enemies.
3. They show summer sleep (aestivation) and winter sleep (hibernation protect them from extreme heat and cold respectively.
4. Habitat: amphibian (both in water and land)

ANATOMY

Digestive system

It consists of alimentary canal and digestive glands.

a) Alimentary canal: frog is carnivore therefore has short alimentary canal.
b) The mouth opens into the buccal cavity that leads to the oesophagus through pharynx.
c) Stomach continues in the intestine, rectum and finally opens outside by the cloaca.
d) Stomach has gastric glands which secretes digestive juice and HCL.
e) Liver: It secretes bile that is stored in the gall bladder.

f) Pancreas: it secretes pancreatic juice.

Digestion of food

a) The HCl and gastric juices digest food in the stomach.
b) In the small intestine the duodenum receives bile from the gall bladder and pancreatic juices from the pancreas through a common bile duct.
c) Bile emulsifies fat and pancreatic juices digest carbohydrates and proteins.

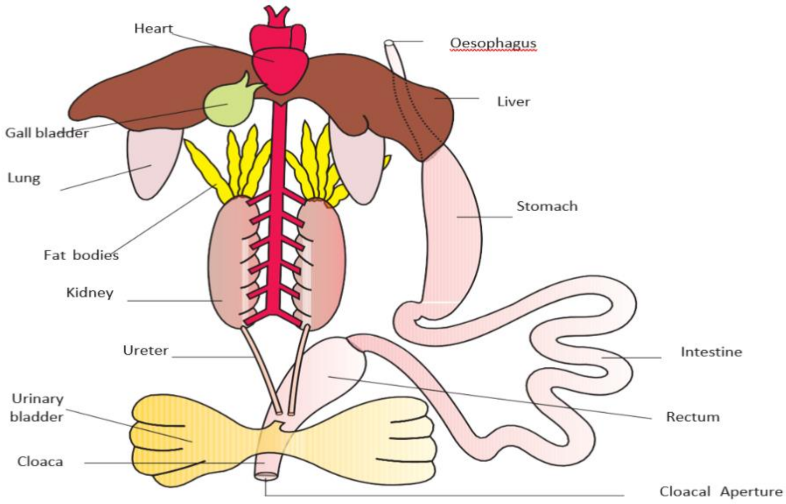


Figure 7.2 Diagrammatic representation of internal organs of frog showing complete digestive system

d) Digested food is absorbed by the numerous villi and microvilli in the intestine.
e) The undigested solid waste moves into the rectum and passes out through the cloaca.

Respiration

a) Cutaneous respiration: In water, skin acts as aquatic respiratory organ. Dissolved oxygen in the water is exchanged through the skin by diffusion.
b) Pulmonary respiration: through lungs
c) During aestivation and hibernation gaseous exchange takes place through skin.
d) Pair of lungs in the thoracic region (upper part of the trunk).

Vascular System

a) It is well-developed and closed type.
b) Frogs also have a lymphatic system. The lymphatic system consists of lymph, lymph channels and lymph nodes.
c) The blood vascular system involves heart, blood vessels and blood.
d) Heart is three chambered- two atria and one ventricle. Heart is covered by a membrane called pericardium.
e) A triangular structure called sinus venosus joins the right

atrium. It receives blood through the major veins called vena cava. The ventricle opens into a saclike conus arteriosus on the ventral side of the heart.

f) The blood from the heart is carried to all parts of the body by the arteries (arterial system).
g) The veins collect blood from different parts of body to the heart and form the venous system.
h) Special venous connection between liver and intestine as well as the kidney and lower parts of the body are present in frogs. The former is called hepatic portal system and the latter is called renal portal system.

Excretory system

a) Frog is a ureotelic animal. Its excretory system consists of a pair of kidneys, ureters, cloaca and urinary bladder.
b) Kidney is composed of structural and functional units called uriniferous tubules or nephrons.
c) In males the ureters act as a urinogenital duct which opens into the cloaca.
d) In females the ureters and oviduct open separately in the cloaca.

Control and Coordination

1. The chemical coordination

a) It is carried out by hormones which are secreted by the endocrine glands. E.g. pituitary, thyroid, parathyroid, thymus, pineal body, pancreatic islets, adrenals and gonads.

The nervous system

a) It consists of CNS (brain and spinal cord), PNS (cranial and spinal nerves) and ANS (sympathetic and parasympathetic).

Brain is enclosed in a bony structure called brain box (cranium). It has three parts fore-brain, mid-brain and hind-brain.

2. Forebrain- olfactory lobes, paired cerebral hemispheres and unpaired diencephalon.
3. Midbrain- It has a pair of optic lobes.
4. Hind-brain- It consists of cerebellum and medulla oblongata.
5. The medulla oblongata passes out through the foramen magnum and continues into spinal cord.
6. Spinal cord is enclosed in the vertebral column.
7. There are ten pairs of cranial nerves arising from the brain.

Sensory organs

a) Main sense organs are for touch (sensory papillae), taste (taste buds), smell (nasal epithelium), vision (eyes) and hearing (tympanum)
b) Eyes in a frog are a pair of spherical structures situated in the orbit in the skull. These are simple
c) eyes (possessing only one unit).
d) Ear is an organ of hearing as well as balancing (equilibrium).

Male Reproductive system

a) It consists of a pair of testes.
b) A testis is found adhered to the upper part of kidneys by a double fold of peritoneum called mesorchium.

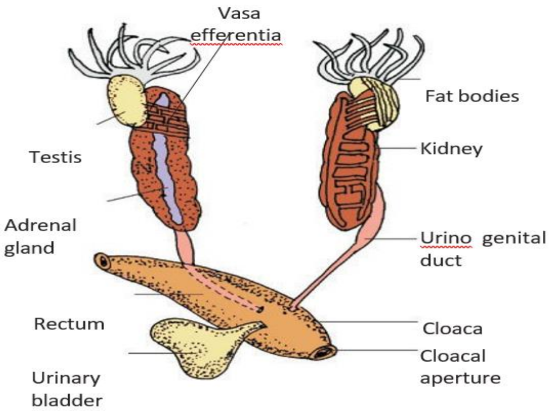


Figure 7.3 Male reproductive system

c) From testes 10-12 vasa efferentia arises. They enter the kidneys on their side and open into Bidder's canal and communicate with the urinogenital duct that comes out of the kidneys and opens into the cloaca.
d) The cloaca is a small, median chamber that is used to pass faecal matter, urine and sperms to the exterior.
e) **Female reproductive system**
   a) It includes a pair of ovaries.
   b) A pair of oviducts arising from the ovaries opens into the cloaca separately.
   c) A mature female can lay 2500 to 3000 ova at a time. Fertilization
   d) It is external and takes place in water.
   e) Development is indirect and involves a larval stage called tadpole.
   f) Tadpole undergoes metamorphosis to form an adult.

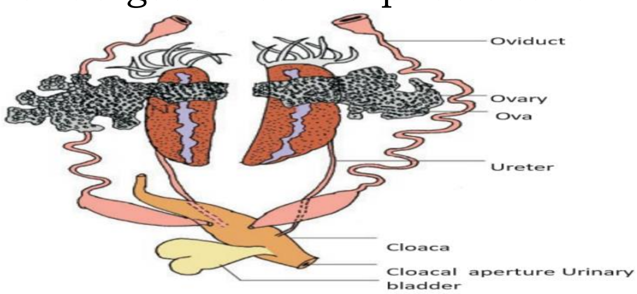


Figure 7.4 Female reproductive system

Economic Importance of Frog

1. Frogs are beneficial for mankind because they eat insects and protect the crop.
2. Frogs maintain ecological balance because these serve as an important link of food chain and food web in the ecosystem.
3. In some countries the muscular legs of frog are used as food by man.

QUESTIONAIRE

Multiple Choice Questions (MCQ's):

Q 1. Cloaca is an organ for-

a-Reproduction b- Excretion

c- Both a and b d- Neither a nor b

Ans: c

Q 2. Nutrient storage and metabolism in frogs take place in-

a- Fat bodies b- Cloaca

c- both a and b d- neither a and b

Ans: a

Q 3. Pair optic lobe is present in-

a- Fore brain b- Mid brain

c- Hind brain d- none of these

Ans: b

Q 4. No of cranial nerves present in frogs in-

a- 10 b- 20 c- 15 d- infinite

Ans: 10

Q 5. Tympanum is-----------------------------.

a- For excretion b- For respiration

c- For reproduction d- For the hearing

Ans: d

Q 6. In the forelimb of a frog how many digits are present-

a- 2 b- 4 c- 6 d- 8

Ans: b

Q 7. On the basis of excretory product, the frogs are-

a- Ammoniotelic b- ureotelic

c- Uricotelic d- none of these

Ans: b

Q 8. How many ova are released at a time by a female frog?

Ans: 2500 to 3000

Q 9. In frogs respiration occur by-

a- Skin b- Lungs c- both a and b d- only nostril

Ans: c

Q 10. Assertion- Frog has a short alimentary canal.

Reason- Frogs are carnivores.

(a) Both Assertion (A) and Reason (R) are true and Reason (R) is a correct explanation of Assertion (A).
(b) Both Assertion (A) and Reason (R) are true but Reason (R) is not a correct explanation of Assertion (A).
(c) Assertion (A) is true and Reason (R) is false.
(d) Assertion (A) is false and Reason (R) is true.

Ans: a

ASSERTION AND REASON BASED QUESTIONS

In the following questions a statement of Assertion (A) is followed by a statement of Reason(R) mark the correct choice as:

a. Both A and R are true and R is the correct explanation of A.
b. Both A and R are true but R is NOT the correct explanation of A.
c. A is true but R is false.
d. A is false but R is true.

1. Assertion- Frog has a long alimentary canal.
   Reason- Frogs are carnivores.
   Ans- (d)
2. Assertion: Frogs have the ability to change colour to hide from enemies.
   Reason: They are Poikilotherms.
   Ans- (b)
3. Assertion: Frogs are sexually dimorphic organisms.
   Reason: Females have copulatory pads on forelimb.
   Ans-(c)
4. Assertion: External fertilization takes place in frogs.
   Reason: They release gametes in water.
   Ans-(a)
5. Assertion: Frogs evade stressful environments by summer sleep and winter sleep.
   Reason: Frogs can maintain a constant internal environment.
   Ans-(c)

Short Answer (SA) type Questions (2 Marks)

Q 1. How do frogs carry out their respiration in land and water?
Ans- In water, skin acts as an aquatic respiratory organ. This type of respiration is called Cutaneous respiration. Dissolved oxygen in the water is exchanged through the skin by diffusion. On land they carry out Pulmonary respiration where lungs are involved.

Q 2. Name the organ in frog that receives urine, faecal matter and gametes. In male frogs the passage of sperms through the kidney is carried out by which organ?
Ans- The organ in frog that receives urine, faecal matter and gametes is Cloaca. In Male frogs the passage of sperms through the kidney is carried out by Bidder's canal.

Q 3. State how frogs protect themselves from their enemies?

Ans- Frogs have the ability to change their colour to hide them from their enemies (camouflage). This protective coloration is called mimicry.

Q 4. State how frogs are beneficial to Nature and mankind?

Ans- Frogs are beneficial to nature and mankind because they eat insects and protect the crop. Frogs maintain ecological balance because these serve as an important link of the food chain and food web in the ecosystem. In some countries the muscular legs of frogs are used as food by man.

Q 5. Among Male or Female frog's reproductive system, in which one there is no functional connection between the kidneys and the sex organ? State the number of vasa efferentia in male reproductive system arising out of testes.

Ans- In female reproductive system there is no functional connection between kidneys and ovaries. In Male reproductive system there are 10-12 no. of vasa efferentia arising out of testes.

Short Answer (SA) type Questions (3 Marks)

Q 1. Where do you find bidder's canal? State its function.

Ans- Bidder's canal is found in Male frogs. The Bidder canal is located in the male frog's kidney. The Vasa-efferentia opens into the Bidder's canal. It receives sperm from the vasa efferentia and aids in sperm passage.

Q 2. Explain how the frogs protect their eyes while in water. State the significance of webbed digits in Frog.

Ans- In water the frog's eyes are protected by Nictitating membrane. Webbed digits in forelimb and hind limb helps them to swim in water.

Q 3. In Frog both Cutaneous and Pulmonary Respiration is found. How are they different from each other?

Ans- Frogs respire on land and in the water by two different methods. In water, skin acts as an aquatic respiratory organ (cutaneous respiration). Dissolved oxygen in the water is exchanged through the skin by diffusion. On land, the buccal cavity, skin and lungs act as the respiratory organs. The respiration by lungs is called pulmonary respiration.

Q 4. Frogs have a short alimentary canal.
Illustrate its significance.

Ans- In frogs the alimentary canal is short because they are carnivores. Carnivores have shorter digestive tracts as meat is easier to digest than plant material.

Q 5. State the different types of sense organs of frogs. Which organ also helps in balancing?

Ans- Frog has different types of sense organs, namely organs of touch (sensory papillae), taste (taste buds), smell (nasal epithelium), vision (eyes) and hearing (tympanum with internal ears). Out of these, eyes and internal ears are well-organised structures and the rest are cellular aggregations around nerve endings. The ear is an organ of hearing as well as balancing (maintaining equilibrium).

CASE BASED QUESTION – (4 marks)

Read the following and answer the questions given below:

1. As soon as the rainy season starts, frog comes out from aestivation. It starts breeding immediately which lasts from July to September. Males gather in shallow waters and attract females by croaking which is often a sex call. The male mounts upon the back of the female and grasps firmly around her thorax by his forelegs. The males have nuptial pads on the bases of inner fingers which are fully developed during breeding season. It helps them in holding the slippery female. Amplexus is the term given for this sexual embrace. Amplexus continues for several days till the female deposits several hundred ova or eggs through her cloaca into water. Milt or seminal fluid is discharged by males over eggs. Milt or seminal fluid contains spermatozoa that fertilizes eggs.

(i) Yellowish ovoid testes are adhered to the upper part of kidneys by a double fold of peritoneum called

(a) Cloaca (b) Mesorchium

(c) Bidder's canal (d) copulatory pads.

Ans- (b) Mesorchium.

(ii) Kidney of frog receives sperms from testes via a number of vasa efferentia into

(a) Cloaca (b) Alimentary canal

(c) Bidder's canal (d) Rectum.

Ans- (c) Bidder's canal

(iii) The gametes are passed to exterior through

(a) Bidder's canal (b) Cloaca

(c) Urinogenital duct (d)None of these.

Ans- (b) Cloaca.

(iv) Females can lay ________ number of ova at a time.

(a) 100- 200 ova (b) 1000 - 2000 ova

(c) 2000- 2500 ova (d) 2500 - 3000 ova

Ans- (d) 2500 - 3000 ova

Long Answer (LA) type Questions (5 Marks)

Q 1. (a) How it is possible to identify a male frog from a female frog?

(b)State the type of circulation in frog and also the number of chambers in the heart of the frog.

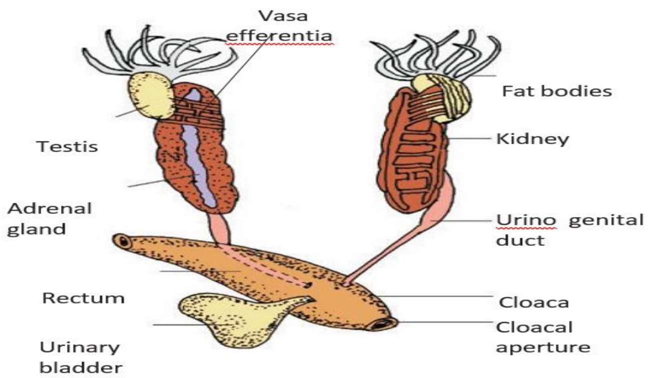
(c) Frogs are ureotelic animals. Illustrate the meaning of the statement. (2+2+1)

Ans- (a) Male frogs can be distinguished by the presence of sound producing vocal sacs and also a copulatory pad on the first digit of the fore limbs which are absent in female frogs.

(b) The vascular system of frogs is well-developed and closed type. Heart is three chambered, two atria and one ventricle.

(c)Frogs are ureotelic as they excrete nitrogenous waste materials in the form of Urea.

Q 2. Draw the Male reproductive system of frog and label in it (i) Testis (ii) Vasa efferentia (iii) Urinogenital duct (iv) Cloacal aperture



Q 3. Answer the followings related with the digestive system of frogs-

(i) How do frogs catch their prey?

(ii) Where is bile stored in the body of a frog?

(iii) Explain the digestion of food in frog. (1+1+3)

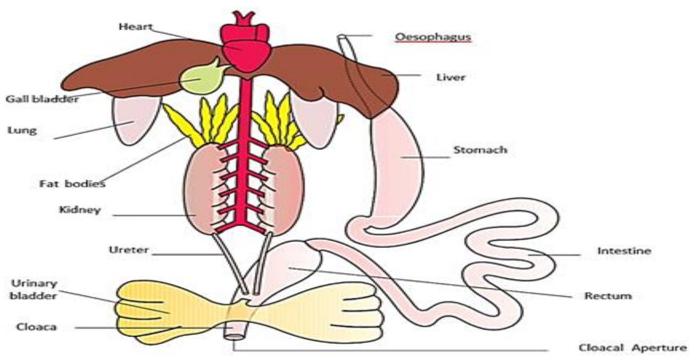
Ans- (i) Frogs catch their prey by the bilobed tongue.

(ii)Bile is stored in the gallbladder in frog.

(iii)Digestion of food takes place by the action of HCl and gastric juices secreted from the walls of the stomach. Partially digested food called chyme is passed from the stomach to the first part of the small intestine, the duodenum. The duodenum receives bile from gallbladder and pancreatic juices from the pancreas through a common bile duct. Bile emulsifies fat and pancreatic juices digest carbohydrates and proteins. Final digestion takes place in the intestine

Q 4. Draw the alimentary canal of frog and label in it (i) Stomach (ii) Liver (iii) Intestine (iv) Rectum in it.

Ans-



Q 5. (i) State the types of nervous coordination found in frogs.
(ii) State the number of cranial nerves that arise from the brain.
(iii) How chemical coordination takes place in Frogs? (2+1+2)

Ans- (i)The nervous system is organised into a central nervous system (brain and spinal cord), a peripheral nervous system (cranial and spinal nerves) and an autonomic nervous system (sympathetic and parasympathetic).
(ii) 10 pairs of cranial nerves arise from the brain in Frogs.
(iii) The chemical coordination in frogs is achieved by hormones which are secreted by the endocrine glands.
The prominent endocrine glands found in frogs are pituitary, thyroid, parathyroid, thymus, pineal body, pancreatic islets, adrenals and gonads.

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UNIT III

Cell: Structure and Function

Chapter 8
Cell-The Unit of Life

Chapter 9
Biomolecules

Chapter 10
Cell Cycle and Cell Division

CHAPTER:8 CELL: THE UNIT OF LIFE

CELL THEORY

Schleiden and Schwann together formulated the cell theory.
Cell theory:
(i) all living organisms are composed of cells and products of cells
(ii) all cells arise from pre-existing cells.

Unicellular Organisms; -are made up of a single cell.
Multicellular Organisms; -are made up of more than one cell.
smallest cells- Mycoplasmas
largest isolated single cell- egg of an ostrich
longest animal cell- nerve cell

CELL MEMBRANE

- Cell membrane is mainly composed of lipids and proteins. The major lipids are phospholipids that are arranged in a bilayer.
- Cell membrane also contains cholesterol.
- Cell membranes also possess protein and carbohydrate.

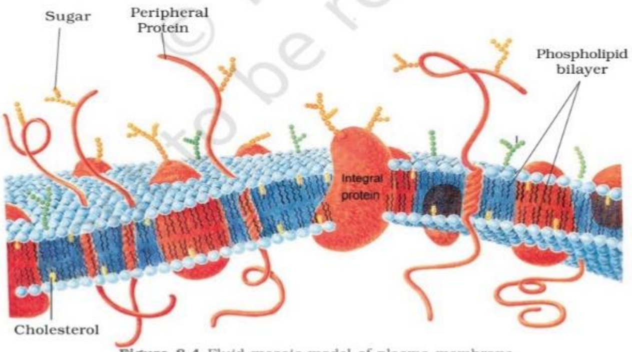


Figure 8.4 Fluid mosaic model of plasma membrane

- Fluid mosaic model of cell membrane was given by Singer and Nicolson (1972).
- Cell membrane performs following important functions- like cell growth, formation of intercellular junctions, secretion, endocytosis, cell division etc.
  Most important function of cell membrane is transport of molecules across it.
- Materials move across the membrane via either active transport or passive transport.

CELL WALL

- It forms outer covering of plasma membrane in fungi & plants.
- Cell wall helps in protection cell-to-cell interaction.
- The cell wall of a young plant cell, the primary wall is capable of growth, & later converts into secondary wall.
- The middle lamella is a outermost layer mainly of calcium pectate which is a cementing layer between two adjacent cells.

ENDOMEMBRANE SYSTEM

The endomembrane system includes endoplasmic reticulum (ER), Golgi complex, lysosomes and vacuoles.

ENDOPLASMIC RETICULUM filled lumen. It is of two types:

ROUGH ENDOPLASMIC RETICULUM (RER)

It is lined with ribosomes. It plays a key role in synthesis of protein as ribosome are attached to it.

SMOOTH ENDOPLASMIC RETICULUM (SER)

It does not have any ribosomes and hence, look smooth. It plays a key role in synthesis of lipids.

GOLGI APPARATUS

The Golgi apparatus principally performs the function of packaging materials, to be delivered either to the intra-cellular targets or secreted outside the cell.

LYSOSOMES

Lysosomes are rich in hydrolytic enzymes (hydrolases – lipases, proteases, carbohydrases. These enzymes are capable of digesting carbohydrates, proteins, lipids and nucleic acids.

MITOCHONDRIA

Membrane-bound structure with the outer membrane and the inner membrane.

Mitochondria are the sites of aerobic respiration.

Mitochondria are the sites of aerobic respiration. They produce cellular energy in the form of ATP, hence they are called 'power houses' of the cell.

PLASTIDS

- Chloroplasts contain chlorophyll
- Chromoplasts contain carotenoid
- Leucoplasts are the colourless
  - Amyloplasts store starch
  - Elaioplasts store oils and fats
  - Aleuroplasts store proteins.

Chloroplasts are double membraned structure & site of photosynthesis.

Inner membrane is called **stroma.** Flattened membranous sacs called **thylakoids** present in stroma.

RIBOSOMES

Ribosomes are spherical bodies made up of RNA (ribonucleic acid) and protein enzyme. They do not have membranes and are present separately in cytoplasm. Ribosomes are the sites where the protein synthesis takes place.

CYTOSKELETON

Cytoskeleton includes microtubules, microfilaments and intermediate filaments

The cytoskeleton in a cell is involved in many functions such as mechanical support, motility, maintenance of the shape of the cell.

CILIA AND FLAGELLA

Cilia and flagella are hair-like outgrowths of the cell membrane.

Cilia are small while Flagella are comparatively longer.

Their core called the axoneme with 9+2 arrangement of microtubules.

CENTROSOME AND CENTRIOLES

Centrosome is an organelle usually containing two cylindrical structures called centrioles.

With 9 + 0 arrangement. Centrioles form the basal body of cilia or flagella and spindle fibres for cell division in animal cells.

NUCLEUS

Nucleus is double membranous organelle. The nucleoplasm contains nucleolus and chromatin.

CHROMOSOMES

Chromosomes are visible during cell division. Every chromosome essentially has a primary constriction the **centromere** on the sides of which disc shaped structures called **kinetochores** are present.

Chromosomes can be divided into four types on basis of position of centromere

Metacentric: Centromere at centre.

Sub-metacentric: Centromere nearer to one end of chromosome.

Acrocentric: Centromere situated close to its end.

Telocentric: Centromere is terminal.

CASE BASED QUESTIONS

Chloroplasts are a type of plastid, which are specialized organelles found in the cells of plants and algae. Other types of plastids include chromoplasts, which contain pigments that give flowers and fruits their vibrant colours, and leucoplasts, which are involved in the synthesis and storage of starch, oils, and proteins. All plastids share a common origin and are crucial for various metabolic functions within plant cells.

1. Mention the pigment responsible for the absorption of photic energy for photosynthesis? Where is that molecule located in photosynthetic cells?
2. Which type of Leucoplasts store proteins and fats?
3. Why stroma is important.

   Or

   Write the two types of carotenoids present in chromoplast and their importance.

   Ans. 1. Chlorophyll

   2. Aleuroplasts store proteins and eliaoplasts store fats.

   3. The stroma of the chloroplast contains enzymes required for the synthesis of carbohydrates and proteins.

   Or

   The two types of carotenoids present in chromoplasts are carotene, xanthophylls.

   Xanthophyll provides yellow colour while carotene gives orange or red colour to a plant part.

MCQ

1. The Golgi apparatus
   (a) Is found in animal cells only
   (b) Is found in prokaryotes only
   (c) Packages and modifies proteins
   (d) Is the site of rapid ATP production

Ans. c

2. Ribosomes are found in all except
   (a) Bacteria
   (b) Mitochondria and chloroplast
   (c) Rough Endoplasmic Reticulum
   (d) Golgi Bodies
   Ans. d
3. 70S ribosomes are found
   (a) In prokaryotic cells, mitochondria and chloroplast
   (b) In prokaryotic cells and in cytoplasm of eukaryotic cells
   (c) On Endoplasmic reticulum
   (d) On Endoplasmic reticulum and nuclear membrane
   Ans. a
4. An organelle with an internal cross section showing characteristic "9 + 2" morphology is the
   (a) Microtubule
   (b) Microfilament
   (c) Cilia or flagella
   (d) Cytoskeleton
   Ans. c
5. Where ribosomes are assembled are called
   (a) Nucleus
   (b) Nucleolus
   (c) Golgi Bodies
   (d) Polyribosomes
   Ans. b

ASSERTION REASON

(a) Both A and R are true and R is the correct explanation of A.

(b) Both A and R are true, but R is not the correct explanation of A.

(c) A is true, but R is false.

(d) A is false, but R is true.

1. Assertion: In mitochondria enzymes of electron transport are embedded in outer membrane.
   Reason: Inner membrane has infoldings called cristae
   Ans. d
2. Assertion: On the sides of centromere disc shaped structures called kinetochores are present
   Reason: Sister chromatids are connected to microtubules extending from the opposite spindle poles via kinetochores
   Ans. a

3. Assertion: Mesosome are formed by the extensions of plasma membrane into the cell.
   Reason: They help in cell wall formation
   Ans. b

SHORT ANSWER (2 Marks)

1. What are the main components of the cytoskeleton?
   Ans. A network of filamentous proteinaceous structures consisting of microtubules, microfilaments and intermediate filaments present in the cytoplasm is collectively referred to as the cytoskeleton.
2. Draw a well labelled diagram of mitochondria.
   Ans.

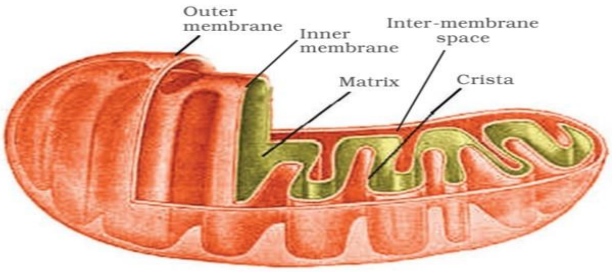
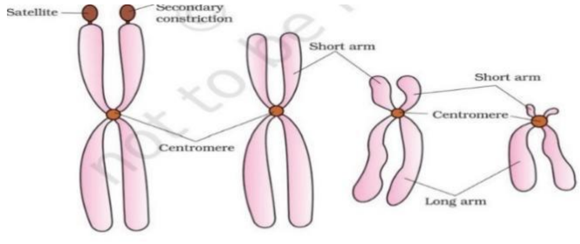


Figure 8.7 Structure of mitochondrion (Longitudinal section)

3. State the cell theory.
   Ans. i. all living organisms are composed of cells and products of cells.
   ii. All cells arise from pre-existing cells.
4. Differentiate between RER and SER.
   Ans.

RER	SER
Ribosomes attached to outer surface.	Lack ribosomes
Involved in protein synthesis and secretion	Site for synthesis of lipid

5. Draw various types of chromosomes on the basis of position of centromere
   Ans.



SHORT ANSWER (3 Marks)

1. Why are lysosomes known as "the cleaners" of the cell waste?
   Ans. Lysosomes are active in acidic pH

They are vesicular structures formed by the process of packaging in the Golgi apparatus.
Lysosomes are rich in almost all types of hydrolytic enzymes hydrolases – lipases, proteases, carbohydrases.
These enzymes are capable of digesting carbohydrates, proteins, lipids.

2. Explain the Fluid Mosaic Model.
Ans. The cell membrane is mainly composed of lipids and proteins. The major lipids are phospholipids that are arranged in a bilayer. Also, the lipids are arranged within the membrane with the polar head towards the outer sides and the hydrophobic tails towards the inner part.

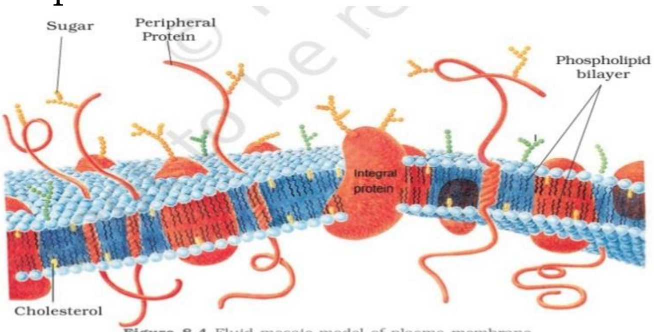


Figure 8.4 Fluid mosaic model of plasma membrane

3. List the functions of mesosome.
Ans. i. Mesosomes help in cell wall formation
ii. DNA replication and distribution to daughter cells
iii. respiration
iv. secretion process
v. to increase surface area of plasma-membrane and enzymatic content.

LONG ANSWER (5 Marks)

1. Explain the structure of Chloroplast.
Ans. i. Chloroplast are lens-shaped, oval, spherical, discoid or even ribbon-like organelles.
ii. Chloroplasts are double membrane structure.
iii. The inner chloroplast membrane is relatively less permeable. The space limited by the inner membrane of the chloroplast is called the stroma.
iv. A number of organised flattened membranous sacs called the thylakoids.
v. Thylakoids are arranged in stacks like the piles of coins called grana
2. Write the functions of the following
a. Centromere
b. Cell wall
c. Smooth ER

d. Golgi Apparatus
e. Centrioles

Ans. a. Centromere- The centromere is a constricted region of a chromosome that plays a key role in cell division, helping the cell to divide up its DNA during mitosis and meiosis.

b. Cell wall- It gives shape to the cell and protects cell from mechanical damage and infection, helps in cell-to-cell interaction

c. Smooth ER- Site for synthesis of lipid

d. Golgi Apparatus- Performs packaging of materials, to be delivered either to the
intra-cellar targets or secreted outside the cell. Important site of formation
of glycoproteins and glycolipids.

e. Centrioles- Centrioles form the basal body of cilia or flagella and spindle fibres for cell division in animal cells.

3. Explain the structure & function of Cell wall.

Ans. Cell Wall is a non-living rigid structure which gives shape to the cell and
protects cell from mechanical damage and infection, helps in cell-to-cell interaction and provides barrier to undesirable macromolecules.

Cell wall of algae is made of cellulose, galectins, mannans and minerals like calcium carbonate. Plant cell wall consists of cellulose, hemicellulose, pectins and proteins.

Middle lamella is made of calcium pectate which holds neighbouring cells together.

Plasmodesmata connect the cytoplasm of neighbouring cells.

CHAPTER:9 BIOMOLECULES

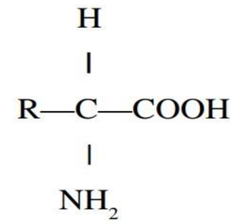
- All the carbon compounds that we get from living tissues can be called 'biomolecules.

BIOMICROMOLECULES (MICROMOLECULES OR BIOMOLECULES)

Molecular weight= 18 to 800 Dalton (Da)

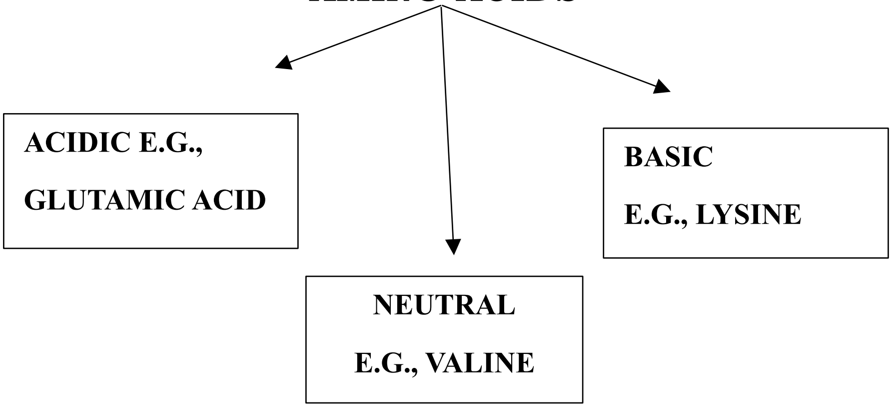
AMINO ACIDS

- Amino acids are organic compounds containing an amino group and an acidic group as substituents on the same carbon i.e., the α-carbon. Hence, they are called α-amino acids.



- Based on number of amino and carboxyl groups, amino acids can be

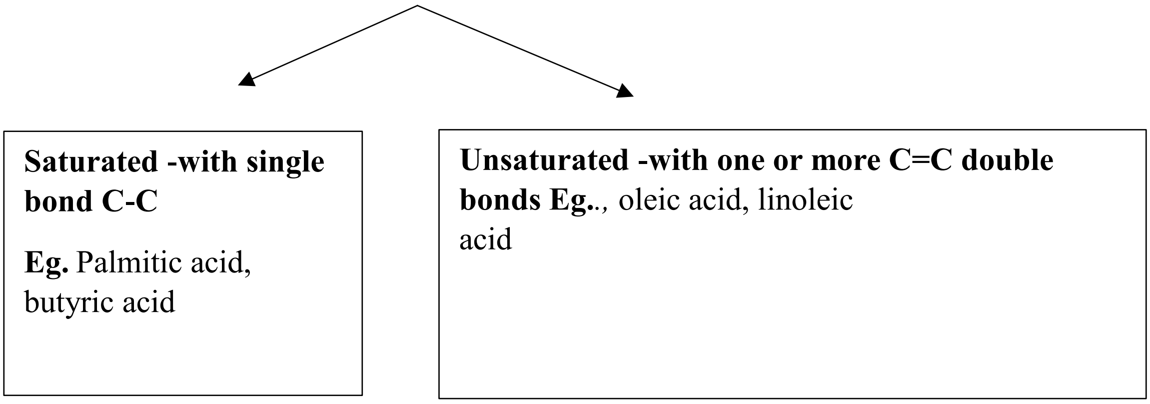
AMINO ACIDS



LIPIDS

- Lipids are generally water insoluble.
- Lipids on hydrolysis yield fatty acids.
- Fatty acid has a carboxyl group attached to an R group i.e methyl ($-CH_3$), or ethyl ($-C_2H_5$) (contains 1 to 19 carbons).

FATTY ACIDS

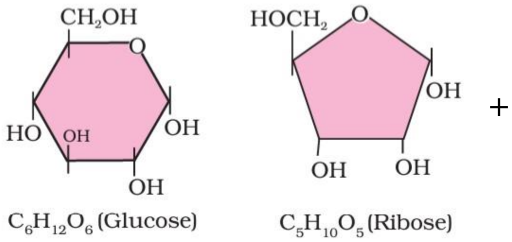


SUGARS (CARBOHYDRATES)

- They are formed of C, H and O in the ratio of 1:2:1.

NITROGEN BASES

Adenine, Guanine, Cytosine & Thymine



Sugars (Carbohydrates)

- NUCLEOSIDE = Nitrogenous base Pentose sugar (linked through *N* −GLYCOSIDIC BOND)
  Example − adenosine, deoxyadenosine, cytidine, etc.
- NUCLEOTIDE=Nucleoside + Phosphate group (linked through PHOSPHODIESTER BOND)
  Example -Adenylic acid Guanylic acid, etc.

BIO-MACROMOLECULES (MACROMOLECULES)

Molecular weight= greater than 1000 Da

They are

- Proteins
- Polysaccharides
- Nucleic acids

PROTEIN

- Protein is a heteropolymer and not a homopolymer.
- Proteins carry out many functions in living organisms, some transport nutrients across cell membrane, some fight infectious organisms, some are hormones, some are enzymes, etc.
- **Primary structure**: It describes the sequence of amino acids, i.e. the positional information in a protein. Left end of the chain has first amino acid (N-terminal amino acid). Right end has last amino acid (C-terminal amino acid).
- **Secondary structure:** Here, one or more polypeptide chains are folded in the form of a helix.
  It has only right-handed helices. E.g. Keratin, Fibroin (silk fibre).
- **Tertiary structure:** Here, helical polypeptide chain is further folded like a hollow woollen ball. It gives 3-D view. Tertiary structure is necessary for many biological activities of proteins. E.g. Myoglobin, enzymes.
- **Quaternary structure:** Here, more than one polypeptide chains form tertiary structure and each chain functions as subunits of protein. E.g. Haemoglobin. It has 4 subunits (2 α subunits and 2 β subunits).

POLYSACCHARIDES

- Carbohydrates (polysaccharides) are of two types -homopolymer and heteropolymer.
- Homopolymer is made up of only one type of monosaccharide units. Eg-cellulose,

starch, glycogen, inulin, chitin.

- Heteropolymer is made up of two or more type of monosaccharides.
- Starch is the stored food of plants. It is a polymer of helically arranged glucose monomers which can hold iodine molecules and give blue black colour.
- Cellulose is a polymer of glucose molecules. It is the most abundant organic molecules on earth.
- Glycogen is the reserve food materials for animals, bacteria and fungi. In this, glucose molecules are arranged in highly branched bush like chain.
- Chitin is a complex polysaccharide having units of N -acetyl glucosamine.

NUCLEIC ACIDS

- Polymer of nucleotides - DNA and RNA.

ENZYMES

- Almost all enzymes are proteins.
- Ribozymes are Nucleic acids that behave like enzymes.
- An active site of an enzyme is a crevice or pocket into which the substrate fits. Thus enzymes, through their active site, catalyse reactions at a high rate.
- Enzymes get damaged at high temperatures.
- Enzymes convert a substrate (S) into a product (P).

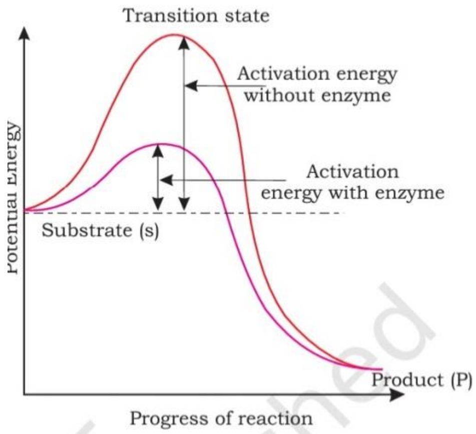


Figure 9.4 Concept of activation energy

$$E + S \quad ES \longrightarrow EP \longrightarrow E + P$$

- Enzymes lower the activation energy of reactions.

Factors affecting enzyme activity:

- **Temperature:** Show highest activity at optimum temperature. Activity declines above and below the optimum value.
  Low temperature- Enzyme inactive, High temperature- Enzyme Denatured
- **pH:** Enzymes function in a narrow range of pH. Highest activity at optimum pH
- **Concentration of substrate:** The velocity of enzymatic reaction rises
  with increase in substrate concentration till it reaches maximum velocity (V*max*). Further increase of substrate does not increase the rate

of reaction as no free enzyme molecules are available to find with additional substrate.

INHIBITION

When the binding of the chemical shuts off enzyme activity, the process is called inhibition and the chemical is called an inhibitor.

Competitive inhibition

Inhibitor closely resembles the substrate in its molecular structure and inhibits the enzyme activity. *E.g.,* inhibition of succinic dehydrogenase by malonate.

CLASSIFICATION AND NOMENCLATURE OF ENZYMES

Oxidoreductases/dehydrogenases

Transferases

Hydrolases

Isomerases

Ligases

CO-FACTORS (Non-protein) + **APOENZYME (Protein)= HOLOENZYME (Catalytically active Enzyme)**

COFACTORS

- **Prosthetic groups:** Are organic compounds tightly bound to apoenzyme. *E.g.,* haem in peroxidase and catalase.
- **Co-enzymes:** Organic compounds which has transient association with enzyme. *E.g.,* NAD, NADP.
- **Metal ions:** Required for enzyme activity. Form coordination bond with side chains at active site and with substrate. *E.g.,* zinc is a co-factor for enzyme carboxypeptidase.

CASE BASED QUESTIONS

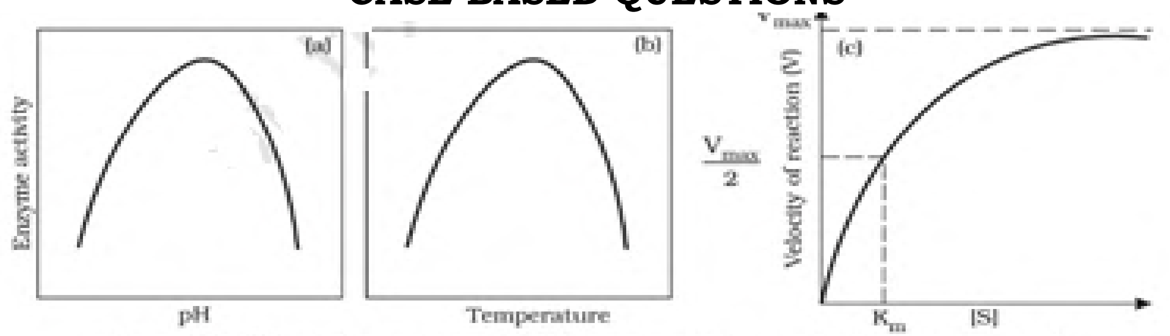


Figure 9.5 Effect of change in : (a) pH (b) Temperature and (c) Concentration of substrate on enzyme activity

1. Observe the given figure carefully and illustrate the effect of pH on the enzyme activity.
2. What changes an enzyme structurally undergo at very high temperature and very low temperature.

With the increase in substrate concentration, the velocity of the enzymatic reaction rises at first but once rate of reaction reaches

Vmax there is no effect of further increase in substrate concentration. Justify the statement. **Or**

What is Km? Give its importance.

Ans.

1. Enzyme shows its highest activity at a particular pH called optimum pH. Activity declines both below and above the optimum pH.
2. Low temperature preserves the enzyme in a temporarily inactive state whereas high temperature destroys enzymatic activity because proteins are denatured by heat.
3. With the increase in substrate concentration, the velocity of the enzymatic reaction rises at first but once rate of reaction reaches Vmax there is no effect of further increase in substrate concentration. This is because the enzyme molecules are fewer than the substrate molecules and after saturation of these molecules, there are no free enzyme molecules to bind with the additional substrate molecules once it reaches Vmax.

Or

Km is Michaelis constant. It is the substrate concentration at which the reaction rate is 50% of the Vmax. Km is a measure of the affinity an enzyme has for its substrate, as the lower the value of Km, the more efficient the enzyme is at carrying out its function at a lower substrate concentration.

ASSERTION REASON

a) Both A and R are true and R is the correct explanation of A.
(b) Both A and R are true, but R is not the correct explanation of A.
(c) A is true, but R is false.
(d) A is false, but R is true.

1. Assertion: Starch gives blue black colour with iodine.
   Reason: Starch forms helical secondary structures which can hold I_2
   Ans. a
2. Assertion: Paper made from plant pulp and cotton fibre is cellulosic.
   Reason: Plant cell walls are made of cellulose.
   Ans. a
3. Assertion: Amino acids are amphoteric in nature.
   Reason: Essential amino acids can be synthesized by the body.
   Ans. c

MCQ

1. Which one is incorrect?
   (a) Cofactor plays crucial role in catalytic activity of the enzymes
   (b) Zn is activator of carboxypeptidase
   (c) Catalase and peroxidase have haem as prosthetic group

(d) Coenzymes are inorganic compounds
Ans. d

2. Which one is the most abundant protein in the animal world
(a) Trypsin
(b) Haemoglobin
(c) Collagen
(d) Insulin
Ans. C

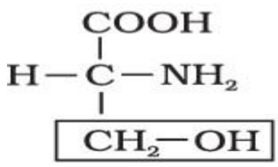
3. Phosphoglyceride is always made up of:
(a) only a saturated fatty acid esterified to a glycerol molecule to which a phosphate group is also attached
(b) only an unsaturated fatty acid esterified to a glycerol molecule to which a phosphate group is also attached
(c) a saturated or unsaturated fatty acid esterified to a glycerol molecule to which a phosphate group is also attached
(d) a saturated or unsaturated fatty acid esterified to a phosphate group which is also attached to a glycerol molecule
Ans. c

4. Number of carbons in a ring of deoxyribose sugar is
(a) Three
(b) Four
(c) Five
(d) Six
Ans. B

5. A typical homopolysaccharide is
(a) Starch
(b) Lignin
(c) Insulin
(d) Suberin
Ans. a

SHORT ANSWER (2 Marks)

1. Name the alcoholic amino acid and draw its structure.
Ans. serine.



Serine

2. Differentiate between primary and secondary metabolite.
Ans.

Primary Metabolite	Secondary Metabolite
The metabolites having identifiable functions and play important role in normal	No significant function is known but are useful to human welfare and have ecological importance.

physiological processes, E.g sugars, amino acids, fats and oils and nucleotides, etc.	Eg. alkaloids lectins Drugs, Pigments, Spices and scents etc.

3. Name the most abundant animal protein and plant protein.
   Ans. Most abundant animal protein is Collagen
   Most abundant plant protein is Ribulose bisphosphate Carboxylase-Oxygenase (Rubisco)
4. Give one complex polysaccharide where is it found in animal world.
   Ans. Exoskeletons of arthropods, for example, have a complex polysaccharide called chitin. These complex polysaccharides are mostly homopolymers.
5. What are the four different nitrogenous bases found in DNA.

Ans, Nitrogenous bases found in DNA are adenine, guanine, uracil, cytosine, and thymine.

SHORT ANSWER (3 Marks)

1. Explain primary, secondary and tertiary structure of protein.
   Ans. Primary structure: Is found in the form of linear sequence of amino acids. First amino acid is called N-terminal amino acid and last amino acid is called C-terminal amino acid.
   (b) Secondary structure: Polypeptide chain undergoes folding or coiling which is stabilized-by hydrogen bonding. Right-handed helices are observed; e.g., Fibrous protein in hair, nails.
   (c) Tertiary structure: Long protein chain is folded upon itself like a hollow woollen ball. Gives a 3-dimensional view of protein, e.g., myosin.
2. How prosthetic groups, co-enzymes and metal ions are different from each other? Explain.
   Ans. **Prosthetic groups** are organic compounds tightly bound to the apoenzyme. In peroxidase and catalase haem is the prosthetic group.**Co-enzymes** are also organic compounds but their association with the apoenzyme is only transient. E.g. coenzyme nicotinamide adenine dinucleotide (NAD) and NADP.
   Metal ions form coordination bonds with side chains of enzyme at the active site and at the same time form one or more coordination bonds with the substrate, e.g., zinc is a cofactor for the proteolytic enzyme carboxypeptidase.
3. What are polysaccharides explain with one example of homopolysaccharide and one example of heteropolysaccharide.
   Ans. Polysaccharides are long chains of sugars.

Homopolysaccharides Constituted of single type of monosaccharide units e.g., starch, glycogen, cellulose

Heteropolysaccharides Constituted by two or more type of monosaccharide unit and their derivatives e.g., Peptidoglycans, chitin

LONG ANSWER (5 Marks)

1. Competitive inhibitor resemble substrate. Justify your answer with an example. Write one use of competitive inhibitor.

   Ans When the inhibitor closely resembles the substrate in its molecular structure and inhibits the activity of the enzyme, it is known as competitive inhibitor. Due to its close structural similarity with the substrate, the inhibitor competes with the substrate for the substrate binding site of the enzyme. Consequently, the substrate cannot bind and as a result, the enzyme action declines,

   E.g. Inhibition of succinic dehydrogenase by malonate which closely resembles the substrate succinate in structure.

   Use- Such competitive inhibitors are often used in the control of bacterial pathogens.

2. List the 6 classes of enzymes along with their functions.

   Ans. **Oxidoreductases/dehydrogenases:** Enzymes which catalyse oxidoreduction between two substrates S and S' e.g.,

   S reduced + S' oxidised → S oxidised + S' reduced.

   Transferases: Enzymes catalysing a transfer of a group, G (other than hydrogen) between a pair of substrate S and S' e.g., S - G + S' → S + S' - G

   Hydrolases: Enzymes catalysing hydrolysis of ester, ether, peptide, glycosidic, C-C, C-halide or P-N bonds.

   Lyases: Enzymes that catalyse removal of groups from substrates by mechanisms other than hydrolysis leaving double bonds.

   Isomerases: Includes all enzymes catalysing inter-conversion of optical, geometric or positional isomers.

   Ligases: Enzymes catalysing the linking together of 2 compounds, e.g., enzymes which catalyse joining of C-O, C-S, C-N, P-O etc. bonds.

3. Describe the structure of DNA along with its functions.

Ans. **Structure**

Nucleic acids are found in acid soluble fraction of living tissue.

- DNA is a polymer of nucleotides.
- A nucleotide has 3 distinct components.

Nucleotide=Nitrogenous bases + Pentose sugar + Phosphate group (linked through phosphodiester bond)

- DNA is a double helix of two polynucleotide chains.
- The backbone of the nucleic acid is uniformly consisting of alternating pentose sugar & phosphate group, held together by hydrogen bonds (two between A and

T and three between C and G).

- At one end of strand, 5-C of pentose sugar is free on another end 3-C of pentose is free.

Function

DNA is a genetic material and passes information from one generation to other.

CHAPTER: 10 CELL CYCLE AND CELL DIVISION

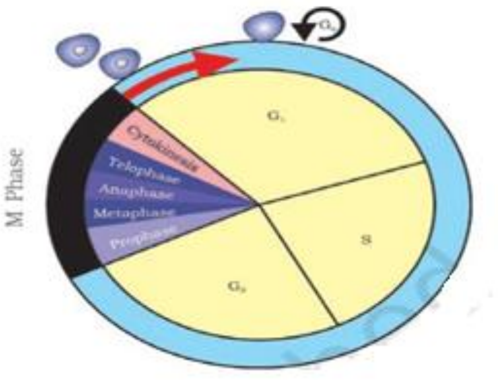
CELL CYCLE: - The sequence of events by which a cell duplicates its genome and eventually divides into two daughter cells is called cell cycle.

→ Cell Cycle is divided into two phases-

1) Interphase - It is the phase between two M phases. During this phase, the cell prepare itself for nuclear division.

2) M phase: - It is the phase when cell division takes place.

→ The interphase is further divided into three phases: -



A diagrammatic view of cell cycle indicating formation of two cells from one cell

INTERPHASE

The interphase is divided into three further phases:

G_1 phase / Gap 1 phase: -

In this phase, cell is metabolically active and continuously grows.

S phase: In this phase, DNA synthesis or replication takes place.

Chromosome number remains same but DNA content gets doubled.

In animal cells, DNA replication takes place in nucleus and centrioles duplicates in cytoplasm.

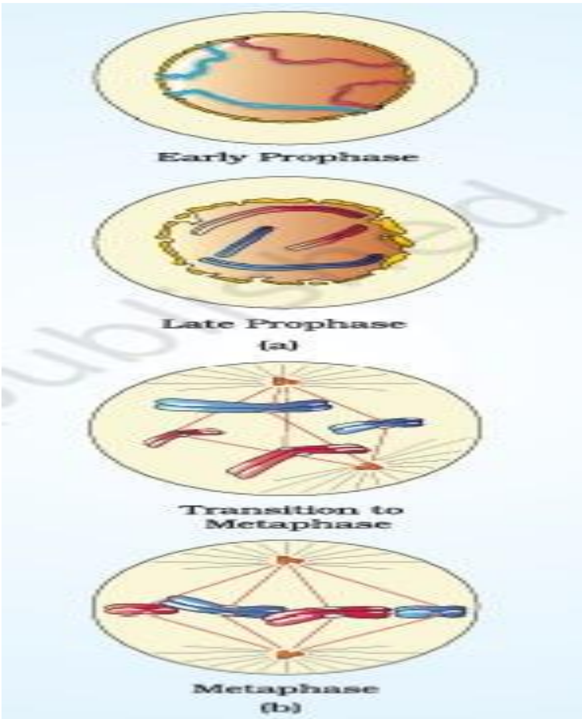
G2 phase: - In this phase, proteins are synthesized & cell growth continues.

Quiescent stage (G0): - Some cells in adult animals do not exhibit division. These cells exit G1phase to enter an inactive stage called quiescent stage (G0).

MITOSIS: -
Also called as equational division because the numbers of chromosomes remain same is parental
and daughter cells.
Mitosis is divided into four stages: - Prophase, Metaphase, Anaphase and telophase.

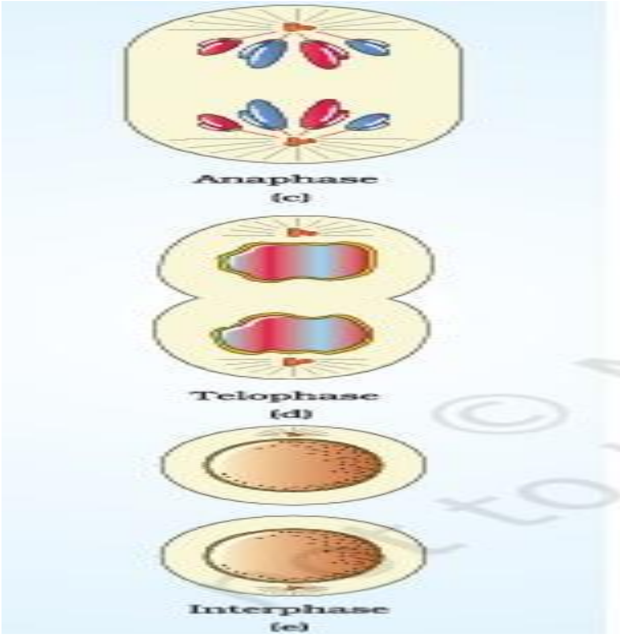
i) Prophase-
Chromosomal material condenses to form compact mitotic chromosomes.
Centrosome begins to move towards opposite poles of the cell.
Each centrosome radiates out microtubules called asters.
Nuclear envelop and nucleolus starts disappearing.

ii) Metaphase-
Spindle fibres attach to kinetochores of chromosomes.
Chromosomes are moved to spindle equator and get arranged at metaphase plate.



iii)Anaphase-
Centromeres split and chromatids separate.
Chromatids move towards the opposite poles.

iv) Telophase-
Chromosomes cluster at opposite spindle poles and their identity is lost as discrete elements.
Nuclear envelope develops around the chromosomes forming two daughter nuclei.
Nucleolus, Golgi body and ER reform.



Cytokinesis: - Division of cytoplasm after Karyokinesis into two daughter cells.

1) Cell furrow: - In animal cells, furrows are appeared in plasma membrane that deepens gradually
and joins to divide cytoplasm.

2) Cell plate- In plant cells, wall starts to form at center and grows outwards. The formation of cell
wall begins with plate formation.

SIGNIFICANCE OF MITOSIS: -

1) Produces diploid daughter cells with identical genetic complement.
2) Helps in repair of cells.
3) Helps in growth of organism.

MEIOSIS

Also called as reductional division because it reduces the number of chromosomes into
half and results in the production of haploid daughter cells.
It involves two phases - meiosis I and meiosis II.

MEIOSIS I

Prophase I: -

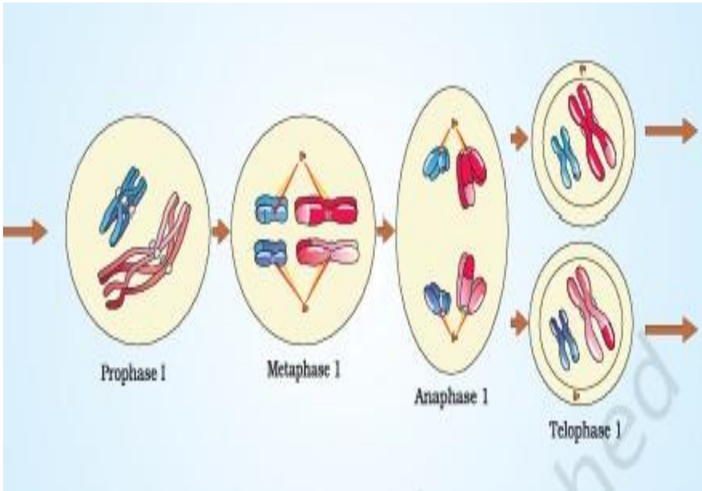
Leptotene- Chromosomes becomes distinct & visible.

Zygotene - Chromosomes start pairing together (synapsis). Synaptonemal complex formed by a pair of homologous chromosomes is called bivalent or tetrad.

Pachytene - crossing over between non sister chromatids of homologous chromosomes takes
place.

Diplotene - dissolution of synaptonemal complex, separation of

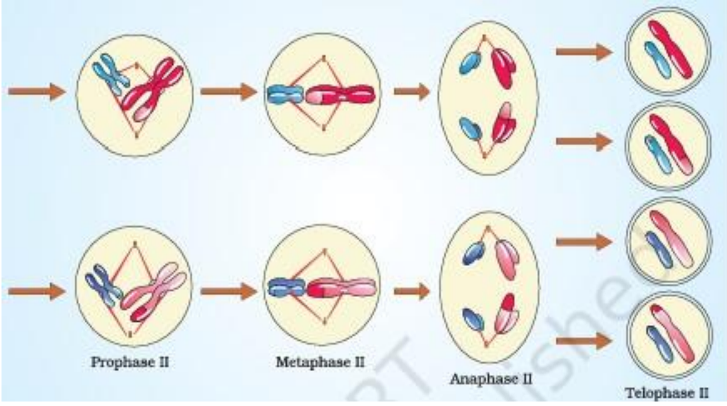
bivalent except at X like structure called chiasmata.
Diakinesis- terminalization of chiasmata, nuclear membrane and nucleolus disappears.
Metaphase I - Bivalent chromosome aligns at equatorial plate, spindles get attached to the pair of homologous chromosomes.
Anaphase I - Homologous chromosomes separate and move towards the opposite poles.
Telophase I - Nuclear membrane and nucleolus reappears and cytokinesis follows.



MEIOSIS II

Prophase II - initiated immediately after cytokinesis, nuclear membrane disappears, chromosomes become compact.
Metaphase II- Chromosomes align at equator.
Anaphase II- Splitting of centromere and chromosomes move to opposite poles.
Telophase II. Chromosomes get enclosed by nuclear membrane followed by cytokinesis to form four haploid daughter cells.

SIGNIFICANCE OF MEIOSIS: -
1) Meiosis forms the gametes that are essential for sexual reproduction.
2) Introduces new recombination of traits.
3) Helps in maintenance of chromosome number of sexually reproducing organism.
4) Provides evidence of basic relationship of organisms.



CASE BASED QUESTIONS

The cell cycle, or cell-division cycle, is the sequential series of events that take place in a cell that causes it to divide into two daughter cells. These events include the growth of the cell, duplication of its DNA (DNA replication) and some of its organelles, and subsequently the partitioning of its cytoplasm, chromosomes and other components into two daughter cells in a process called cell division.

1. Can a cell undergo mitosis without entering 'S' phase?
2. Write the different phases of interphase.
3. How the amount of DNA content (C) per cell changes during different stages of the cell cycle

   Or

   What happen to the cell entering quiescent stage. Is there any cell which enters permanently into this stage.

Ans.

1. No. During the S phase, DNA synthesis or replication of DNA takes place. DNA replication is essential for cell division.
2. G1 phase (Gap 1), S phase (Synthesis), G2 phase (Gap 2)
3. Amount of DNA content in the cell remains the same in the G1 phase, but in the S phase, it
   doubles as the DNA replication takes place. It remains double in the G2 phase but halved in the M phase of the cell cycle.

   Or

   Cells in quiescent stage remain metabolically active but no longer proliferate unless called on to do so depending on the requirement of the organism. Yes, heart cells in the adult animals enter quiescent stage permanently.

ASSERTION REASON

(a) Both A and R are true and R is the correct explanation of A.
(b) Both A and R are true, but R is not the correct explanation of A.
(c) A is true, but R is false.
(d) A is false, but R is true.

1. Assertion: Chromosomes are moved to spindle equator and get aligned along metaphase plate through spindle fibres.
   Reason: kinetochores serve as the sites of attachment of spindle fibres
   Ans. b
2. Assertion: Anaphase is characterised by separation of chromatids
   Reason: Splitting of Centromeres results in separation of chromosomes
   Ans. a
3. Assertion: Meiosis is important for gamete formation
   Reason: Meiosis is the cell division through which haploid cells can be produced.
   Ans. a

MCQ

1.The mitotic spindle is composed of -
(a) Chromosomes (b) Chromatids
(c) Microtubules (d) Chromatin
Ans. c

2. How many equational divisions are necessary in a cell of onion root tip to form 128 cells?
(a)64 (b)128 (c) 6 (d) 7
Ans. d

3. What would be the number of chromosomes of the aleurone cells of a plant with 42 chromosomes in its roots tip cells?
(a) 21 (b) 42 (c) 63 (d) 84
Ans. b

4. The chromosomes become gradually visible with compaction of chromatin during the meiotic stage
((a) diplotene (b) leptotene
(c) zygotene (d) pachytene
Ans. a

5. In human there are 23 bivalents in metaphase -I , what will be the number of chromosomes in daughter cells after meiosis - I and meiosis - II?
(a) 46 and 46 (b) 92 and 46
(c) 23 and 23 (d) 46 and 23
Ans. c

SHORT ANSWER (2 Marks)

1. Name the cell division by which the haploid organisms divide also mention names of two such organisms.
   Ans. Mitosis is the cell division by which the haploid organisms divide.
   Eg. Lower plants like fungi and some insects like male honey bee.

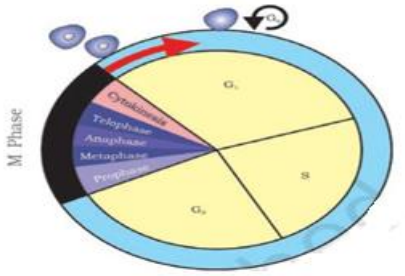
2. Differentiate between the Cytokinesis of plants and animals.

Ans.

Cytokinesis in Plants	Cytokinesis in animals
1. In plant cells, wall formation starts in the centre of the cell and grows outward to meet the existing lateral walls. 2. Cell-plate is the precursor of cell wall which later forms middle lamella between two adjacent cells.	1. In an animal cell, this is achieved by the appearance of a furrow in the plasma membrane. 2. The furrow gradually deepens and ultimately joins in the centre dividing the cell cytoplasm into two.

3. Draw a diagram to show cell cycle.

Ans.

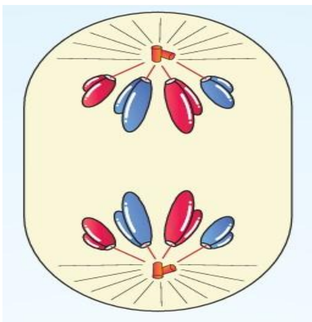


A diagrammatic view of cell cycle indicating formation of two cells from one cell

4. What is synaptonemal complex?

Ans. Pairing of homologous chromosomes is called synapsis. The complex formed by a pair of synapsed homologous chromosomes is called a bivalent or a tetrad.

5. Sketch the position of chromosomes in anaphase stage of mitosis.



Anaphase

SHORT ANSWER (3 Marks)

1. Write the significance of mitosis.

Ans. i. growth of multicellular organisms.

ii. Maintain Nucleo–cytoplasmic ratio

iii. cell repair

iv. Regeneration
v. maintenance of chromosome number
vi. Reproduction in unicellular organisms, lower plants and some insects.

2. Differentiate between mitosis and meiosis.
Ans.

Mitosis	Meiosis
Occurs in Somatic cells	Occurs in germ cells
Number of chromosomes remain same in daughter cells.	Number of chromosomes reduces o half in daughter cells.
No exchange of genetic material.	Exchange of genetic material occurs due to crossing over.

3. In which phase of meiosis are the following formed? Choose the answers
from hint points given below.
a. Synaptonemal complex ____________________________
b. Recombination nodules ____________________________
c. Appearance/activation of ____________________________
enzyme recombinase
d. Termination of chiasmata ____________________________
e. Interkinesis ____________________________
f. Formation of dyad of cells ____________________________

Ans. a. Zygotene
b. Pachytene
c. Diakinesis
d. After Telophase-I /before Meiosis-II
e. Telophase-I
f. After Meiosis-I

LONG ANSWER (5 Marks)

1. What are the various stages of meiotic prophase-I? Enumerate the chromosomal events during each stage?
Ans. **Prophase I**: -
Leptotene- Chromosomes becomes distinct & visible.
Zygotene - Chromosomes start pairing together (synapsis). Synaptonemal complex formed by a pair of homologous chromosomes is called bivalent or tetrad.
Pachytene - crossing over between non sister chromatids of homologous chromosomes takes place.
Diplotene - dissolution of synaptonemal complex, separation of bivalent except at X like structure called chiasmata.

Diakinesis- terminalization of chiasmata, nuclear membrane and nucleolus disappears.

With the help of labelled diagrams, explain various stages of mitosis cell division.

Ans. 1. Prophase: (i) Replicated chromosomes, each consisting of 2 chromatids,
condense and become visible.

(i) Microtubules are assembled into mitotic spindle.

(iii) Nucleolus and nuclear envelope disappear.

(ii) Centriole moves to opposite poles.

2. Metaphase: (i) Spindle fibres attached to kinetochores (small disc-shaped
structures at the surface of centromere) of chromosomes.

(ii) Chromosomes line up at the equator of the spindle to form metaphase plate.

3. Anaphase: (i) Centromeres split and chromatids separate.

(ii) Chromatids move to opposite poles due to shortening of spindal fibres.

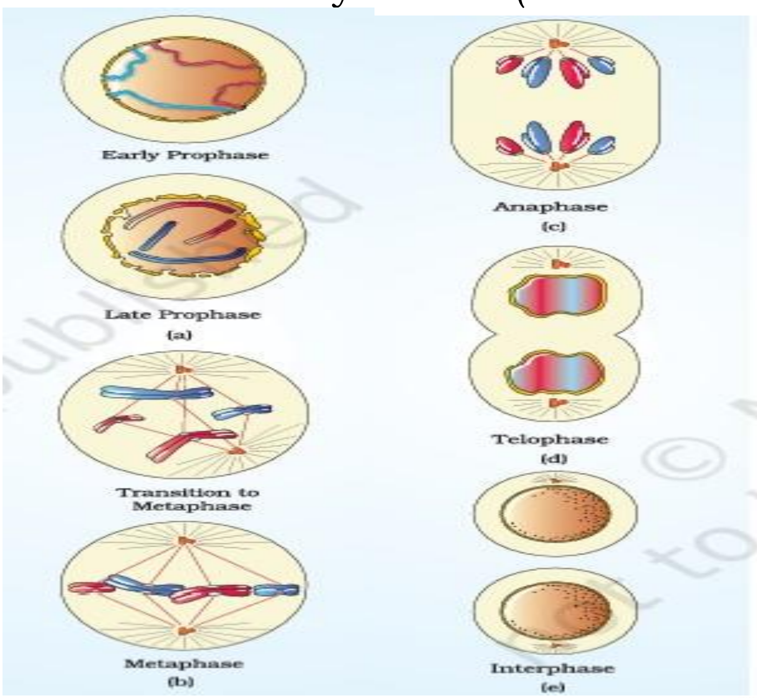
4. Telophase:

(i) Chromosomes cluster at opposite poles.

(ii) Nuclear envelope assembles around chromosomes clusters.

(iii) Nucleolus, Golgi Complex, E.R. reforms.

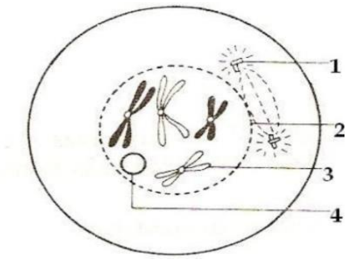
(iv) Cytokinesis: Is the division of protoplast of a cell into two daughter cells after karyokinesis (nuclear division)



2. Examine the figure and answer the questions:

i) Identify the stage.

ii) Label the 1,2,3 & 4 in the diagram.



iii) What is the importance of '1'
iv) What will happen after this phase?

Ans. i. Prophase of mitosis
ii. 1. Centriole
2.Disintegrating nuclear envelope
3.Chromosome.
4. disappearing Nucleolus
iii. Helps in formation of spindle fibres
iv. Metaphase

UNIT IV

Plant Physiology

Chapter 13
Photosynthesis in Higher Plants
Chapter 14
Respiration in Plants
Chapter 15
Plant - Growth and Development

CHAPTER 13: PHOTOSYNTHESIS IN HIGHER PLANTS

1. Introduction
Photosynthesis Basics: Green plants synthesize their own food using sunlight. This process is known as photosynthesis.
Importance: Photosynthesis is essential as it is the primary source of all food on Earth and responsible for the release of oxygen into the atmosphere.
2. What Do We Know About Photosynthesis?
Essential Components: Chlorophyll (green pigment), light, and carbon dioxide (CO_2) are necessary for photosynthesis.
Experiments: Simple experiments with variegated leaves or leaves covered with black paper demonstrate that photosynthesis occurs only in the green parts of the leaves in the presence of light.
3. Early Experiments
- Joseph Priestley: Discovered that plants restore the air damaged by burning candles or breathing animals by placing a mint plant in a closed jar with a candle and a mouse.
- Jan Ingenhousz: Showed that sunlight is essential for this air purification process by observing oxygen bubbles forming around aquatic plants in sunlight.
- Julius von Sachs: Provided evidence that glucose is produced in green parts of plants, specifically in chloroplasts.

- T.W. Engelmann: Demonstrated that blue and red light are most effective for photosynthesis using a prism and green alga Cladophora.

4. Where Does Photosynthesis Take Place?
   - Location: Photosynthesis primarily occurs in the green leaves, specifically in the chloroplasts within the mesophyll cells.
   - Chloroplast Structure: Chloroplasts contain a membranous system of grana, stroma lamellae, and stroma, where the light reactions and Calvin cycle occur.

5. **How Many Pigments Are Involved in Photosynthesis? **
   - Main Pigments:
      - Chlorophyll a: Bright or blue-green pigment.
      - Chlorophyll b: Yellow-green pigment - Xanthophylls: Yellow pigments.
      - Carotenoids: Yellow to orange pigments.
   - Role of Pigments: These pigments absorb light at different wavelengths and transfer energy to chlorophyll a, which is the main pigment responsible for photosynthesis.

Absorption Spectrum and Action Spectrum:

Absorption Spectrum

The absorption spectrum of chlorophyll pigments shows the wavelengths of light absorbed by different pigments involved in photosynthesis. The primary pigments are chlorophyll a, chlorophyll b, carotenoids, and xanthophylls.

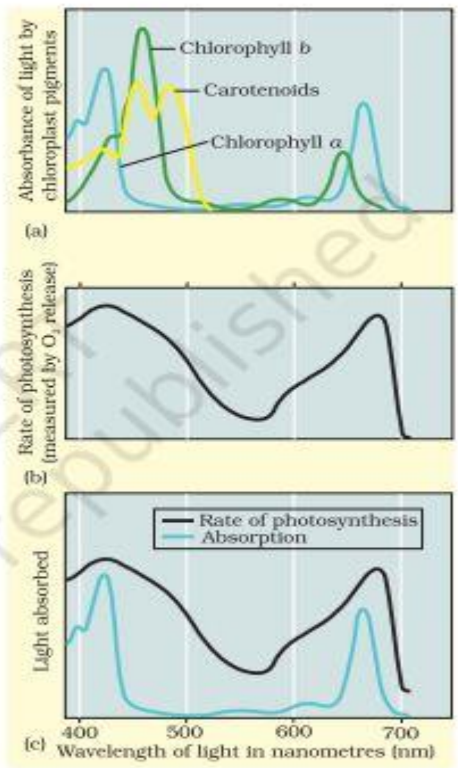


Figure 11.3a Graph showing the absorption spectrum of chlorophyll *a*, *b* and the carotenoids
Figure 11.3b Graph showing action spectrum of photosynthesis
Figure 11.3c Graph showing action spectrum of photosynthesis superimposed on absorption spectrum of chlorophyll *a*

Key Points:
- Chlorophyll a absorbs light mainly in the blue-violet and red regions of the spectrum.
- Chlorophyll b absorbs light in the blue and red-orange regions.
- Carotenoids absorb light in the blue and blue-green regions.
- Xanthophylls absorb light in the blue region.

Explanation:
- The peaks indicate the wavelengths where each pigment has maximum absorption.
- Chlorophyll a shows peaks at around 430 nm and 662 nm.
- Chlorophyll b shows peaks at around 453 nm and 642 nm.
- Carotenoids have peaks between 400-500 nm.

Action Spectrum

The action spectrum of photosynthesis shows the overall rate of photosynthesis at different wavelengths of light. It indicates which wavelengths are most effective for the photosynthetic process.
Key Points:
- The action spectrum closely follows the absorption spectrum of chlorophyll pigments but also includes contributions from other pigments and processes.
- Photosynthesis is most efficient at wavelengths where chlorophyll a and b absorb light the most.
Explanation:
- The action spectrum shows the rate of photosynthesis measured by the production of oxygen or the uptake of CO_2.
- Peaks in the action spectrum correspond to the absorption peaks of chlorophyll a and b.
- The highest rates of photosynthesis are observed in the blue (around 450 nm) and red (around 680 nm) regions.
Combined Graph of Absorption and Action Spectrum: **
Explanation:
- The combined graph shows how the absorption of light by chlorophyll pigments correlates with the effectiveness of photosynthesis at different wavelengths.
- The similarity between the action spectrum and absorption spectrum of chlorophyll a indicates that it is the primary pigment driving photosynthesis.
- Accessory pigments like chlorophyll b and carotenoids expand the range of light that can be used for photosynthesis, contributing to the overall efficiency.

6. What is Light Reaction?

- Process: Light reactions involve light absorption, water splitting, oxygen release, and formation of ATP and NADPH.
- Photosystems: Photosystems I (PS I) and II (PS II) are involved in light reactions. PS I has a reaction centre that absorbs light at 700 nm (P700), and PS II absorbs light at 680 nm (P680).
- Electron Transport: Electrons are excited and transported through these photosystems, creating a proton gradient that generates ATP and NADPH.

7. Splitting of Water: Water is split into oxygen, protons, and electrons in the presence of PS II, replenishing the electrons lost by PS II and releasing oxygen as a by-product.

8. Cyclic and Non-cyclic Photophosphorylation

Photophosphorylation is the process of converting light energy into chemical energy in the form of ATP during photosynthesis. It occurs in the thylakoid membranes of chloroplasts and involves the flow of electrons through photosystems. There are two types of photophosphorylation: cyclic and non-cyclic.

Non-Cyclic Photophosphorylation

Non-cyclic photophosphorylation, also known as the Z-scheme, involves both Photosystem I (PS I) and Photosystem II (PS II). It results in the production of both ATP and NADPH and the release of oxygen as a byproduct.

1. **Photosystem II (PS II)**:
   - **Activation**: Light energy is absorbed by the chlorophyll molecules in PS II (P680), exciting electrons to a higher energy level.
   - **Electron Transport**: The excited electrons are transferred to the primary electron acceptor and then passed through an electron transport chain (ETC) to Photosystem I.
2. **Photolysis of Water**: The lost electrons in PS II are replaced by electrons obtained from the splitting of water molecules (photolysis), releasing oxygen and protons (H^+).

$$2H_2O \longrightarrow 4H^+ + O_2 + 4e^-$$

3. **Electron Transport Chain (ETC)**:
   - **Flow of Electrons**: Electrons move from PS II to PS I through a series of electron carriers, including plastoquinone (PQ), the cytochrome b6f complex, and plastocyanin (PC).
   - **Proton Gradient**: The movement of electrons through the ETC pumps protons from the stroma into the thylakoid lumen, creating a proton gradient across the thylakoid membrane.
4. **Photosystem I (PS I)**:
   - **Activation**: Light energy is absorbed by the chlorophyll molecules in PS I (P700), exciting electrons to a higher energy level.
   - **$NADP^+$ Reduction**: The excited electrons are transferred to the primary electron acceptor of PS I and then to $NADP^+$, reducing it to NADPH.
     NADP++2e−+2H+→NADPH+H+NADP^+ + 2e^- + 2H^+ \right arrow NADPH + H^+NADP++2e−+2H+→NADPH+H+
5. **ATP Synthesis**:
   - **Chemiosmosis**: The proton gradient created by the ETC drives protons back into the stroma through ATP synthase, synthesizing ATP from ADP and inorganic phosphate (Pi).

Summary of Non-Cyclic Photophosphorylation:

- Involves both PS II and PS I.
- Produces ATP and NADPH.
- Releases oxygen as a byproduct.
- Electrons flow in a linear path from water to $NADP^+$.

Cyclic Photophosphorylation

Cyclic photophosphorylation involves only Photosystem I (PS I) and results in the production of ATP but not NADPH or oxygen. It occurs when the demand for ATP is higher than that for NADPH.

1. **Photosystem I (PS I)**:
   - **Activation**: Light energy is absorbed by the chlorophyll molecules in PS I (P700), exciting electrons to a higher energy level.
   - **Electron Transport**: The excited electrons are transferred to the primary electron acceptor and then back to the cytochrome b6f complex through an electron transport chain (ETC).
2. **Electron Transport Chain (ETC)**:
   - **Flow of Electrons**: Electrons move from the primary electron acceptor of PS I to ferredoxin (Fd), then to the cytochrome b6f complex, plastoquinone (PQ), and plastocyanin (PC), and finally return to PS I.
   - **Proton Gradient**: The movement of electrons through the ETC pumps protons from the stroma into the thylakoid lumen, creating a proton gradient across the thylakoid membrane.
3. **ATP Synthesis**:
   - **Chemiosmosis**: The proton gradient drives protons back into the stroma through ATP synthase, synthesizing ATP from ADP and inorganic phosphate (Pi).

Summary of Cyclic Photophosphorylation:

- Involves only PS I.
- Produces ATP only.
- Does not produce NADPH or release oxygen.
- Electrons cycle back to PS I.

Comparison Between Cyclic and Non-Cyclic Photophosphorylation

Feature	Non-Cyclic Photophosphorylation	Cyclic Photophosphorylation
Photosystems Involved	PS II and PS I	PS I
Electron Source	Water (H_2O)	PS I
Final Electron Acceptor	$NADP^+$ (forming NADPH)	PS I (electrons cycle back)
ATP Production	Yes	Yes
NADPH Production	Yes	No
Oxygen Release	Yes	No
Pathway	Linear (Z-scheme)	Cyclic
Occurrence	Common under normal light conditions	Common under conditions of high ATP demand and low NADPH demand

Diagram of Cyclic and Non-Cyclic Photophosphorylation

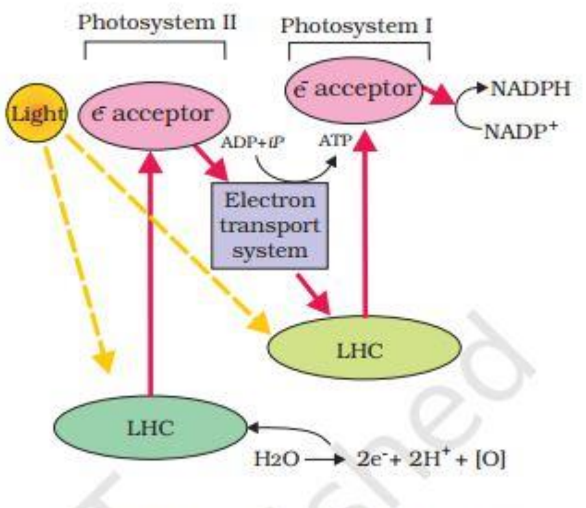


Figure 11.5 Z scheme of light reaction

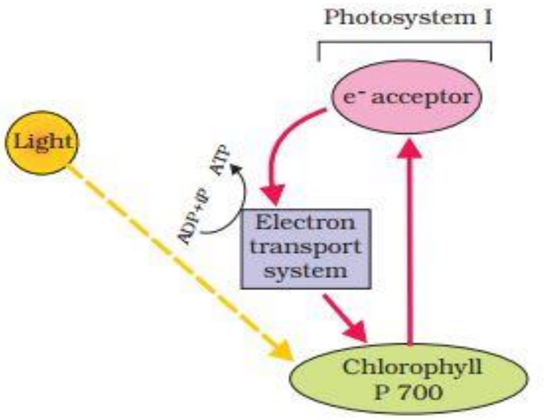


Figure 11.6 Cyclic photophosphorylation

9. Chemiosmotic Hypothesis

The chemiosmotic hypothesis, proposed by Peter Mitchell in 1961, explains how ATP is synthesized in the chloroplasts during photosynthesis and in mitochondria during cellular respiration. It involves the generation of a proton gradient across a membrane and the use of this gradient to drive ATP synthesis.

Key Components
1. Membrane
   - Thylakoid membrane in chloroplasts.
   - Inner mitochondrial membrane in mitochondria.
2. Proton Pump
   - Enzyme complexes (such as the electron transport chain) that move protons (H^+) across the membrane.
3. Proton Gradient
   - A difference in proton concentration across the membrane, creating a potential energy difference.
4. ATP Synthase
   - An enzyme complex that uses the energy stored in the proton gradient to synthesize ATP from ADP and inorganic phosphate (Pi).

Process Overview
1. **Electron Transport Chain (ETC)**
   - Electrons are transferred through a series of protein complexes in the membrane.
   - In chloroplasts, light energy excites electrons in Photosystems I and II, which are then passed along the ETC.
   - In mitochondria, electrons from NADH and $FADH_2$ are passed through the ETC.
2. Proton Pumping
   - As electrons move through the ETC, energy released is used to pump protons from the stroma into the thylakoid lumen (chloroplasts) or from the mitochondrial matrix into the intermembrane space (mitochondria).
   - This creates a high concentration of protons inside the thylakoid lumen or intermembrane space, establishing a proton gradient.
3. Formation of Proton Gradient
   - The accumulation of protons inside the thylakoid lumen or intermembrane space creates a difference in pH and electrical charge across the membrane.
   - This gradient represents stored potential energy.
4. ATP Synthase Activation
   - Protons flow back across the membrane through ATP synthase due to the proton gradient (chemiosmosis).

- The flow of protons through ATP synthase provides the energy needed to convert ADP and Pi into ATP.

5. ATP Production

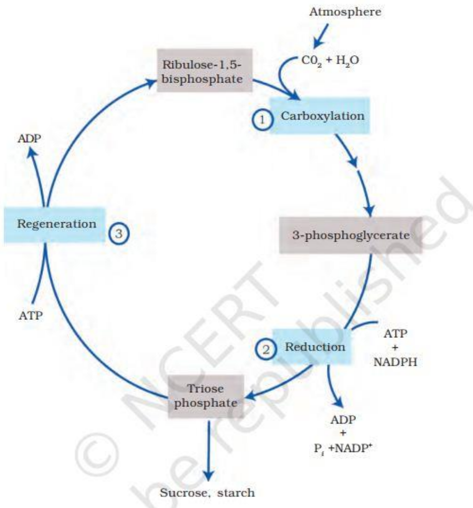
- The energy from the proton gradient is harnessed by ATP synthase to produce ATP, which is then used for various cellular processes, including the Calvin cycle in photosynthesis and cellular activities in respiration.

Where are the ATP and NADPH Used?

- Calvin Cycle: ATP and NADPH produced in the light reactions are used in the Calvin cycle for carbon fixation, leading to the synthesis of sugars.

11. The Calvin Cycle

- Stages: The Calvin cycle involves three stages: carboxylation, reduction, and regeneration.
  - Carboxylation: CO_2 is fixed into a stable organic intermediate.
  - Reduction: ATP and NADPH are used to convert the intermediate into glucose.
  - Regeneration: RuBP (Ribulose-1,5-bisphosphate) is regenerated to continue the cycle.



12. C4 Pathway and Kranz Anatomy

The C4 pathway is a photosynthetic process found in certain plants adapted to high light intensity, high temperatures, and dry conditions. It is more efficient than the C3 pathway under these conditions because it minimizes photorespiration.

Key Characteristics:

- **Primary CO_2 Acceptor**: Phosphoenolpyruvate (PEP).
- **First Stable Product**: Oxaloacetic acid (OAA), a 4-carbon compound.
- **Enzyme for CO_2 Fixation**: PEP Carboxylase.
- **CO_2 Concentration Mechanism**: Increases CO_2 concentration around RuBisCO to reduce photorespiration.

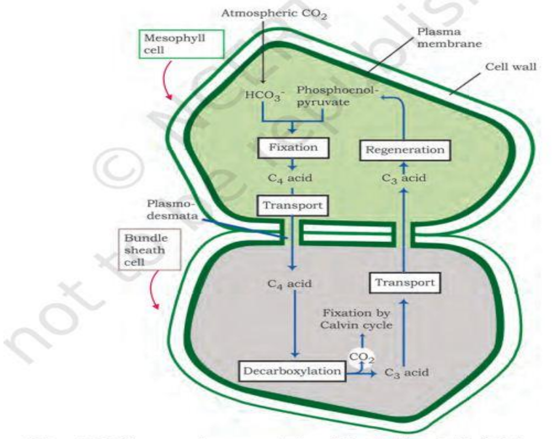


Figure 11.9 Diagrammatic representation of the Hatch and Slack Pathway

Detailed Steps:

1. **Initial CO_2 Fixation in Mesophyll Cells**:
    - CO_2 is captured by PEP to form OAA.
    - OAA is then converted into malate or aspartate (4-carbon compounds).
2. **Transport to Bundle Sheath Cells**:
    - Malate/aspartate is transported from mesophyll cells to bundle sheath cells.
3. **Release of CO_2 in Bundle Sheath Cells**:
    - In bundle sheath cells, malate/aspartate is decarboxylated to release CO_2 and form pyruvate.
    - The released CO_2 is concentrated around RuBisCO, which then enters the Calvin cycle for further processing into sugars.
4. **Regeneration of PEP in Mesophyll Cells**:
    - Pyruvate is transported back to mesophyll cells.
    - ATP is used to regenerate PEP from pyruvate, allowing the cycle to continue.

Advantages of C4 Pathway:

- **High Efficiency**: More efficient under high light, high temperature, and low CO_2 conditions.
- **Reduced Photorespiration**: High CO_2 concentration around RuBisCO minimizes photorespiration.
- **Higher Productivity**: Leads to higher biomass production and growth rates.

Examples of C4 Plants:

- Maize (corn), sugarcane, sorghum, and certain grasses.

Kranz Anatomy

Kranz anatomy is a specialized leaf structure found in C4 plants, characterized by the arrangement of mesophyll and bundle sheath cells.

Key Characteristics:

- **Cell Arrangement**: Bundle sheath cells form a sheath around the vascular bundles, surrounded by mesophyll cells.
- **Chloroplast Distribution**: Bundle sheath cells have large chloroplasts with reduced grana, while mesophyll cells have smaller chloroplasts with well-developed grana.
- **Cell Wall Structure**: Bundle sheath cells have thick walls that are impervious to gases, reducing the leakage of CO_2.

Detailed Structure:

1. **Mesophyll Cells**:
    - Located around the bundle sheath cells.

- Capture atmospheric CO_2 and convert it into a 4-carbon compound (OAA).

2. **Bundle Sheath Cells**:
   - Form a layer around the vascular bundles.
   - Receive 4-carbon compounds from mesophyll cells and release CO_2 for the Calvin cycle.
   - Contain RuBisCO and are the site of the Calvin cycle.
   - Thick walls minimize gas exchange with surrounding cells, maintaining high CO_2 concentration.

Advantages of Kranz Anatomy:

- **CO_2 Concentration Mechanism**: Maintains high CO_2 levels around RuBisCO, enhancing photosynthetic efficiency and reducing photorespiration.
- **Adaptation to Stress**: Efficient under high light intensity, drought, and high temperatures.

Examples of Plants with Kranz Anatomy:

- Maize, sugarcane, sorghum, and other C4 plant,.

Photorespiration

- **Definition**: Photorespiration is a process in plant metabolism where the enzyme RuBisCO oxygenates RuBP, leading to a decrease in photosynthetic output.
- **Enzyme Involved**: The enzyme RuBisCO, which normally fixes CO_2 during photosynthesis, can also react with O_2, leading to photorespiration.
- **Conditions**: Occurs primarily when the concentration of CO_2 is low and O_2 is high, typically under high light intensity and temperature conditions.
- **Pathway**:
  - RuBP reacts with O_2 instead of CO_2, producing one molecule of 3-phosphoglycerate (3-PGA) and one molecule of phosphoglycolate.
  - Phosphoglycolate is converted into glycolate, which is then transported to peroxisomes and mitochondria.
  - In peroxisomes, glycolate is converted to glycine.
  - Glycine is transported to mitochondria, where two glycine molecules are converted to serine, releasing CO_2.
- **Energy Cost**: Photorespiration consumes ATP and releases fixed carbon as CO_2, making it a wasteful process compared to the Calvin cycle.
- **Impact on Photosynthesis**: Reduces the efficiency of photosynthesis by diverting RuBP and energy away from the Calvin cycle.
- **Adaptive Responses**:

- **C4 Plants**: Have a mechanism to increase the concentration of CO_2 around RuBisCO, minimizing photorespiration.
- **CAM Plants**: Open their stomata at night to take in CO_2, reducing the chance of photorespiration during the day.

- **Ecological Significance**: Although photorespiration is often considered wasteful, it may help protect plants from damage under stressful conditions by dissipating excess energy.

Differences Between C3 and C4 Plants

Characteristic	C3 Plants	C4 Plants
Primary CO_2 Acceptor	Ribulose-1,5-bisphosphate (RuBP)	Phosphoenolpyruvate (PEP)
First Stable Product	3-phosphoglycerate (3-PGA)	Oxaloacetic acid (OAA)
Number of Carbon Atoms in First Product	3	4
Photosynthetic Pathway	Calvin Cycle (C3 pathway)	C4 Pathway followed by Calvin Cycle
Enzyme for CO_2 Fixation	RuBP Carboxylase-Oxygenase (RuBisCO)	PEP Carboxylase
Site of CO_2 Fixation	Mesophyll Cells	Mesophyll Cells and Bundle Sheath Cells
Kranz Anatomy	Absent	Present
Photorespiration	High	Negligible
Optimal Temperature	20-25°C	30-40°C
Efficiency of Photosynthesis	Lower	Higher
Examples	Wheat, Rice, Soybean	Maize, Sugarcane, Sorghum

Factors Affecting Photosynthesis

<u>Internal Factors</u>

1. **Chlorophyll Content**
   - The amount of chlorophyll present in the leaves determines the plant's ability to capture light energy.
   - Higher chlorophyll content usually means higher photosynthetic activity.
2. **Leaf Structure**
   - **Surface Area**: Larger leaf surface area can capture more light.

- **Thickness**: Thicker leaves might have more chloroplasts but can also reduce gas exchange efficiency.
- **Stomatal Density**: More stomata can enhance gas exchange but also increase water loss.

3. **Age of the Leaf**
   - Young leaves have more efficient photosynthetic machinery compared to older leaves.
   - Senescent leaves have reduced photosynthetic capacity due to the breakdown of chlorophyll and other components.
4. **Water Content**
   - Adequate water supply maintains cell turgidity, keeping stomata open for gas exchange.
   - Water stress can lead to stomatal closure, reducing CO_2 uptake and thereby photosynthesis.

External Factors

1. **Light**
   - **Light Quality**: Different wavelengths of light affect photosynthesis differently. Blue and red lights are most effective.
   - **Light Intensity**: Higher light intensity increases photosynthesis up to a point (light saturation point), beyond which no further increase in photosynthesis is observed.
   - **Light Duration**: Longer light exposure can enhance overall photosynthetic productivity, but excessive light can damage chlorophyll (photo-inhibition).
2. **Carbon Dioxide Concentration**
   - Increasing CO_2 concentration generally enhances the rate of photosynthesis up to a certain level.
   - C3 plants are more responsive to elevated CO_2 levels compared to C4 plants.
3. **Temperature**
   - Each plant species has an optimal temperature range for photosynthesis.
   - **Low Temperatures**: Slow down enzyme activities, reducing the photosynthetic rate.
   - **High Temperatures**: Can cause enzyme denaturation and increase photorespiration, reducing efficiency.
4. **Water Availability**
   - Essential for the photosynthetic process as it provides electrons through the splitting of water molecules.
   - Water stress leads to stomatal closure, limiting CO_2 uptake and reducing photosynthesis.
5. **Mineral Nutrients**
   - **Nitrogen**: Crucial for chlorophyll production and the synthesis of amino acids and proteins.

- **Magnesium**: Central atom in the chlorophyll molecule.
- **Phosphorus**: Important for ATP formation, which is used in the Calvin cycle.
- Deficiency in these nutrients can limit the photosynthetic capacity.

6. **Oxygen Concentration**
   - High oxygen levels can increase photorespiration, which competes with photosynthesis and reduces its efficiency.
7. **Environmental Stress**
   - **Pollutants**: Can damage leaf structures and impair photosynthetic machinery.
   - **Salinity**: High salt concentrations can lead to osmotic stress and ion toxicity, affecting photosynthesis.

QUESTION BANK

Long-Answer Type Questions

1. Explain the process of photosynthesis in higher plants in detail.
2. Describe the light-dependent reactions and the role of photosystems in photosynthesis.
3. Discuss the Calvin cycle and its three main stages.
4. Compare and contrast the C3 and C4 pathways of photosynthesis.
5. Describe the process and significance of photorespiration in plants.
6. Explain the chemiosmotic hypothesis and its importance in ATP synthesis.
7. Describe the Kranz anatomy and its role in C4 photosynthesis.
8. Discuss the factors affecting the rate of photosynthesis in higher plants.
9. Explain the importance of chlorophyll and other pigments in the process of photosynthesis.
10. Describe how the absorption and action spectra are related to photosynthesis.
11. Discuss the role of ATP and NADPH in the Calvin cycle.
12. Explain how light intensity, CO_2 concentration, and temperature affect photosynthesis.
13. Describe the water-splitting reaction and its significance in the light reactions.
14. Explain the process of cyclic and non-cyclic photophosphorylation.
15. Discuss the adaptations of C4 plants to high light intensity and temperature.

Short-Answer Type Questions

1. What are the two main stages of photosynthesis?
2. What is the role of chlorophyll in photosynthesis?
3. Where do the light-dependent reactions take place in the chloroplast?
4. What is the primary function of Photosystem II?
5. What are the end products of the light-dependent reactions?

6. What molecule is the primary CO_2 acceptor in the Calvin cycle?
7. What enzyme is responsible for fixing CO_2 in the Calvin cycle?
8. What are the three stages of the Calvin cycle?
9. How is oxygen produced in the light reactions?
10. What is the significance of the proton gradient in the thylakoid membrane?
11. What is photorespiration and why is it considered wasteful?
12. How do C4 plants minimize photorespiration?
13. What are the main pigments involved in photosynthesis?
14. What is the function of ATP synthase in the light reactions?
15. How does temperature affect the rate of photosynthesis?

Very Short Answer Type Questions

1. Define photosynthesis.
2. What is the primary pigment involved in photosynthesis?
3. What is the initial electron donor in the light reactions?
4. What is the main product of the Calvin cycle?
5. Where does the Calvin cycle take place?
6. What is the role of $NADP^+$ in photosynthesis?
7. What is the importance of water in photosynthesis?
8. Define the term "photophosphorylation."
9. What is the role of RuBisCO?
10. What does the term "carbon fixation" refer to?
11. Name one C3 plant.
12. Name one C4 plant.
13. What is the main difference between cyclic and non-cyclic photophosphorylation?
14. What is the significance of the stomata in photosynthesis?
15. Define Kranz anatomy.

Multiple Choice Questions

1. Which of the following is the primary pigment involved in photosynthesis?
   a) Chlorophyll a
   b) Chlorophyll b
   c) Carotenoids
   d) Xanthophylls
2. Where do the light-dependent reactions of photosynthesis take place?
   a) Stroma
   b) Thylakoid membrane
   c) Cytoplasm
   d) Mitochondria
3. Which enzyme is responsible for CO_2 fixation in the Calvin cycle?
   a) ATP synthase
   b) PEP carboxylase
   c) RuBisCO

d) NADP reductase

4. What is the main product of the Calvin cycle?
   a) Glucose
   b) Oxygen
   c) ATP
   d) NADPH
5. What is the first stable product of the C4 pathway?
   a) 3-phosphoglycerate
   b) Oxaloacetic acid
   c) Pyruvate
   d) Malate
6. What is the role of water in the light reactions of photosynthesis?
   a) Electron donor
   b) Proton acceptor
   c) ATP producer
   d) Glucose producer
7. Which of the following processes occurs in the stroma?
   a) Light-dependent reactions
   b) Calvin cycle
   c) Glycolysis
   d) Electron transport chain
8. What is the primary function of Photosystem I?
   a) Split water
   b) Produce ATP
   c) Reduce $NADP^+$ to NADPH
   d) Release oxygen
9. What is the function of ATP synthase?
   a) Split water
   b) Synthesize ATP
   c) Fix carbon dioxide
   d) Absorb light
10. Which pigment absorbs light in the blue-violet and red regions of the spectrum?
    a) Chlorophyll a
    b) Chlorophyll b
    c) Carotenoids
    d) Xanthophylls
11. What is the primary acceptor of CO_2 in the C4 pathway?
    a) RuBP
    b) PEP
    c) PGA
    d) NADPH
12. What is the final electron acceptor in the light reactions?
    a) Water
    b) $NADP^+$

c) Oxygen
d) CO_2

13. What does the term "photorespiration" refer to?
a) CO_2 fixation
b) O_2 consumption and CO_2 release
c) ATP synthesis
d) NADPH production

14. Which structure within the chloroplast is responsible for the light reactions?
a) Stroma
b) Thylakoid membrane
c) Outer membrane
d) Inner membrane

15. What is the function of the Calvin cycle?
a) Produce ATP and NADPH
b) Fix carbon dioxide into organic molecules
c) Split water molecules
d) Release oxygen

Competency-Based Questions

1. Design an experiment to demonstrate the necessity of light for photosynthesis.
2. Explain how you would measure the rate of photosynthesis in aquatic plants using an experimental setup.
3. Describe how you would investigate the effect of different wavelengths of light on the rate of photosynthesis.
4. Propose a method to determine the optimal CO_2 concentration for photosynthesis in a controlled environment.
5. Discuss how you would use chromatography to separate and identify the different pigments involved in photosynthesis.

Case-Study Based Questions

1. A farmer notices that his C4 plants are growing better than his C3 plants in high-temperature conditions. Explain the physiological reasons behind this observation.
2. A greenhouse is set up with adjustable light, temperature, and CO_2 levels. Design a study to determine the optimal conditions for maximizing photosynthesis in tomato plants.
3. During a prolonged drought, a research team observes that certain plants maintain higher photosynthetic rates than others. Explain the possible adaptations these plants might have.
4. A scientist wants to compare the photosynthetic efficiency of wild-type plants with genetically modified plants that have increased levels of chlorophyll. Describe how this comparison could be made.
5. In a polluted environment with high levels of atmospheric pollutants, some plants show reduced photosynthetic activity. Discuss the

potential impacts of pollutants on the photosynthetic machinery and overall plant health.

ANSWER SCHEME/HINTS

Long-Answer Type Questions - Answers

1. **Explain the process of photosynthesis in higher plants in detail.**
 - Photosynthesis in higher plants occurs in chloroplasts and involves two main stages: light-dependent reactions and the Calvin cycle. Light-dependent reactions convert light energy into chemical energy (ATP and NADPH) and release oxygen by splitting water. The Calvin cycle, occurring in the stroma, uses ATP and NADPH to fix CO_2 into glucose.

2. **Describe the light-dependent reactions and the role of photosystems in photosynthesis.**
 - Light-dependent reactions take place in the thylakoid membranes and involve two photosystems, PS II and PS I. Light energy excites electrons in PS II, which are transferred through the electron transport chain, generating ATP. Water is split to replace lost electrons, releasing oxygen. In PS I, electrons are re-excited by light and reduce $NADP^+$ to NADPH.

3. **Discuss the Calvin cycle and its three main stages.**
 - The Calvin cycle has three stages: carboxylation, reduction, and regeneration. In carboxylation, CO_2 is fixed to RuBP by RuBisCO, forming 3-PGA. During reduction, ATP and NADPH convert 3-PGA to G3P, a sugar precursor. Regeneration uses ATP to convert G3P back to RuBP, allowing the cycle to continue.

4. **Compare and contrast the C3 and C4 pathways of photosynthesis.**
 - C3 plants fix CO_2 directly into a 3-carbon compound (3-PGA) via the Calvin cycle, while C4 plants fix CO_2 into a 4-carbon compound (OAA) using PEP carboxylase. C4 plants have Kranz anatomy, minimizing photorespiration and enhancing efficiency in high light and temperature conditions.

5. **Describe the process and significance of photorespiration in plants.**
 - Photorespiration occurs when RuBisCO fixes O_2 instead of CO_2, producing 3-PGA and phosphoglycolate. It consumes ATP and releases CO_2, reducing photosynthetic efficiency. It occurs in C3 plants under high oxygen and low CO_2 conditions.

6. **Explain the chemiosmotic hypothesis and its importance in ATP synthesis.**
 - The chemiosmotic hypothesis, proposed by Peter Mitchell, explains ATP synthesis via a proton gradient across a membrane. In chloroplasts, light energy drives electron transport, pumping protons into the thylakoid lumen. Protons flow back through ATP synthase, generating ATP.

7. **Describe the Kranz anatomy and its role in C4 photosynthesis.**
- Kranz anatomy in C4 plants features bundle sheath cells surrounding vascular bundles, with mesophyll cells outside. CO_2 is initially fixed in mesophyll cells and transported as a 4-carbon compound to bundle sheath cells, where CO_2 is released for the Calvin cycle, minimizing photorespiration.
8. **Discuss the factors affecting the rate of photosynthesis in higher plants.**
- Factors include light intensity, quality, and duration, CO_2 concentration, temperature, water availability, and nutrient status. Optimal conditions for these factors enhance photosynthetic efficiency and plant growth.
9. **Explain the importance of chlorophyll and other pigments in the process of photosynthesis.**
- Chlorophyll a is the primary pigment, absorbing light energy for photosynthesis. Chlorophyll b, carotenoids, and xanthophylls are accessory pigments, broadening the range of light absorption and protecting the plant from photodamage.
10. **Describe how the absorption and action spectra are related to photosynthesis.**
- The absorption spectrum shows the wavelengths of light absorbed by photosynthetic pigments, while the action spectrum indicates the effectiveness
of different wavelengths in driving photosynthesis. Peaks in the action spectrum align with absorption peaks of chlorophylls.
11. **Discuss the role of ATP and NADPH in the Calvin cycle.**
- ATP provides energy, and NADPH provides reducing power for the conversion of 3-PGA to G3P in the Calvin cycle. These molecules are produced in the light-dependent reactions and used in the Calvin cycle to synthesize glucose.
12. **Explain how light intensity, CO_2 concentration, and temperature affect photosynthesis.**
- Photosynthesis increases with light intensity up to a saturation point, is enhanced by higher CO_2 concentration, and has an optimal temperature range. Extreme temperatures can denature enzymes and reduce efficiency.
13. **Describe the water-splitting reaction and its significance in the light reactions.**
- Water splitting in PS II provides electrons to replace those lost by chlorophyll, produces protons for the proton gradient, and releases oxygen as a by-product. This reaction is essential for sustaining the light-dependent reactions.
14. **Explain the process of cyclic and non-cyclic photophosphorylation.**

- Non-cyclic photophosphorylation involves both PS II and PS I, producing ATP and NADPH. Cyclic photophosphorylation involves only PS I, producing ATP but not NADPH. It helps balance the ATP/NADPH ratio.

15. **Discuss the adaptations of C4 plants to high light intensity and temperature.**
   - C4 plants have Kranz anatomy and PEP carboxylase for initial CO_2 fixation, minimizing photorespiration and increasing efficiency. They thrive in high light and temperature conditions, maintaining high photosynthetic rates and productivity.

Short-Answer Type Questions - Answers

1. **What are the two main stages of photosynthesis?**
   - Light-dependent reactions and the Calvin cycle.
2. **What is the role of chlorophyll in photosynthesis?**
   - Chlorophyll absorbs light energy, which is used to drive the light-dependent reactions.
3. **Where do the light-dependent reactions take place in the chloroplast?**
   - In the thylakoid membranes.
4. **What is the primary function of Photosystem II?**
   - To absorb light energy and use it to split water molecules, releasing oxygen and providing electrons for the electron transport chain.
5. **What are the end products of the light-dependent reactions?**
   - ATP, NADPH, and oxygen.
6. **What molecule is the primary CO_2 acceptor in the Calvin cycle?**
   - Ribulose-1,5-bisphosphate (RuBP).
7. **What enzyme is responsible for fixing CO_2 in the Calvin cycle?**
   - RuBisCO (Ribulose-1,5-bisphosphate carboxylase/oxygenase).
8. **What are the three stages of the Calvin cycle?**
   - Carboxylation, reduction, and regeneration.
9. **How is oxygen produced in the light reactions?**
   - Through the splitting of water molecules by Photosystem II.
10. **What is the significance of the proton gradient in the thylakoid membrane?**
    - It drives the synthesis of ATP via ATP synthase.
11. **What is photorespiration and why is it considered wasteful?**
    - Photorespiration occurs when RuBisCO fixes O_2 instead of CO_2, consuming ATP and releasing CO_2, reducing photosynthetic efficiency.
12. **How do C4 plants minimize photorespiration?**
    - By using PEP carboxylase for initial CO_2 fixation and concentrating CO_2 around RuBisCO in bundle sheath cells.
13. **What are the main pigments involved in photosynthesis?**
    - Chlorophyll a, chlorophyll b, carotenoids, and xanthophylls.
14. **What is the function of ATP synthase in the light reactions?**

- To produce ATP from ADP and inorganic phosphate using the energy from the proton gradient.

5. **How does temperature affect the rate of photosynthesis?**
   - Temperature influences enzyme activity; optimal temperatures enhance photosynthesis, while extreme temperatures reduce it.

Very Short Answer Type Questions - Answers

1. **Define photosynthesis.**
   - The process by which green plants use sunlight to synthesize food from CO_2 and water.
2. **What is the primary pigment involved in photosynthesis?**
   - Chlorophyll a.
3. **What is the initial electron donor in the light reactions?**
   - Water (H_2O).
4. **What is the main product of the Calvin cycle?**
   - Glucose (or G3P as an intermediate).
5. **Where does the Calvin cycle take place?**
   - In the stroma of the chloroplast.
6. **What is the role of $NADP^+$ in photosynthesis?**
   - To accept electrons and form NADPH, which is used in the Calvin cycle.
7. **What is the importance of water in photosynthesis?**
   - It provides electrons for the light reactions and releases oxygen.
8. **Define the term "photophosphorylation."**
   - The process of ATP formation in the light-dependent reactions using light energy.
9. **What is the role of RuBisCO?**
   - To fix CO_2 to RuBP in the Calvin cycle.
10. **What does the term "carbon fixation" refer to?**
    - The process of converting inorganic CO_2 into organic compounds during photosynthesis.
11. **Name one C3 plant.**
    - Wheat.
12. **Name one C4 plant.**
    - Maize (corn).
13. **What is the main difference between cyclic and non-cyclic photophosphorylation?**
    - Cyclic produces only ATP, while non-cyclic produces both ATP and NADPH.
14. **What is the significance of the stomata in photosynthesis?**
    - Stomata allow gas exchange, letting CO_2 in and O_2 out.
15. **Define Kranz anatomy.**
    - A leaf anatomy in C4 plants where bundle sheath cells surround the vascular bundles, minimizing photorespiration.

Multiple Choice Questions - Answers

1. **Which of the following is the primary pigment involved in photosynthesis?**
   - a) Chlorophyll a
2. **Where do the light-dependent reactions of photosynthesis take place?**
   - b) Thylakoid membrane
3. **Which enzyme is responsible for CO_2 fixation in the Calvin cycle?**
   - c) RuBisCO
4. **What is the main product of the Calvin cycle?**
   - a) Glucose
5. **What is the first stable product of the C4 pathway?**
   - b) Oxaloacetic acid
6. **What is the role of water in the light reactions of photosynthesis?**
   - a) Electron donor
7. **Which of the following processes occurs in the stroma?**
   - b) Calvin cycle
8. **What is the primary function of Photosystem I?**
   - c) Reduce $NADP^+$ to NADPH
9. **What is the function of ATP synthase?**
   - b) Synthesize ATP
10. **Which pigment absorbs light in the blue-violet and red regions of the spectrum?**
    - a) Chlorophyll a
11. **What is the primary acceptor of CO_2 in the C4 pathway?**
    - b) PEP
12. **What is the final electron acceptor in the light reactions?**
    - b) $NADP^+$
13. **What does the term "photorespiration" refer to?**
    - b) O_2 consumption and CO_2 release
14. **Which structure within the chloroplast is responsible for the light reactions?**
    - b) Thylakoid membrane
15. **What is the function of the Calvin cycle?**
    - b) Fix carbon dioxide into organic molecules

Competency-Based Questions - Answers

1. **Design an experiment to demonstrate the necessity of light for photosynthesis.**
   - Set up two identical plants in a controlled environment. Place one plant in the dark and the other in light. Measure oxygen production or starch formation in both plants. The plant in light will show evidence of photosynthesis (e.g., oxygen bubbles in aquatic plants, starch presence in leaves using iodine test).

2. **Explain how you would measure the rate of photosynthesis in aquatic plants using an experimental setup.**

- Place aquatic plants (e.g., Elodea) in water containing sodium bicarbonate (source of CO_2). Use a light source and count oxygen bubbles produced over time or use a dissolved oxygen meter to measure changes in oxygen concentration in the water.

3. **Describe how you would investigate the effect of different wavelengths of light on the rate of photosynthesis.**

- Use coloured filters to provide light of different wavelengths to identical plants. Measure the rate of photosynthesis by oxygen production, CO_2 uptake, or change in biomass over a fixed period. Compare results across different wavelengths.

4. **Propose a method to determine the optimal CO_2 concentration for photosynthesis in a controlled environment.**

- Grow plants in sealed chambers with varying CO_2 concentrations. Measure photosynthetic rate using oxygen production or CO_2 uptake. Identify the concentration at which photosynthesis is maximized without adverse effects.

5. **Discuss how you would use chromatography to separate and identify the different pigments involved in photosynthesis.**

- Extract pigments from plant leaves using a solvent (e.g., acetone). Apply the extract to a chromatography paper strip and place it in a solvent. Allow the solvent to carry the pigments up the paper. Identify separated pigments based on their colours and Rf values (distance travelled by pigment/distance travelled by solvent).

Case-Study Based Questions - Answers

1. **A farmer notices that his C4 plants are growing better than his C3 plants in high-temperature conditions. Explain the physiological reasons behind this observation.**

- C4 plants have a specialized mechanism (Kranz anatomy) that concentrates CO_2 around RuBisCO, reducing photorespiration and increasing efficiency in high temperatures. They also use PEP carboxylase, which has a higher affinity for CO_2 and works efficiently at high temperatures.

2. **A greenhouse is set up with adjustable light, temperature, and CO_2 levels. Design a study to determine the optimal conditions for maximizing photosynthesis in tomato plants.**

- Conduct a factorial experiment varying light intensity, temperature, and CO_2 concentration. Measure photosynthetic rate using gas exchange analysis (CO_2 uptake and O_2 production) and monitor plant growth and yield. Analyze data to determine the combination of factors that maximize photosynthesis and plant productivity.

3. **During a prolonged drought, a research team observes that certain plants maintain higher photosynthetic rates than others. Explain the possible adaptations these plants might have.**

- These plants might have adaptations such as deep root systems, CAM photosynthesis (stomata open at night), waxy leaf coatings to reduce water loss, efficient water use, and the ability to maintain turgor pressure under low water conditions.

4. **A scientist wants to compare the photosynthetic efficiency of wild-type plants with genetically modified plants that have increased levels of chlorophyll. Describe how this comparison could be made. **

- Measure chlorophyll content, gas exchange rates (CO_2 uptake and O_2 release), and growth parameters (biomass accumulation) under identical conditions. Use chlorophyll fluorescence analysis to assess photosystem efficiency. Compare photosynthetic rates and overall plant performance between wild-type and genetically modified plants.

5. **In a polluted environment with high levels of atmospheric pollutants, some plants show reduced photosynthetic activity. Discuss the potential impacts of pollutants on the photosynthetic machinery and overall plant health.**

- Pollutants can damage chlorophyll and other pigments, interfere with light absorption, disrupt electron transport chains, and reduce enzyme activity in the Calvin cycle. This leads to lower photosynthetic rates, stunted growth, and increased susceptibility to diseases and environmental stressors.

Sure! Here are some multimedia resources related to photosynthesis, which can help enhance understanding through visual and auditory learning.

CHAPTER 14: RESPIRATION IN PLANTS

Do Plants Breathe?

- Plants, like all living organisms, require energy for various life processes, such as absorption, transport, movement, and reproduction.
- This energy is derived from the oxidation of macromolecules, commonly referred to as 'food'.

- Respiration in Plants:

- Plants do not have specialized organs for gas exchange like animals. Instead, they use structures such as stomata (found in leaves) and lenticels (found in stems and roots).
- Each part of the plant manages its own gas exchange, and the demand for gases is generally lower than in animals.
- Oxygen is used in respiration, and carbon dioxide is released.

- Photosynthesis vs. Respiration:
  - Photosynthesis occurs in chloroplasts, converting light energy into chemical energy stored in carbohydrates.
  - Respiration occurs in the cytoplasm and mitochondria, breaking down carbohydrates to release energy.

- Not all plant cells photosynthesize; thus, food must be transported to non-photosynthetic cells.

Glycolysis

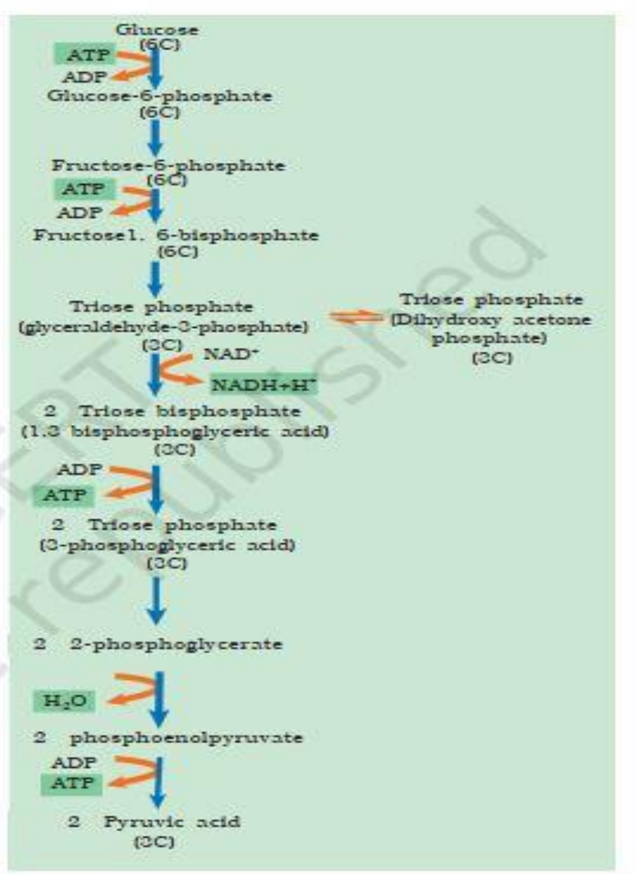


Figure 14.1 Steps of glycolysis

- Definition and Location:
  - Glycolysis is the first step in cellular respiration where glucose is partially oxidized to form pyruvic acid.
  - It occurs in the cytoplasm and is common to both aerobic and anaerobic respiration.

- Process:
  - Glucose (6-carbon molecule) is converted into two molecules of pyruvic acid (3-carbon molecule).
  - Glycolysis involves a series of 10 enzyme-catalyzed reactions.

- Key Steps:
  - Phosphorylation: Glucose is phosphorylated by hexokinase to form glucose-6-phosphate.
  - Isomerization: Glucose-6-phosphate is isomerized to fructose-6-phosphate.
  - Second Phosphorylation: Fructose-6-phosphate is phosphorylated to fructose-1,6-bisphosphate.
  - Cleavage: Fructose-1,6-bisphosphate is split into two 3-carbon molecules: dihydroxyacetone phosphate and glyceraldehyde-3-phosphate.
  - Energy Extraction: Each 3-carbon molecule undergoes further reactions to produce pyruvate, with the net gain of 2 ATP molecules and 2 NADH molecules.

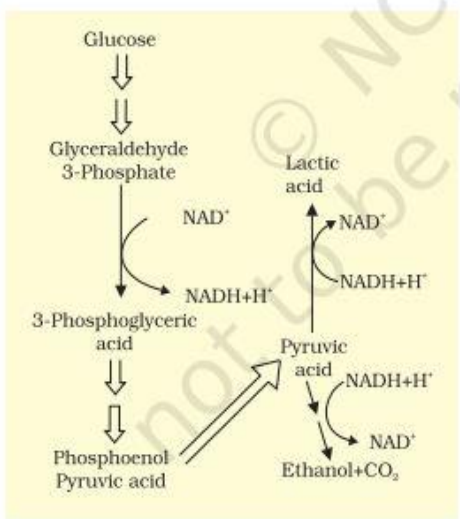
Fermentation

- Fermentation is an anaerobic process where glucose is incompletely oxidized to produce either ethanol and CO_2 or lactic acid.

- Types of Fermentation:

<u>- Alcoholic Fermentation:</u>

  - Carried out by yeast and some bacteria.
  - Pyruvic acid is converted to ethanol and CO_2 by the enzymes pyruvic acid decarboxylase and alcohol dehydrogenase.



- Lactic Acid Fermentation:
  - Occurs in certain bacteria and in muscle cells during intense activity.
  - Pyruvic acid is reduced to lactic acid by lactate dehydrogenase.
  - NADH is oxidized to NAD^+, which is reused in glycolysis.

- Energy Yield:
- Fermentation yields only 2 ATP molecules per glucose molecule, much less than aerobic respiration.

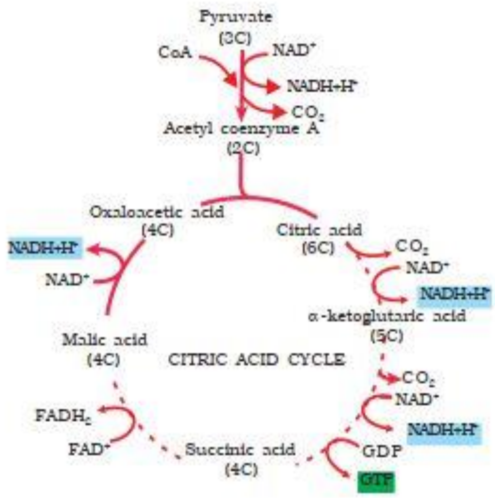
Aerobic Respiration

- Aerobic respiration is the complete oxidation of glucose in the presence of oxygen, resulting in CO_2, H_2O, and a large amount of energy.

- Key Processes:

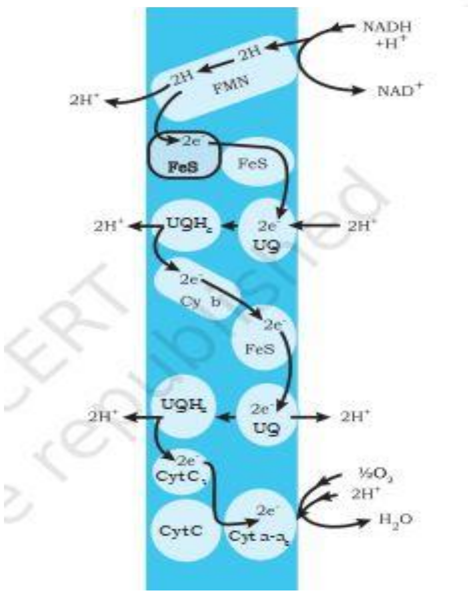
Pyruvate Decarboxylation:

- Pyruvate from glycolysis enters the mitochondria and is converted to Acetyl-CoA by the enzyme pyruvate dehydrogenase, producing NADH and CO_2.



Krebs Cycle:

- Acetyl-CoA enters the Krebs cycle (also known as the citric acid cycle or TCA cycle) in the mitochondrial matrix.
- Involves a series of reactions that produce CO_2, NADH, $FADH_2$, and ATP.



Electron Transport System (ETS) and Oxidative Phosphorylation

- Location: Inner mitochondrial membrane.

- Components:

- Complex I (NADH Dehydrogenase): Receives electrons from NADH, pumps protons into the intermembrane space.
- Complex II (Succinate Dehydrogenase): Receives electrons from $FADH_2$, does not pump protons.
- Ubiquinone (Coenzyme Q): Mobile carrier that transfers electrons from Complex I and II to Complex III.
- Complex III (Cytochrome bc1 Complex): Transfers electrons to cytochrome c, pumps protons into the intermembrane space.
- Cytochrome c: Small protein that transfers electrons between Complex III and Complex IV.

- Complex IV (Cytochrome c Oxidase): Transfers electrons to oxygen, the final electron acceptor, forming water. Pumps protons into the intermembrane space.

- Proton Gradient:- Protons are pumped from the mitochondrial matrix to the intermembrane space, creating a proton gradient (electrochemical gradient).

- This gradient represents potential energy used in ATP synthesis.

Oxidative Phosphorylation:

- ATP Synthase:
  - Large enzyme complex located in the inner mitochondrial membrane.
  - Utilizes the proton gradient created by ETS.
  - Protons flow back into the matrix through ATP synthase (chemiosmosis).
  - Energy from proton flow drives the synthesis of ATP from ADP and inorganic phosphate (Pi).
- Overall Efficiency:
  - Each NADH molecule can produce approximately 2.5-3 ATP.
  - Each $FADH_2$ molecule can produce approximately 1.5-2 ATP.
- Importance:
  - Major ATP production mechanism in aerobic organisms.
  - Links the electron transport chain to ATP synthesis.

The Respiratory Balance Sheet

- **Glycolysis**:
  - ATP: 2 (net gain)
  - NADH: 2 (producing approximately 4-6 ATP through oxidative phosphorylation)
- **Pyruvate Decarboxylation (Link Reaction)**:
  - NADH: 2 (producing approximately 6 ATP)
- **Krebs Cycle (Per Glucose Molecule)**:
  - ATP (or GTP): 2
  - NADH: 6 (producing approximately 15 ATP)
  - $FADH_2$: 2 (producing approximately 3-4 ATP)

- **Total ATP Yield (Theoretical)**:
  - Glycolysis: 2 ATP + (4-6 ATP from NADH) = 6-8 ATP
  - Pyruvate Decarboxylation: 6 ATP
  - Krebs Cycle: 2 ATP + 15 ATP (from NADH) + 3-4 ATP (from $FADH_2$) = 20-21 ATP
  - **Total Theoretical Yield**: 36-38 ATP per glucose molecule.

- **Actual Yield**:

- Often lower due to factors like proton leakage, intermediate uses of NADH and $FADH_2$, and the cost of transporting ADP and Pi into the mitochondria.

Amphibolic Pathway

- Respiration pathway that involves both catabolic (breakdown) and anabolic (biosynthetic) processes.

- Catabolic Role:

- Breakdown of carbohydrates, fats, and proteins to produce energy (ATP) and metabolic intermediates.

- Anabolic Role:

- Provides intermediates for the synthesis of amino acids, nucleotides, lipids, and other essential biomolecules.

- Key Intermediates:

- Acetyl-CoA: Used for synthesizing fatty acids and steroids.

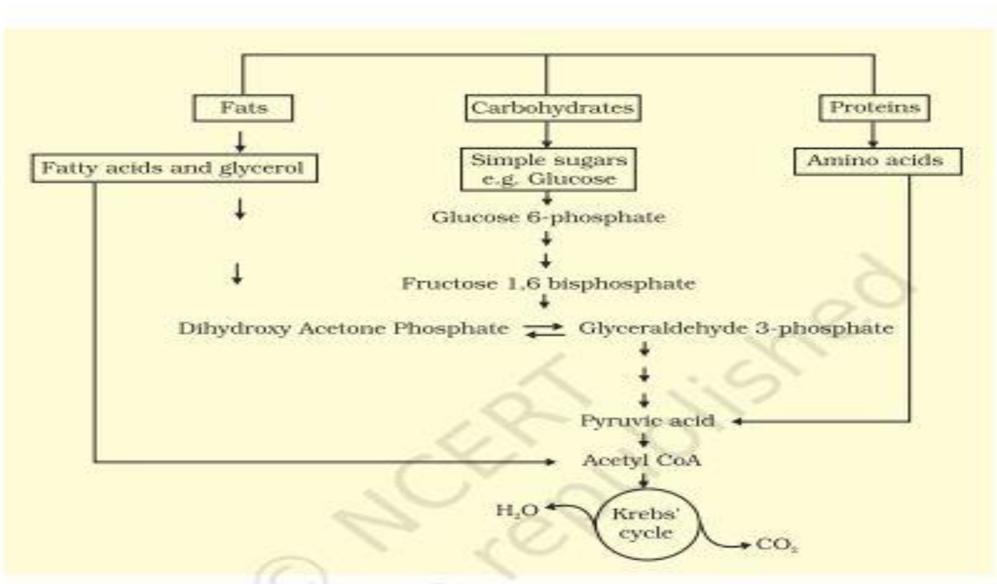
- α-Ketoglutarate and Oxaloacetate: Precursors for amino acids and nucleotides.

- Pyruvate: Can be converted into amino acids like alanine.

- Dual Role of Krebs Cycle:

- Central hub of metabolism, linking anabolic and catabolic pathways.

- Provides key intermediates for biosynthetic processes while also generating energy through the oxidation of Acetyl-CoA.



Respiratory Quotient (RQ)

- Ratio of CO_2 produced to O_2 consumed during respiration.
- RQ = (Volume of CO_2 evolved) / (Volume of O_2 consumed).

- RQ Values for Different Substrates:
  - Carbohydrates: RQ = 1 (equal amounts of CO_2 produced and O_2 consumed).
    - Example: Glucose ($C_6H_{12}O_6$) + $6O_2 \rightarrow 6CO_2 + 6H_2O$.
  - Fats: RQ < 1 (less CO_2 produced relative to O_2 consumed).
    - Example: Palmitic acid ($C_{16}H_{32}O_2$) + $23O_2 \rightarrow 16CO_2 + 16H_2O$, RQ = 0.7.
  - Proteins: RQ ≈ 0.9 (intermediate values).
    - Example: Amino acid metabolism often produces CO_2 and urea.
- Significance:
  - Indicates the type of substrate being metabolized.
  - Helps in assessing metabolic states in different conditions (e.g., fasting, exercise).
  - Useful in clinical settings to monitor respiratory function and energy metabolism.
- Variation with Conditions:
  - Starvation: Lower RQ (fats and proteins used for energy).
  - High-Carbohydrate Diet: Higher RQ (carbohydrates predominantly used for energy).

Question Bank For "Respiration In Plants"

Long-Answer Type Questions

1. Explain the process of glycolysis, including all the steps and enzymes involved.
2. Describe aerobic respiration, detailing the Krebs cycle and the electron transport system.
3. Discuss the differences between aerobic respiration and fermentation.
4. Explain how the respiratory quotient varies with different substrates and why.
5. Describe the amphibolic nature of the respiratory pathway.
6. Explain the process of oxidative phosphorylation and its importance in ATP synthesis.
7. Discuss the role of mitochondria in cellular respiration.
8. Describe the process of alcoholic fermentation and its commercial importance.
9. Explain the significance of the proton gradient in the electron transport chain.
10. Describe the structure and function of ATP synthase.

11. Explain the link between glycolysis and the Krebs cycle.
12. Discuss the factors affecting the rate of respiration in plants.
13. Describe the role of NADH and $FADH_2$ in cellular respiration.
14. Explain the significance of the Krebs cycle in both catabolic and anabolic pathways.
15. Discuss the regulation of cellular respiration by feedback mechanisms.

Short-Answer Type Questions

1. What are the end products of glycolysis?
2. Where does the Krebs cycle occur?
3. What is the main difference between aerobic and anaerobic respiration?
4. What is the role of oxygen in cellular respiration?
5. What are the two main types of fermentation?
6. How is pyruvate converted to Acetyl-CoA?
7. What is the net gain of ATP from glycolysis?
8. What is the function of the electron transport chain?
9. What are the end products of the Krebs cycle per Acetyl-CoA molecule?
10. What is the significance of NADH and $FADH_2$ in respiration?
11. What is the respiratory quotient (RQ)?
12. How does the proton gradient drive ATP synthesis?
13. What is the role of cytochrome c in the electron transport chain?
14. What is the function of Coenzyme Q (Ubiquinone) in the ETS?
15. What happens to the electrons at the end of the electron transport chain?

Very Short Answer Type Questions

1. Define respiration.
2. What is glycolysis?
3. What is the main function of mitochondria?
4. Name the first enzyme in the glycolytic pathway.
5. What is the end product of the Krebs cycle?
6. What is oxidative phosphorylation?
7. Define fermentation.
8. What is the role of ATP in cellular respiration?

9. Name one anaerobic condition in which fermentation occurs.
10. What is pyruvate?
11. What are the two main stages of cellular respiration?
12. What is the role of oxygen in the electron transport chain?
13. What is the main difference between NADH and $FADH_2$?
14. Define the term 'amphibolic pathway.'
15. What is the function of ATP synthase?

Multiple Choice Questions

1. Where does glycolysis occur?
   - a) Nucleus
   - b) Cytoplasm
   - c) Mitochondria
   - d) Chloroplast
2. What is the end product of glycolysis?
   - a) Lactic acid
   - b) Ethanol
   - c) Pyruvic acid
   - d) Acetyl-CoA
3. Which enzyme catalyzes the first step of glycolysis?
   - a) Hexokinase
   - b) Pyruvate kinase
   - c) Phosphofructokinase
   - d) Aldolase
4. What is the primary function of the Krebs cycle?
   - a) ATP production
   - b) NADH and $FADH_2$ production
   - c) Glucose synthesis
   - d) Oxygen consumption
5. Which of the following is a product of fermentation?
   - a) Oxygen
   - b) CO_2
   - c) Water
   - d) $NADP^+$
6. Where does the Krebs cycle take place?
   - a) Cytoplasm
   - b) Mitochondrial matrix
   - c) Thylakoid membrane
   - d) Stroma
7. What is the final electron acceptor in the electron transport chain?
   - a) $NADP^+$
   - b) O_2
   - c) H_2O
   - d) CO_2

8. Which molecule is the main energy currency in cells?
   - a) DNA
   - b) RNA
   - c) ATP
   - d) NADPH
9. How many ATP molecules are produced from one glucose molecule during aerobic respiration?
   - a) 2
   - b) 10
   - c) 36-38
   - d) 50
10. What is the primary role of NADH and $FADH_2$ in respiration?
   - a) Energy storage
   - b) Electron carriers
   - c) Oxygen transport
   - d) Carbon fixation
11. Which of the following processes generates the most ATP during cellular respiration?
   - a) Glycolysis
   - b) Krebs cycle
   - c) Electron transport chain
   - d) Fermentation
12. What is the role of ATP synthase?
   - a) Split water
   - b) Synthesize ATP
   - c) Fix carbon dioxide
   - d) Absorb light
13. Which of the following is an anaerobic process?
   - a) Glycolysis
   - b) Krebs cycle
   - c) Electron transport chain
   - d) Oxidative phosphorylation
14. What is the respiratory quotient (RQ) for carbohydrates?
   - a) 0.7
   - b) 1.0
   - c) 0.9
   - d) 0.8
15. Which of the following is not a product of the Krebs cycle?
   - a) NADH
   - b) $FADH_2$
   - c) Oxygen
   - d) CO_2

Competency-Based Questions

1. Design an experiment to measure the rate of respiration in germinating seeds.
2. Explain how you would differentiate between aerobic and anaerobic respiration in plant tissues using an experimental setup.
3. Propose a method to investigate the effect of temperature on the rate of respiration in plants.
4. Describe how you would measure the respiratory quotient (RQ) in different plant tissues.
5. Explain how chromatography can be used to identify the different pigments involved in plant respiration and photosynthesis.

Case-Study Based Questions

1. A farmer observes that his crops are wilting even though the soil is adequately moist. He suspects an issue with root respiration. How would you investigate this problem?
2. In a controlled environment, researchers notice that a certain plant species exhibits higher RQ values compared to others. What could be the possible reasons for this observation?
3. A scientist is studying the effects of various environmental stresses on plant respiration. Design a study to determine how drought stress affects respiration in a particular plant species.
4. A greenhouse experiment shows that plants exposed to higher CO_2 levels have altered respiration rates. Discuss the potential impacts of increased atmospheric CO_2 on plant respiration.
5. During an experiment, students notice that plants kept in the dark have different respiration rates compared to those exposed to light. Explain the possible reasons behind this observation and design a follow-up experiment to test your hypothesis.

Answers Scheme

Long-Answer Type Questions - Answers

1. **Explain the process of glycolysis, including all the steps and enzymes involved.**
    - Glycolysis involves the conversion of glucose into pyruvic acid through a series of ten enzyme-catalyzed reactions. Key steps include phosphorylation by hexokinase, conversion to fructose-6-phosphate, and further phosphorylation to fructose-1,6-bisphosphate. This is split into two three-carbon molecules, which undergo further reactions to produce ATP and NADH, resulting in pyruvic acid.

2. **Describe aerobic respiration, detailing the Krebs cycle and the electron transport system.**
   - Aerobic respiration includes the Krebs cycle and the electron transport system (ETS). Pyruvic acid enters the mitochondria, converts to Acetyl-CoA, and enters the Krebs cycle, generating NADH, $FADH_2$, and ATP. Electrons from NADH and $FADH_2$ pass through the ETS, creating a proton gradient that drives ATP synthesis through oxidative phosphorylation.
3. **Discuss the differences between aerobic respiration and fermentation.**
   - Aerobic respiration fully oxidizes glucose to CO_2 and H_2O, yielding about 36-38 ATP per glucose molecule, while fermentation partially breaks down glucose into lactic acid or ethanol and CO_2, yielding only 2 ATP per glucose molecule.
4. **Explain how the respiratory quotient varies with different substrates and why.**
   - The respiratory quotient (RQ) is 1 for carbohydrates, less than 1 for fats, and about 0.9 for proteins. It varies because different substrates require different amounts of oxygen for complete oxidation.
5. **Describe the amphibolic nature of the respiratory pathway.**
   - The respiratory pathway is amphibolic as it involves both catabolic breakdown of molecules for energy and anabolic synthesis of molecules for cellular functions. Intermediates in respiration are used for synthesizing amino acids, nucleotides, and other biomolecules.
6. **Explain the process of oxidative phosphorylation and its importance in ATP synthesis.**
   - Oxidative phosphorylation occurs in the inner mitochondrial membrane where the electron transport chain (ETS) creates a proton gradient. ATP synthase uses this gradient to convert ADP and Pi into ATP, providing the cell with a major source of energy.
7. **Discuss the role of mitochondria in cellular respiration.**
   - Mitochondria are the sites of aerobic respiration. They house the Krebs cycle and the electron transport chain, where the oxidation of nutrients occurs, leading to ATP production. The mitochondrial matrix contains enzymes for the Krebs cycle, while the inner membrane contains proteins for the ETS and ATP synthase.
8. **Describe the process of alcoholic fermentation and its commercial importance.**
   - Alcoholic fermentation converts glucose into ethanol and

CO_2 in the absence of oxygen. Carried out by yeast, this process is commercially important for brewing, winemaking, and baking industries.

9. **Explain the significance of the proton gradient in the electron transport chain.**
   - The proton gradient created by the ETS across the inner mitochondrial membrane drives the synthesis of ATP. Protons flow back into the matrix through ATP synthase, generating ATP from ADP and Pi.
10. **Describe the structure and function of ATP synthase.**
   - ATP synthase is a complex enzyme located in the inner mitochondrial membrane. It consists of a proton channel (F_0) and a catalytic domain (F_1). The flow of protons through the F_0 channel drives the rotation of the F_1 domain, catalyzing the conversion of ADP and Pi into ATP.
11. **Explain the link between glycolysis and the Krebs cycle.**
   - Pyruvate, the end product of glycolysis, is transported into the mitochondria, where it is converted to Acetyl-CoA. Acetyl-CoA then enters the Krebs cycle, linking glycolysis to the cycle.
12. **Discuss the factors affecting the rate of respiration in plants.**
   - Factors include temperature, oxygen concentration, availability of respiratory substrates, water availability, and the physiological state of the plant. Higher temperatures and adequate oxygen increase the rate of respiration, while drought and low substrate availability decrease it.
13. **Describe the role of NADH and $FADH_2$ in cellular respiration.**
   - NADH and $FADH_2$ are electron carriers that transport high-energy electrons to the electron transport chain. Their oxidation releases energy used to pump protons across the inner mitochondrial membrane, creating a proton gradient that drives ATP synthesis.
14. **Explain the significance of the Krebs cycle in both catabolic and anabolic pathways.**
   - The Krebs cycle generates energy through the oxidation of Acetyl-CoA and provides intermediates for the synthesis of

amino acids, nucleotides, and other essential biomolecules, linking catabolic and anabolic pathways.

15. **Discuss the regulation of cellular respiration by feedback mechanisms.**
    - Cellular respiration is regulated by feedback mechanisms involving key enzymes like hexokinase, phosphofructokinase, and pyruvate dehydrogenase. High levels of ATP inhibit these enzymes, slowing down respiration, while high levels of ADP and NAD^+ activate them, increasing the rate of respiration.

Short-Answer Type Questions - Answers

1. **What are the end products of glycolysis?**
    - Pyruvic acid, ATP, and NADH.
2. **Where does the Krebs cycle occur?**
    - In the mitochondrial matrix.
3. **What is the main difference between aerobic and anaerobic respiration?**
    - Aerobic respiration requires oxygen and produces more ATP, while anaerobic respiration does not require oxygen and produces less ATP.
4. **What is the role of oxygen in cellular respiration?**
    - Oxygen is the final electron acceptor in the electron transport chain, forming water.
5. **What are the two main types of fermentation?**
    - Alcoholic fermentation and lactic acid fermentation.
6. **How is pyruvate converted to Acetyl-CoA?**
    - Pyruvate is decarboxylated by pyruvate dehydrogenase to form Acetyl-CoA, releasing CO_2 and producing NADH.
7. **What is the net gain of ATP from glycolysis?**
    - 2 ATP.
8. **What is the function of the electron transport chain?**
    - To transfer electrons from NADH and $FADH_2$ to oxygen, creating a proton gradient that drives ATP synthesis.
9. **What are the end products of the Krebs cycle per Acetyl-CoA molecule?**
    - 3 NADH, 1 $FADH_2$, 1 ATP (or GTP), and 2 CO_2.
10. **What is the significance of NADH and $FADH_2$ in respiration?**
    - They carry high-energy electrons to the electron transport chain, where their oxidation drives ATP production.

11. **What is the respiratory quotient (RQ)?**
    - The ratio of CO_2 produced to O_2 consumed during respiration.
12. **How does the proton gradient drive ATP synthesis?**
    - The flow of protons back into the mitochondrial matrix through ATP synthase drives the conversion of ADP and Pi into ATP.
13. **What is the role of cytochrome c in the electron transport chain?**
    - It transfers electrons between Complex III and Complex IV.
14. **What is the function of Coenzyme Q (Ubiquinone) in the ETS?**
    - It transfers electrons from Complex I and II to Complex III.
15. **What happens to the electrons at the end of the electron transport chain?**
    - They are accepted by oxygen, forming water.

Very Short Answer Type Questions - Answers

1. **Define respiration.**
    - The process of breaking down glucose to release energy in the form of ATP.
2. **What is glycolysis?**
    - The process of breaking down glucose into pyruvic acid in the cytoplasm.
3. **What is the main function of mitochondria?**
    - To produce ATP through aerobic respiration.
4. **Name the first enzyme in the glycolytic pathway.**
    - Hexokinase.
5. **What is the end product of the Krebs cycle?**
    - Oxaloacetic acid, which is regenerated to start the cycle again.
6. **What is oxidative phosphorylation?**
    - The process of ATP formation using the energy released by the electron transport chain and the proton gradient.
7. **Define fermentation.**
    - The anaerobic process of breaking down glucose into lactic acid or ethanol and CO_2.
8. **What is the role of ATP in cellular respiration?**
    - To provide energy for cellular activities.
9. **Name one anaerobic condition in which fermentation occurs.**
    - Intense exercise in muscle cells.
10. **What is pyruvate?**
    - A three-carbon molecule produced at the end of glycolysis.

11. **What are the two main stages of cellular respiration?**
    - Glycolysis and aerobic respiration (including the Krebs cycle and electron transport chain).
12. **What is the role of oxygen in the electron transport chain?**
    - To act as the final electron acceptor, forming water.
13. **What is the main difference between NADH and $FADH_2$?**
    - NADH donates electrons to Complex I, while $FADH_2$ donates electrons to Complex II of the electron transport chain.
14. **Define the term 'amphibolic pathway.'**
    - A pathway that involves both catabolic and anabolic processes.
15. **What is the function of ATP synthase?**
    - To synthesize ATP from ADP and Pi using the proton gradient.

Multiple Choice Questions - Answers

1. **Where does glycolysis occur?**
    - b) Cytoplasm
2. **What is the end product of glycolysis?**
    - c) Pyruvic acid
3. **Which enzyme catalyzes the first step of glycolysis?**
    - a) Hexokinase
4. **What is the primary function of the Krebs cycle?**
    - b) NADH and $FADH_2$ production
5. **Which of the following is a product of fermentation?**
    - b) CO_2
6. **Where does the Krebs cycle take place?**
    - b) Mitochondrial matrix
7. **What is the final electron acceptor in the electron transport chain?**
    - b) O_2
8. **Which molecule is the main energy currency in cells?**
    - c) ATP
9. **How many ATP molecules are produced from one glucose molecule during aerobic respiration?**
    - c) 36-38
10. **What is the primary role of NADH and $FADH_2$ in respiration?**
    - b) Electron carriers
11. **Which of the following processes generates the most ATP during cellular respiration?**
    - c) Electron transport chain
12. **What is the role of ATP synthase?**
    - b) Synthesize ATP
13. **Which of the following is an anaerobic process?**

- a) Glycolysis

14. **What is the respiratory quotient (RQ) for carbohydrates?**
    - b) 1.0
15. **Which of the following is not a product of the Krebs cycle?**
    - c) Oxygen

Competency-Based Questions - Answers

1. **Design an experiment to measure the rate of respiration in germinating seeds.**
    - **Setup**: Place germinating seeds in a sealed container with a CO_2 absorbent (e.g., potassium hydroxide solution) and an oxygen sensor.
    - **Procedure**: Measure the decrease in oxygen concentration over time using the oxygen sensor. This indicates the rate of respiration.
    - **Data Collection**: Record oxygen levels at regular intervals and plot a graph of oxygen concentration versus time.
    - **Conclusion**: The slope of the graph indicates the respiration rate of the germinating seeds.
2. **Explain how you would differentiate between aerobic and anaerobic respiration in plant tissues using an experimental setup.**
    - **Setup**: Use two sets of plant tissues, one in an aerobic environment (with oxygen) and one in an anaerobic environment (without oxygen, possibly by using nitrogen gas to displace oxygen).
    - **Procedure**: Measure the production of CO_2 and ethanol in both setups.
    - **Observation**: Aerobic respiration will produce CO_2 and water, while anaerobic respiration will produce CO_2 and ethanol (in the case of alcoholic fermentation) or lactic acid.
    - **Conclusion**: The presence of ethanol or lactic acid indicates anaerobic respiration, whereas only CO_2 production indicates aerobic respiration.
    -
3. **Propose a method to investigate the effect of temperature on the rate of respiration in plants.**
    - **Setup**: Place plant tissues in respiration chambers connected to CO_2 sensors.

- **Procedure**: Subject the plant tissues to different temperatures (e.g., 10°C, 20°C, 30°C, 40°C) and measure the rate of CO_2 production at each temperature.
- **Data Collection**: Record CO_2 levels at regular intervals and plot graphs of CO_2 concentration versus time for each temperature.
- **Conclusion**: Compare the respiration rates at different temperatures to determine the effect of temperature on respiration.

4. **Describe how you would measure the respiratory quotient (RQ) in different plant tissues.**
   - **Setup**: Place plant tissues in sealed containers with sensors for measuring CO_2 and O_2 concentrations.
   - **Procedure**: Measure the amount of CO_2 produced and O_2 consumed over a fixed period.
   - **Calculation**: Calculate the RQ using the formula RQ = CO_2 produced / O_2 consumed.
   - **Conclusion**: Compare RQ values for different plant tissues to understand their metabolic processes and substrate usage.
5. **Explain how chromatography can be used to identify the different pigments involved in plant respiration and photosynthesis.**
   - **Setup**: Extract pigments from plant tissues using a suitable solvent (e.g., acetone).
   - **Procedure**: Apply the pigment extract to chromatography paper and place it in a solvent.
   - **Observation**: The solvent will carry the pigments up the paper, separating them based on their solubility and interaction with the paper.
   - **Conclusion**: Identify the separated pigments by their Rf values (distance traveled by pigment / distance traveled by solvent) and compare them to known standards.

Case-Study Based Questions - Answers

1. **A farmer observes that his crops are wilting even though the soil is adequately moist. He suspects an issue with root respiration. How would you investigate this problem?**
   - **Hypothesis**: The roots may not be getting enough oxygen for respiration.
   - **Investigation**: Measure the oxygen concentration in the soil around the roots using an oxygen sensor. Compare this with soil from healthy plants.
   - **Conclusion**: If oxygen levels are low, improve soil aeration by reducing compaction or increasing organic matter to enhance root respiration and prevent wilting.
2. **In a controlled environment, researchers notice that a certain plant species exhibits higher RQ values compared to theirs. What could be the possible reasons for this observation?**
   - **Possible Reasons**:
     - The plant may be utilizing carbohydrates more than fats or proteins, leading to a higher RQ.
     - The plant might have a higher rate of photosynthesis relative to respiration.
   - **Investigation**: Analyze the metabolic pathways and substrate usage in the plant to confirm the reason for the higher RQ.
3. **A scientist is studying the effects of various environmental stresses on plant respiration. Design a study to determine how drought stress affects respiration in a particular plant species.**
   - **Setup**: Grow plants under controlled conditions with adequate water supply. Introduce drought stress by withholding water from a set of plants.
   - **Procedure**: Measure the rate of respiration in both stressed and control plants using CO_2 sensors.
   - **Data Collection**: Record CO_2 production rates over time.
   - **Conclusion**: Compare the respiration rates to determine the effect of drought stress on plant respiration. Analyze any changes in RQ values to infer shifts in metabolic pathways.
4. **A greenhouse experiment shows that plants exposed to higher CO_2 levels have altered respiration rates. Discuss the potential impacts of increased atmospheric CO_2 on plant respiration.**
   - **Potential Impacts**:

        - Increased CO_2 levels may enhance photosynthesis, leading to higher availability of respiratory substrates and increased respiration rates.
        - Altered CO_2 levels may change the balance between photosynthesis and respiration, affecting plant growth and biomass.
    - **Investigation**: Measure the respiration rates and RQ values under different CO_2 concentrations to understand the physiological responses of plants to increased CO_2 levels.
5. **During an experiment, students notice that plants kept in the dark have different respiration rates compared to those exposed to light. Explain the possible reasons behind this observation and design a follow-up experiment to test your hypothesis.**
    - **Possible Reasons**:
        - In the dark, plants rely solely on stored carbohydrates for respiration, potentially reducing respiration rates.
        - Light exposure enhances photosynthesis, providing more substrates for respiration and increasing respiration rates.
    - **Follow-Up Experiment**:
        - **Setup**: Grow identical plants and divide them into two groups. Keep one group in complete darkness and the other in a lighted environment.
        - **Procedure**: Measure respiration rates in both groups using CO_2 sensors.
        - **Data Collection**: Record CO_2 production rates over time.
        - **Conclusion**: Compare respiration rates between the two groups to confirm the impact of light exposure on plant respiration. Analyze changes in metabolic pathways using RQ values and substrate analysis.

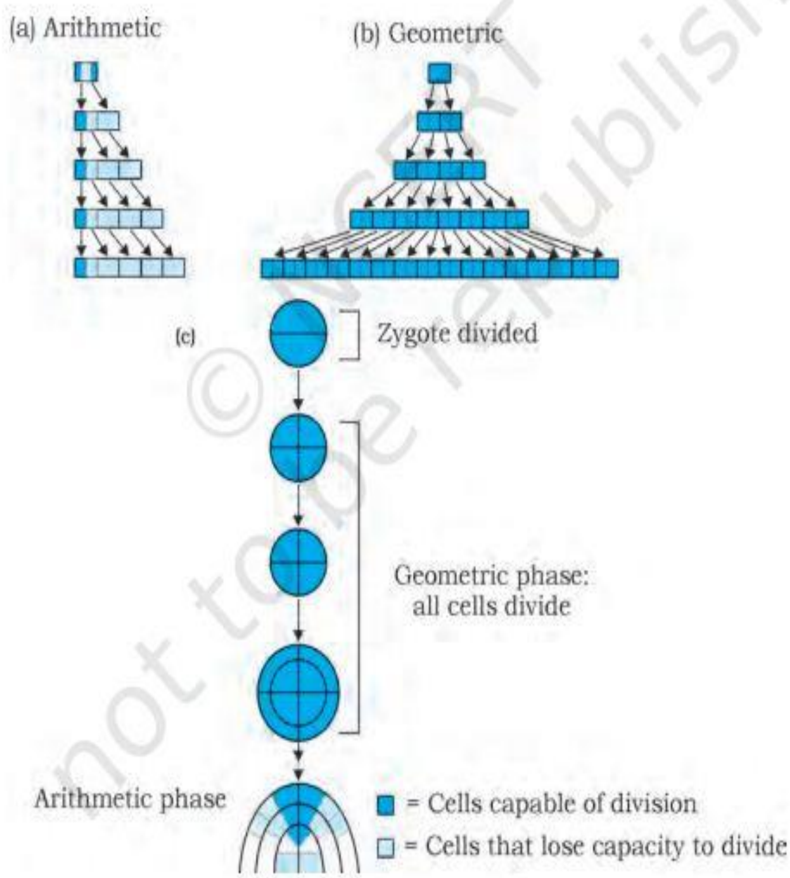
CHAPTER 15 "PLANT GROWTH AND DEVELOPMENT"

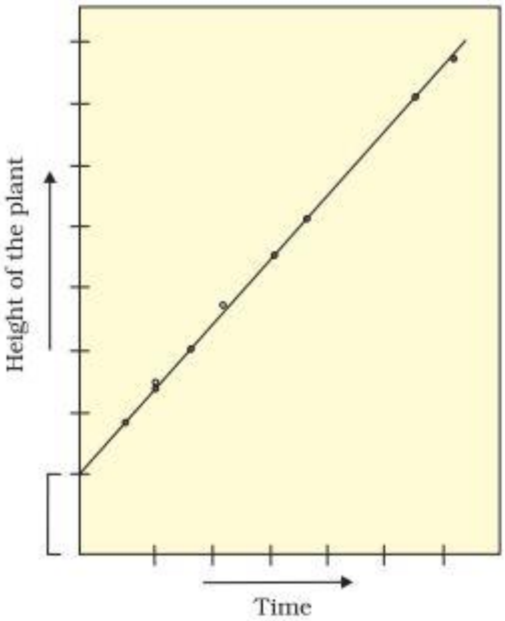
Growth

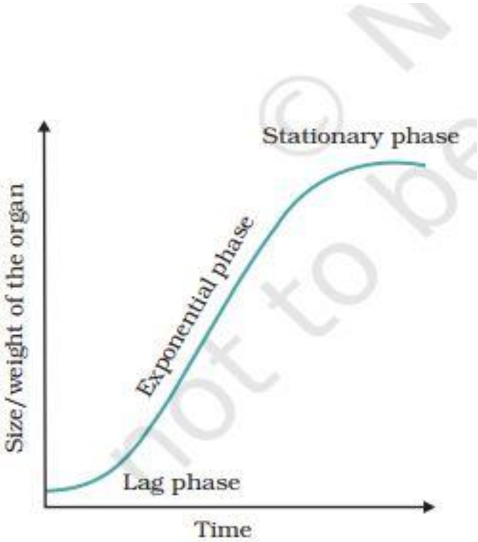
- **Definition**:
    - Growth is an irreversible permanent increase in size of an organ, its parts, or an individual cell.
    - It involves metabolic processes (both anabolic and catabolic) and requires energy.
- **Indeterminate Growth**:

- Plants have the capacity for unlimited growth throughout their life due to the presence of meristems.
- Meristems are regions in the plant where cells divide continuously.

- **Measurability**:
  - Growth can be measured using parameters such as fresh weight, dry weight, length, area, volume, and cell number.
  - Examples: The growth of a pollen tube can be measured in length; leaf growth can be measured in surface area.
- **Phases of Growth**:
  - **Meristematic Phase**: Active cell division occurs at the root and shoot apices.
  - **Elongation Phase**: Cells enlarge and elongate.
  - **Maturation Phase**: Cells attain their maximum size and differentiate to perform specific functions.
- **Growth Rates**:
  - Growth rate can be arithmetic or geometric.
  - **Arithmetic Growth**: One daughter cell continues to divide while the other differentiates. Linear increase in size.
  - **Geometric Growth**: All daughter cells retain the capacity to divide. Exponential increase in size, resulting in a sigmoid (S-shaped) growth curve.







- **Conditions for Growth**:
  - Essential elements: water, oxygen, nutrients.
  - Environmental factors: temperature, light, gravity.

Differentiation, Dedifferentiation, and Redifferentiation

- **Differentiation**:
  - The process where cells derived from meristems become specialized to perform specific functions.
  - Example: Formation of tracheary elements involves loss of protoplasm and development of lignocellulosic secondary cell walls.
- **Dedifferentiation**:
  - The process where differentiated cells regain the capacity to divide under certain conditions.
  - Example: Formation of meristems like interfascicular cambium and cork cambium from parenchyma cells.
- **Redifferentiation**:
  - The process where dedifferentiated cells once again lose the capacity to divide and mature to perform specific functions.

Development

- **Definition**:
  - Development includes all changes that an organism goes through during its life cycle from germination to senescence.
- **Plasticity**:
  - The ability of plants to follow different pathways in response to the environment or phases of life to form different kinds of structures.
  - Example: Heterophylly in cotton, coriander, and larkspur where juvenile and mature leaves differ in shape.

Plant Growth Regulators (PGRs) in Detail

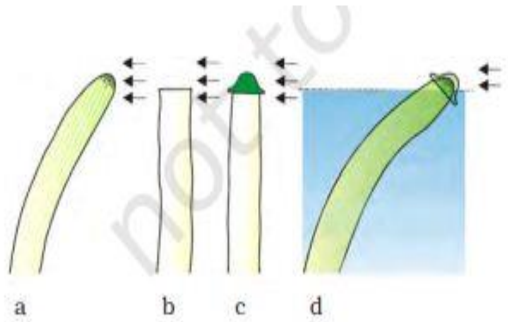
Introduction

- **Definition**: Plant Growth Regulators (PGRs) are naturally occurring or synthetic compounds that influence the growth and development of plants.
- **Characteristics**: They are small, simple molecules with diverse chemical compositions.
- **Types**: PGRs include growth promoters (auxins, gibberellins, cytokinins) and growth inhibitors (abscisic acid, ethylene).

Types of Plant Growth Regulators

1. Auxins

- **Discovery**:
  - Discovered by Charles Darwin and his son while studying phototropism in canary grass.
  - First identified auxin was Indole-3-acetic acid (IAA).



- **Chemical Nature**:
  - Indole compounds, with IAA being the most common natural auxin.
  - Synthetic auxins include NAA (Naphthaleneacetic acid) and 2,4-D (2,4-Dichlorophenoxyacetic acid).
- **Physiological Effects**:
  - **Cell Elongation**: Auxins stimulate cell elongation by increasing cell wall plasticity.
  - **Apical Dominance**: Suppress the growth of lateral buds, promoting a single, dominant growth point.
  - **Root Initiation**: Promote root initiation and development, used in vegetative propagation.
  - **Prevention of Abscission**: Delay leaf and fruit drop.
  - **Parthenocarpy**: Induce fruit development without fertilization.
  - **Tropisms**: Involved in phototropism (growth towards light) and geotropism (growth in response to gravity).

2. Gibberellins

- **Discovery**:
  - Discovered due to the 'bakanae' (foolish seedling) disease in rice caused by Gibberella fujikuroi.
  - First isolated by Japanese scientist Kurosawa.

- **Chemical Nature**:
  - Diterpenoids, with Gibberellic Acid (GA3) being the most studied.
- **Physiological Effects**:
  - **Stem Elongation**: Promote elongation of stems and internodes, leading to taller plants.
  - **Seed Germination**: Break seed dormancy and promote germination by stimulating enzyme production.
  - **Flowering**: Induce flowering in long-day plants.
  - **Fruit Development**: Increase fruit size and induce parthenocarpy.
  - **Delay Senescence**: Prolong the life of leaves and fruits, delaying aging processes.

3. Cytokinins

- **Discovery**:
  - Discovered by F. Skoog while working with tobacco stem callus.
  - First identified cytokinin was kinetin.
- **Chemical Nature**:
  - Adenine derivatives, with kinetin and zeatin being the most common.
- **Physiological Effects**:
  - **Cell Division**: Promote cell division and differentiation.
  - **Shoot Formation**: Stimulate the growth of lateral buds, counteracting apical dominance.
  - **Delay Senescence**: Delay the aging of leaves by maintaining chlorophyll and protein content.
  - **Nutrient Mobilization**: Enhance nutrient mobilization and transport within the plant.

4. Ethylene

- **Discovery**:
  - Identified as a volatile substance influencing fruit ripening and other growth processes.
  - Known to be produced by ripening fruits and aging leaves.
- **Chemical Nature**:
  - A simple gaseous hydrocarbon (C2H4).
- **Physiological Effects**:
  - **Fruit Ripening**: Promotes ripening of fruits like bananas, tomatoes, and apples.
  - **Abscission**: Accelerates the dropping of leaves, flowers, and fruits.

  - **Flowering**: Induces flowering in certain plants like pineapples and mangos.
  - **Seed Dormancy**: Breaks seed and bud dormancy.
  - **Stress Responses**: Involved in responses to biotic and abiotic stresses, such as wounding and flooding.

5. Abscisic Acid (ABA)

- **Discovery**:
  - Identified for its role in abscission and dormancy.
  - First isolated by F.T. Addicott.
- **Chemical Nature**:
  - A carotenoid derivative.
- **Physiological Effects**:
  - **Growth Inhibition**: Inhibits growth by counteracting the effects of other PGRs like auxins and gibberellins.
  - **Dormancy**: Induces dormancy in seeds and buds, helping plants survive unfavorable conditions.
  - **Stomatal Closure**: Promotes the closing of stomata to reduce water loss during drought stress.
  - **Stress Responses**: Increases tolerance to various stresses by inducing the synthesis of protective proteins and compounds.

Applications of PGRs

- **Agriculture**:
  - Used to enhance crop yields, control plant size, and improve fruit quality.
  - Auxins are used for rooting cuttings and preventing fruit drop.
  - Gibberellins are used to increase fruit size and stimulate seed germination.
  - Cytokinins are used to promote shoot growth and delay leaf senescence.
  - Ethylene is used to synchronize fruit ripening and induce flowering.
  - ABA is used to induce dormancy and improve stress tolerance.
- **Horticulture**:
  - PGRs are used to manage plant growth and development in ornamental plants.
  - Auxins and cytokinins are used in tissue culture for plant propagation.
- **Research**:
  - PGRs are used to study plant physiology and development processes.
  - Understanding PGRs helps in developing genetically modified plants with desired traits.

By understanding the roles and applications of plant growth regulators, students can appreciate their significance in plant growth, development, and agricultural practices.

Question Bank for "Plant Growth and Development"

Long-Answer Type Questions

1. Explain the phases of growth in plants and their significance.
2. Describe the process of differentiation, dedifferentiation, and redifferentiation in plants.
3. Discuss the role of plant growth regulators in plant development.
4. Explain the concept of plasticity in plant development with examples.
5. Describe the process and importance of photoperiodism in plants.
6. Discuss the physiological effects and applications of auxins in plant growth and development.
7. Explain the process and significance of seed dormancy and its regulation by abscisic acid (ABA).
8. Describe the role of gibberellins in stem elongation and seed germination.
9. Discuss the role of cytokinins in cell division and delay of senescence in plants.
10. Explain the mechanism of action of ethylene in fruit ripening and abscission.
11. Describe the process of vernalization and its significance in flowering.
12. Discuss the factors affecting seed germination and the role of PGRs in this process.
13. Explain the sigmoid growth curve and its phases in plant growth.
14. Describe the structure and function of meristems in plant growth.
15. Discuss the role of environmental factors in plant growth and development.

Short-Answer Type Questions

1. What is the difference between primary and secondary growth in plants?
2. Define photoperiodism and give an example of a long-day plant.
3. What is the role of auxins in apical dominance?
4. How do gibberellins influence seed germination?
5. What are the commercial uses of cytokinins in agriculture?
6. How does ethylene affect fruit ripening?
7. What is vernalization and why is it important?
8. How does abscisic acid (ABA) help plants during water stress?
9. What are the phases of the sigmoid growth curve?

10. What is the role of meristems in plant growth?
11. Define the term 'plasticity' in plant development.
12. What are the effects of light on plant growth?
13. How does temperature influence plant growth and development?
14. What is the role of auxins in root initiation?
15. Describe the process of seed dormancy.

Very Short Answer Type Questions

1. Define growth in plants.
2. What is meant by differentiation in plants?
3. Name the plant hormone responsible for apical dominance.
4. What is the function of gibberellins in plants?
5. Which plant hormone delays senescence?
6. What is the role of ethylene in plants?
7. Name a plant hormone that induces seed dormancy.
8. What is photoperiodism?
9. Define vernalization.
10. What is meant by dedifferentiation?
11. Name a synthetic auxin used in agriculture.
12. What is the significance of meristems in plants?
13. What is the effect of abscisic acid on stomata?
14. Which plant hormone is involved in fruit ripening?
15. Define the term 'growth rate'.

Multiple Choice Questions

1. Which hormone is known as the stress hormone in plants?
    - a) Auxin
    - b) Gibberellin
    - c) Abscisic acid
    - d) Cytokinin
2. What is the primary function of cytokinins in plants?
    - a) Stem elongation
    - b) Cell division
    - c) Fruit ripening
    - d) Inducing dormancy
3. Which plant growth regulator is a gas?
    - a) Auxin
    - b) Ethylene
    - c) Gibberellin
    - d) Cytokinin

4. What is the role of gibberellins in plants?
   - a) Inhibit growth
   - b) Promote stem elongation
   - c) Induce fruit ripening
   - d) Delay senescence
5. Which hormone is involved in apical dominance?
   - a) Auxin
   - b) Cytokinin
   - c) Gibberellin
   - d) Ethylene
6. What process is promoted by auxins in plant cuttings?
   - a) Leaf senescence
   - b) Root initiation
   - c) Flowering
   - d) Fruit ripening
7. Which hormone is primarily responsible for seed dormancy?
   - a) Auxin
   - b) Abscisic acid
   - c) Cytokinin
   - d) Ethylene
8. Which of the following is a function of ethylene?
   - a) Promote cell division
   - b) Delay senescence
   - c) Induce fruit ripening
   - d) Stimulate seed germination
9. What is the significance of vernalization in plants?
   - a) Inducing dormancy
   - b) Inducing flowering
   - c) Root development
   - d) Seed germination
10. Which hormone is known to delay leaf senescence?
    - a) Auxin
    - b) Gibberellin
    - c) Cytokinin
    - d) Ethylene
11. What is the effect of abscisic acid (ABA) on stomata?
    - a) Opens stomata
    - b) Closes stomata
    - c) Increases transpiration

- d) Promotes cell division

12. Which hormone can break seed dormancy?
    - a) Ethylene
    - b) Abscisic acid
    - c) Auxin
    - d) Cytokinin
13. What is the role of gibberellins in seed germination?
    - a) Inducing dormancy
    - b) Breaking dormancy
    - c) Inhibiting growth
    - d) Promoting root growth
14. Which hormone is commonly used to promote fruit setting in tomatoes?
    - a) Auxin
    - b) Cytokinin
    - c) Gibberellin
    - d) Ethylene
15. What is the function of the enzyme ACC synthase in ethylene biosynthesis?
    - a) Catalyzes the formation of ACC
    - b) Converts ACC to ethylene
    - c) Inhibits ethylene production
    - d) Promotes cell division

Competency-Based Questions

1. Design an experiment to study the effect of auxins on root initiation in stem cuttings.
2. Explain how you would measure the rate of cell division in a plant tissue culture experiment.
3. Propose a method to investigate the role of gibberellins in breaking seed dormancy.
4. Describe how you would use chromatography to separate and identify different plant hormones.
5. Explain how you would assess the impact of ethylene on fruit ripening in different fruit species.

Case-Study Based Questions

1. A farmer notices that his crop plants are not flowering as expected despite favorable environmental conditions. How would you investigate the potential role of photoperiodism and plant growth regulators in this issue?
2. In a controlled greenhouse experiment, researchers observe that certain plants exhibit stunted growth and delayed flowering.
3. What could be the possible reasons, and how would you design a study to identify the underlying causes?
4. A scientist is studying the effects of drought stress on plant growth. Design an experiment to determine how abscisic acid (ABA) levels change in plants under drought conditions.
5. During an experiment, students observe that plants grown under red light have different growth patterns compared to those grown under blue light. Explain the potential reasons for these differences and design a follow-up study to test your hypothesis.
6. In a botanical garden, certain plants show signs of early leaf senescence. How would you investigate the role of cytokinins and environmental factors in this phenomenon?

Answers Scheme

Long-Answer Type Questions - Answers

1. **Explain the phases of growth in plants and their significance.**
   - Growth in plants occurs in three phases: meristematic phase, elongation phase, and maturation phase. In the meristematic phase, cells divide actively at the root and shoot apices. During the elongation phase, cells enlarge and elongate. In the maturation phase, cells attain their maximum size and differentiate to perform specific functions. These phases are significant as they determine the overall growth pattern and the ability of plants to adapt to their environment.

2. **Describe the process of differentiation, dedifferentiation, and redifferentiation in plants.**
    - Differentiation is the process where cells derived from meristems become specialized to perform specific functions. Dedifferentiation occurs when differentiated cells regain the capacity to divide under certain conditions. Redifferentiation is when dedifferentiated cells once again lose the capacity to divide and mature to perform specific functions. These processes are essential for plant growth, repair, and regeneration.
3. **Discuss the role of plant growth regulators in plant development.**
    - Plant growth regulators (PGRs) such as auxins, gibberellins, cytokinins, ethylene, and abscisic acid play crucial roles in regulating various aspects of plant growth and development. Auxins promote cell elongation, root initiation, and apical dominance. Gibberellins promote stem elongation, seed germination, and flowering. Cytokinins promote cell division and delay senescence. Ethylene induces fruit ripening and abscission. Abscisic acid induces dormancy and helps plants respond to stress.
4. **Explain the concept of plasticity in plant development with examples.**
    - Plasticity in plant development refers to the ability of plants to alter their growth and development in response to environmental conditions. For example, heterophylly in cotton, coriander, and larkspur shows different leaf shapes at different stages of development or in different environmental conditions. This plasticity allows plants to
    - adapt to varying environmental conditions, enhancing their survival and reproductive success.
5. **Describe the process and importance of photoperiodism in plants.**
    - Photoperiodism is the response of plants to the relative lengths of day and night. It regulates various developmental processes such as flowering, seed germination, and dormancy. Long-day plants flower when the day length exceeds a critical duration, while short-day plants flower when the day length is shorter than a critical duration. Photoperiodism ensures that flowering and other developmental processes occur at optimal times for pollination and seed dispersal.
6. **Discuss the physiological effects and applications of auxins in plant growth and development.**

- Auxins stimulate cell elongation, root initiation, and apical dominance. They prevent premature fruit and leaf drop and induce parthenocarpy. Auxins are used in agriculture for rooting cuttings, promoting uniform flowering, and preventing fruit drop. They are also used in herbicides to control weed growth.

7. **Explain the process and significance of seed dormancy and its regulation by abscisic acid (ABA).**
   - Seed dormancy is a state where seeds do not germinate despite favorable conditions. ABA induces dormancy by inhibiting seed germination and promoting desiccation tolerance. Dormancy ensures that seeds germinate only under optimal conditions, enhancing seedling survival. Breaking dormancy involves reducing ABA levels and increasing gibberellin levels, allowing seeds to germinate.
8. **Describe the role of gibberellins in stem elongation and seed germination.**
   - Gibberellins promote stem elongation by stimulating cell division and elongation. They break seed dormancy by stimulating the production of hydrolytic enzymes that degrade stored food reserves, providing energy for germination. Gibberellins also promote flowering and fruit development.
9. **Discuss the role of cytokinins in cell division and delay of senescence in plants.**
   - Cytokinins promote cell division and differentiation, especially in the presence of auxins. They delay senescence by maintaining chlorophyll and protein content in leaves, promoting nutrient mobilization, and enhancing plant
   - growth and development. Cytokinins are used in tissue culture to promote shoot formation and delay leaf aging.
10. **Explain the mechanism of action of ethylene in fruit ripening and abscission.**
    - Ethylene promotes fruit ripening by increasing the activity of enzymes that soften the fruit, convert starches to sugars, and degrade chlorophyll. It induces abscission by stimulating the production of enzymes that degrade cell walls in the abscission zone, leading to the shedding of leaves, flowers, and fruits. Ethylene is used commercially to ripen fruits uniformly and to promote flower induction.
11. **Describe the process of vernalization and its significance in flowering.**
    - Vernalization is the exposure of seeds or plants to low temperatures to induce flowering. It is significant in temperate regions where it ensures that flowering occurs in

spring, following a period of winter cold. Vernalization promotes flowering in biennials and winter annuals by accelerating the transition from vegetative to reproductive growth.

12. **Discuss the factors affecting seed germination and the role of PGRs in this process.**
    - Seed germination is affected by factors such as water, oxygen, temperature, and light. PGRs like gibberellins promote germination by breaking dormancy and stimulating enzyme production. Abscisic acid inhibits germination and maintains dormancy. Ethylene can promote or inhibit germination depending on the species and environmental conditions.
13. **Explain the sigmoid growth curve and its phases in plant growth.**
    - The sigmoid growth curve represents the growth of a plant over time and has three phases: lag phase, exponential phase, and stationary phase. In the lag phase, growth is slow as cells acclimate to conditions. In the exponential phase, growth is rapid due to active cell division and elongation. In the stationary phase, growth slows as resources become limited and cells mature.
14. **Describe the structure and function of meristems in plant growth.**
    - Meristems are regions of actively dividing cells in plants. Apical meristems are located at the tips of roots and shoots and are responsible for primary growth, increasing the length of the plant. Lateral meristems, such as the vascular
    - cambium and cork cambium, are responsible for secondary growth, increasing the thickness of the plant. Meristems produce new cells that differentiate to form various tissues and organs.

Short-Answer Type Questions - Answers

1. **What is the difference between primary and secondary growth in plants?**
    - Primary growth increases the length of the plant through the activity of apical meristems, while secondary growth increases the thickness of the plant through the activity of lateral meristems.
2. **Define photoperiodism and give an example of a long-day plant.**

- Photoperiodism is the response of plants to the relative lengths of day and night. An example of a long-day plant is spinach.

3. **What is the role of auxins in apical dominance?**
   - Auxins suppress the growth of lateral buds, promoting the dominance of the apical bud and leading to a single, main stem.
4. **How do gibberellins influence seed germination?**
   - Gibberellins break seed dormancy by stimulating the production of hydrolytic enzymes that degrade stored food reserves, providing energy for germination.
5. **What are the commercial uses of cytokinins in agriculture?**
   - Cytokinins are used to promote cell division, delay leaf senescence, enhance shoot growth, and improve tissue culture propagation.
6. **How does ethylene affect fruit ripening?**
   - Ethylene promotes fruit ripening by increasing the activity of enzymes that soften the fruit, convert starches to sugars, and degrade chlorophyll.
7. **What is vernalization and why is it important?**
   - Vernalization is the exposure of seeds or plants to low temperatures to induce flowering. It ensures that flowering occurs in spring, following a period of winter cold.
8. **How does abscisic acid (ABA) help plants during water stress?**
   - ABA promotes the closing of stomata to reduce water loss and induces the synthesis of proteins that help plants survive drought conditions.
9. **What are the phases of the sigmoid growth curve?**
   - The sigmoid growth curve has three phases: lag phase, exponential phase, and stationary phase.
10. **What is the role of meristems in plant growth?**
    - Meristems are regions of actively dividing cells that produce new cells for growth and differentiation, contributing to the length and thickness of the plant.
11. **Define the term 'plasticity' in plant development.**
    - Plasticity is the ability of plants to alter their growth and development in response to environmental conditions.
12. **What are the effects of light on plant growth?**
    - Light influences photosynthesis, photoperiodism, and photomorphogenesis, affecting plant growth, flowering, and development.
13. **How does temperature influence plant growth and**

development?

- Temperature affects enzyme activity, metabolic rates, and processes like germination and flowering, influencing overall plant growth and development.

14. **What is the role of auxins in root initiation?**
    - Auxins promote root initiation and development, making them useful in vegetative propagation and tissue culture.
15. **Describe the process of seed dormancy.**
    - Seed dormancy is a state where seeds do not germinate despite favorable conditions. It is regulated by factors such as abscisic acid, temperature, and light.

Very Short Answer Type Questions - Answers

1. **Define growth in plants.**
    - Growth is an irreversible increase in size and mass of plant organs or cells.
2. **What is meant by differentiation in plants?**
    - Differentiation is the process by which cells become specialized to perform specific functions.
3. **Name the plant hormone responsible for apical dominance.**
    - Auxin.
4. **What is the function of gibberellins in plants?**
    - Promote stem elongation, seed germination, and flowering.
5. **Which plant hormone delays senescence?**
    - Cytokinins.
6. **What is the role of ethylene in plants?**
    - Induces fruit ripening, abscission, and responses to stress.
7. **Name a plant hormone that induces seed dormancy.**
    - Abscisic acid (ABA).
8. **What is photoperiodism?**
    - The response of plants to the relative lengths of day and night.
9. **Define vernalization.**
    - The exposure of seeds or plants to low temperatures to induce flowering.
10. **What is meant by dedifferentiation?**
    - The process where differentiated cells regain the capacity to divide.
11. **Name a synthetic auxin used in agriculture.**
    - 2,4-D (2,4-Dichlorophenoxyacetic acid).
12. **What is the significance of meristems in plants?**
    - Meristems produce new cells for growth and differentiation, contributing to the plant's length and thickness.
13. **What is the effect of abscisic acid on stomata?**
    - Abscisic acid promotes the closing of stomata.
14. **Which plant hormone is involved in fruit ripening?**

- Ethylene.

15. **Define the term 'growth rate'.**
    - Growth rate is the increase in size or number of cells per unit time.

Multiple Choice Questions - Answers

1. Which hormone is known as the stress hormone in plants?
   - c) Abscisic acid
2. What is the primary function of cytokinins in plants?
   - b) Cell division
3. Which plant growth regulator is a gas?
   - b) Ethylene
4. What is the role of gibberellins in plants?
   - b) Promote stem elongation
5. Which hormone is involved in apical dominance?
   - a) Auxin
6. What process is promoted by auxins in plant cuttings?
   - b) Root initiation
7. Which hormone is primarily responsible for seed dormancy?
   - b) Abscisic acid
8. Which of the following is a function of ethylene?
   - c) Induce fruit ripening
9. What is the significance of vernalization in plants?
   - b) Inducing flowering
10. Which hormone is known to delay leaf senescence?
    - c) Cytokinin
11. What is the effect of abscisic acid (ABA) on stomata?
    - b) Closes stomata
12. Which hormone can break seed dormancy?
    - a) Ethylene
13. What is the role of gibberellins in seed germination?
    - b) Breaking dormancy
14. Which hormone is commonly used to promote fruit setting in tomatoes?
    - a) Auxin
15. What is the function of the enzyme ACC synthase in ethylene biosynthesis?
    - a) Catalyzes the formation of ACC

Competency-Based Questions - Answers

1. **Design an experiment to study the effect of auxins on root initiation in stem cuttings.**

- **Setup**: Collect stem cuttings from a suitable plant species and divide them into two groups.
- **Procedure**: Treat one group with an auxin solution (e.g., IAA or NAA) and leave the other group untreated as a control.

- **Planting**: Insert the cuttings into a rooting medium (e.g., soil or vermiculite) and maintain consistent environmental conditions.
- **Observation**: Monitor and record the number of roots formed and the length of roots in each group over a specified period.
- **Conclusion**: Compare the root initiation and growth between the treated and untreated groups to assess the effect of auxins.

2. **Explain how you would measure the rate of cell division in a plant tissue culture experiment.**

- **Setup**: Prepare a tissue culture with explants in a nutrient medium containing growth hormones.
- **Procedure**: At regular intervals, take samples of the tissue culture and stain them with a suitable dye (e.g., acetocarmine) to visualize dividing cells.
- **Observation**: Count the number of cells undergoing mitosis under a microscope.
- **Data Collection**: Record the number of dividing cells at different time points.
- **Conclusion**: Calculate the rate of cell division by determining the number of dividing cells per unit time.

3. **Propose a method to investigate the role of gibberellins in breaking seed dormancy.**

- **Setup**: Obtain seeds of a plant species known for dormancy and divide them into two groups.
- **Treatment**: Soak one group in a gibberellin solution (e.g., GA_3) and the other in water as a control.
- **Germination**: Place the seeds on a moist filter paper in petri dishes and incubate under optimal germination conditions.
- **Observation**: Monitor and record the germination rate of seeds in both groups over a specified period.
- **Conclusion**: Compare the germination rates to determine the effectiveness of gibberellins in breaking seed dormancy.

4. **Describe how you would use chromatography to separate and identify different plant hormones.**

- **Sample Preparation**: Extract plant hormones from plant tissues using an appropriate solvent (e.g., methanol).
- **Chromatography Setup**: Prepare a chromatography paper or thin-layer chromatography (TLC) plate.
- **Application**: Apply the plant hormone extract to the chromatography paper or TLC plate.
  Development: Place the paper or plate in a solvent system to separate the hormones based on their solubility and affinity to the stationary phase.
- **Visualization**: Use a suitable method (e.g., UV light or staining) to visualize the separated hormone spots.

- **Identification**: Compare the Rf values (distance traveled by the hormone/distance traveled by the solvent) with known standards to identify the hormones.

5. **Explain how you would assess the impact of ethylene on fruit ripening in different fruit species.**

- **Setup**: Select different fruit species and divide them into two groups.
- **Treatment**: Expose one group to ethylene gas and leave the other group untreated as a control.
- **Observation**: Monitor and record the changes in color, texture, and firmness of the fruits over time.
- **Data Collection**: Measure the ethylene concentration in the environment and the internal ethylene levels in the fruits.
- **Conclusion**: Compare the ripening process between the treated and untreated groups to assess the impact of ethylene on fruit ripening.

Case-Study Based Questions - Answers

1. **A farmer notices that his crop plants are not flowering as expected despite favorable environmental conditions. How would you investigate the potential role of photoperiodism and plant growth regulators in this issue?**

- **Investigation**: Determine the photoperiodic requirements of the crop plants (short-day, long-day, or day-neutral).
- **Method**: Record the day length in the field and compare it with the photoperiodic requirements.
- **Plant Growth Regulators**: Analyze the levels of gibberellins and cytokinins in the plants.
- **Follow-Up**: Adjust the light exposure in a controlled environment and treat plants with appropriate PGRs to observe any changes in flowering.

2. **In a controlled greenhouse experiment, researchers observe that certain plants exhibit stunted growth and delayed flowering. What could be the possible reasons, and how would you design a study to identify the underlying causes?**

- **Possible Reasons**: Nutrient deficiency, improper light conditions, hormonal imbalance, or genetic factors.
- **Study Design**:
  - **Setup**: Divide plants into groups and vary one factor at a time (e.g., nutrient levels, light intensity, PGR application).
  - **Observation**: Monitor growth and flowering time in each group.
  - **Data Collection**: Record plant height, leaf number, and flowering time.
  - **Conclusion**: Identify the factor(s) affecting growth and flowering by comparing the results across different groups.

3. **A scientist is studying the effects of drought stress on plant**

growth. Design an experiment to determine how abscisic acid (ABA) levels change in plants under drought conditions.

- **Setup**: Grow plants under controlled conditions and divide them into two groups (well-watered and drought-stressed).
- **Procedure**: Induce drought stress by withholding water from one group.
- **Observation**: Measure plant growth parameters (e.g., height, leaf area) and collect leaf samples at regular intervals.
- **ABA Analysis**: Extract ABA from leaf samples and quantify using techniques such as ELISA or HPLC.
- **Conclusion**: Compare ABA levels between well-watered and drought-stressed plants to determine the impact of drought on ABA synthesis.

3. **During an experiment, students observe that plants grown under red light have different growth patterns compared to those grown under blue light. Explain the potential reasons for these differences and design a follow-up study to test your hypothesis.**

- **Potential Reasons**: Red and blue light affect different aspects of plant growth and development (e.g., red light promotes flowering, blue light enhances vegetative growth).
- **Follow-Up Study**:
  - **Setup**: Grow identical plants under controlled conditions with red light, blue light, and white light as a control.
  - **Observation**: Monitor and record growth parameters (e.g., stem length, leaf size, flowering time).
  - **Data Collection**: Measure chlorophyll content, photosynthetic rate, and hormone levels.
  - **Conclusion**: Analyze the data to understand how different light wavelengths influence plant growth and development.

4. **In a botanical garden, certain plants show signs of early leaf senescence. How would you investigate the role of cytokinins and environmental factors in this phenomenon?**

- **Investigation**:
  - **Cytokinins**: Measure cytokinin levels in the leaves showing early senescence.
  - **Environmental Factors**: Record environmental conditions (e.g., light intensity, temperature, humidity) in the garden.
- **Method**:
  - **Treatment**: Apply exogenous cytokinins to some plants and compare the senescence rate with untreated plants.
  - **Observation**: Monitor changes in leaf color, chlorophyll content, and overall plant health. **Conclusion**: Determine the role of cytokinins and environmental factors in early leaf senescence by analyzing the results. ------------------

UNIT V

Human Physiology

Chapter 17

Breathing and Exchange of Gases

Chapter 18

Body Fluids and Circulation

Chapter 19

Excretory Products and their Elimination

Chapter 20

Locomotion and Movement

Chapter 21

Neural Control and Coordination

Chapter 22

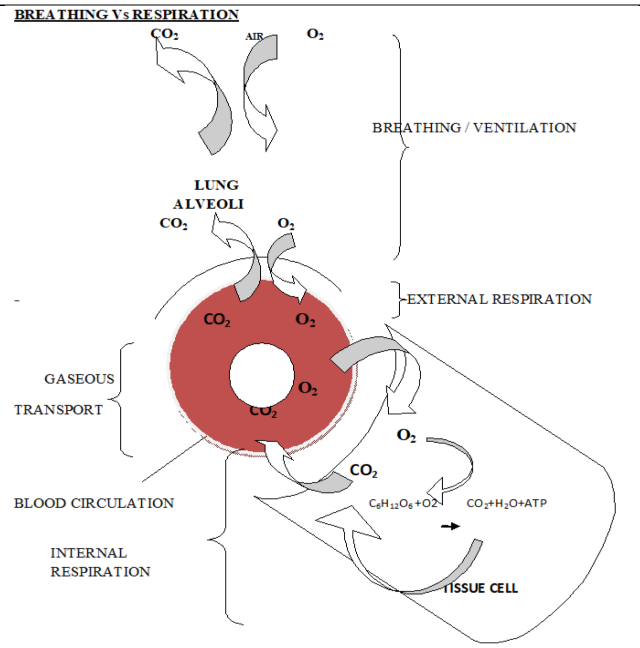
Chemical Coordination and Integration

CHAPTER-17 Breathing and Exchange of Gases

Breathing / Ventilation – First step of respiration, refers to the movements that send fresh air or with dissolved in water to the respiratory organs (inspiration) and removes foul air or water from them (expiration).

External respiration – intake of oxygen by the blood from water or air in the respiratory organs and elimination of carbon dioxide.

Internal respiration – involves uptake of oxygen by tissue cells via tissue fluid, oxidation of food in tissue cells leading to production of carbon dioxide, water and energy, storage of



energy in the form of ATP and release of CO_2 from tissue cells into blood via tissue fluid.	

Respiration – a physio-chemical **catabolic** process which involves exchange of environmental oxygen with the carbon dioxide produced in the cells during oxidation, at a moist surface to utilize the oxygen for the **oxidation of glucose** in the mitochondria (power house of cell) to produce the energy, some of which is stored in ATP molecules as **biological useful energy**.

$$\underset{\text{(Glucose)}}{C_6H_{12}O_6} + \underset{\text{(Oxygen)}}{6O_2} \longrightarrow \underset{\substack{\text{(Carbon dioxide)}\\ \text{(Released)}}}{6CO_2} + \underset{\substack{\text{(Water)}\\ \text{(Reused)}}}{6H_2O} + \underset{\text{(Stored as ATP)}}{\text{Energy}}$$

$$ATP \xrightarrow{\text{Hydrolysis}} ADP + Pi + \text{Energy used in life activities}$$

Aerobic respiration – involves use of molecular oxygen for breakdown of respiratory substrate and release of carbon dioxide simultaneously. Occurs in most animals and plants.

Anaerobic respiration –does not utilize molecular oxygen, for the breakdown of organic substrate and CO_2 may or may not be released.

In Yeast -

$$\underset{\text{(Glucose)}}{C_6H_{12}O_6} \longrightarrow \underset{\text{(Ethanol)}}{2\ C_2H_5OH} + 2CO_2 + \text{Energy}$$

In Certain Bacteria and Parasitic Worms *(Ascaris, Tapeworm)*

$$\underset{\text{(Glucose)}}{C_6H_{12}O_6} \longrightarrow \underset{\text{(Lactic acid)}}{2CH_3CHOHCOOH} + \text{Energy}$$

Types of respiration –

Cutaneous respiration – Exchange of respiratory gases through the thin, moist, permeable and highly vascularised skin.

Buccopharyngeal respiration – Exchange of respiratory gases through thin, vascular lining of buccopharyngeal cavity.

Branchial respiration – Exchange of respiratory gases in gills.

Pulmonary respiration – Exchange of gases through lungs.

Respiratory medium – Source of oxygen (air or water), which provides oxygen to the body at the body's respiratory surface.

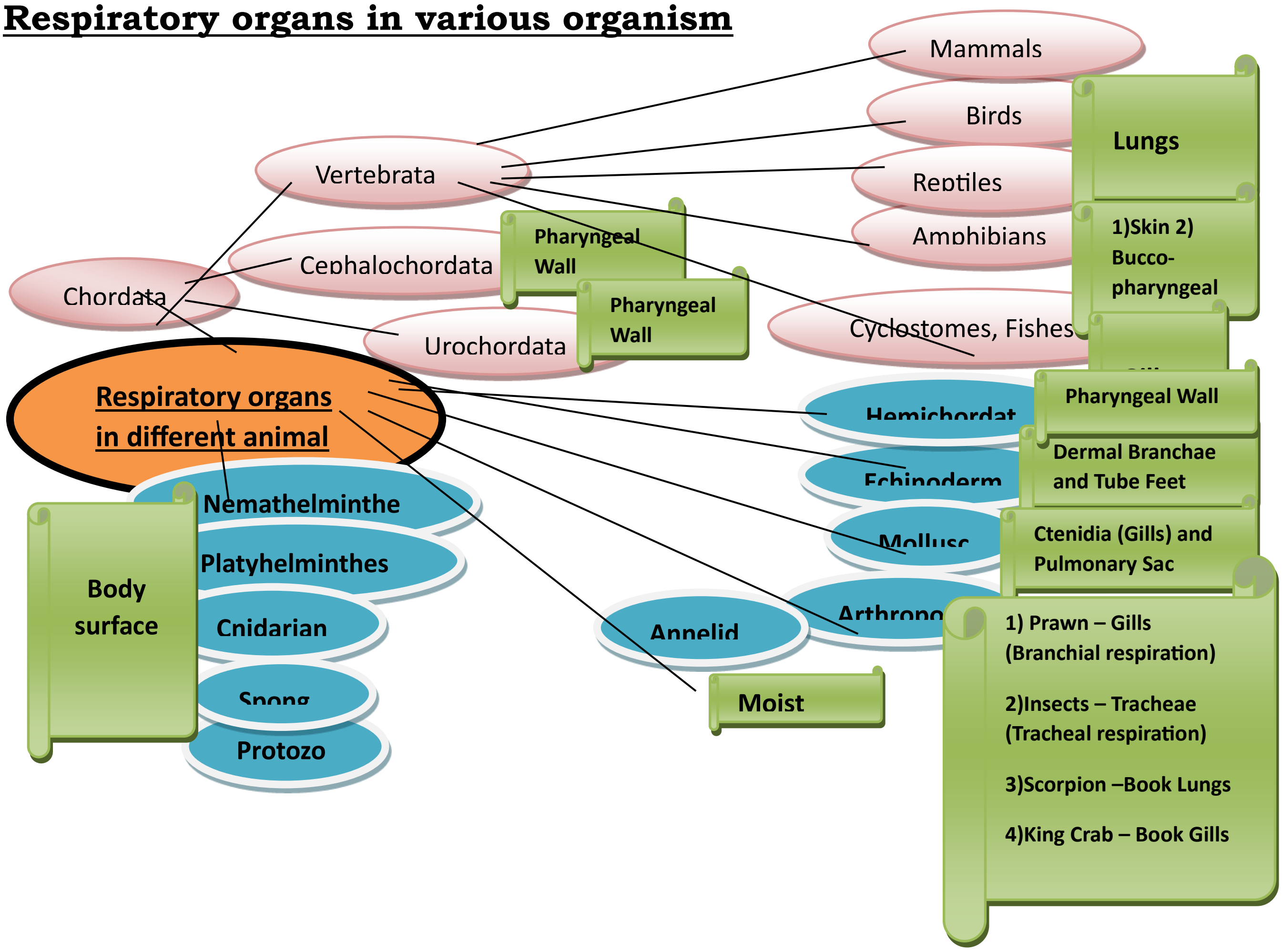
Respiratory surface – an efficient respiration requires a thin, permeable, moist, large and highly vascular surface in direct or indirect contact with source of oxygen (air/ water) and presence of a respiratory pigment.

Respiratory pigments – greatly increase the capacity of blood to carry oxygen and carbon dioxide.

Haemocyanin – respiratory pigment in plasma in crustaceans and mollusks.

Haemoglobin - respiratory pigment in the red blood cells in vertebrates and in annelids in the plasma.

Respiratory organs in various organism



Human Respiratory System

Trachea/ Windpipe – thin walled tube extends downward through the neck. 11cm long and 2.5 cm wide.

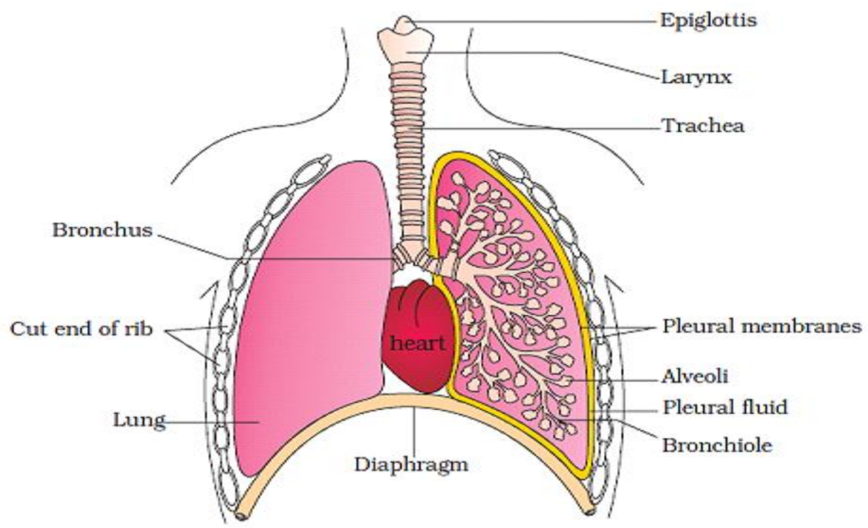
Bronchi – Trachea divides into two tubes called bronchi in the middle of the thorax.

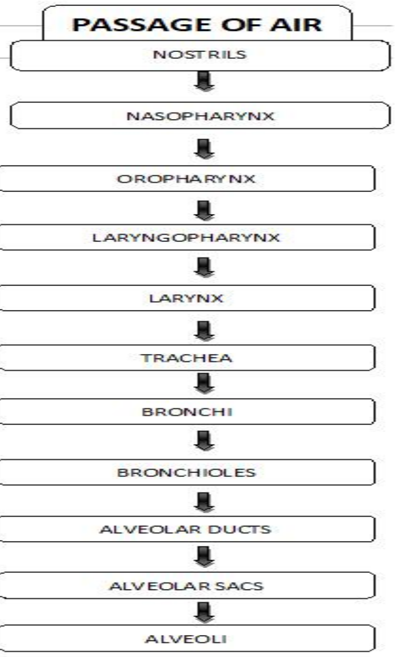
Bronchioles – Bronchi divide and re-divide into tertiary bronchi which divide into alveolar ducts which enter into alveolar sacs.

Lungs – Human respiratory organs , located in the thoracic cavity.

Alveolar Sac- In the lung, each alveolar duct opens into a blind chamber, the alveolar sac which appears like a small bunch of grapes.

HUMAN RESPIRATORY SYSTEM





Alveoli / Air sacs – The central passage of each alveolar sac gives off several small pouches on all sides, the alveoli or air sacs.

Alveolar wall – is very thin (0.0001 mm) wall composed of simple moist, non-ciliated, squamous epithelium which easily recoil and expand during breathing. Number of alveoli is countless which increase the surface area of lungs, thus accelerating gaseous exchange in alveoli. It is closely surrounded by a network of pulmonary capillaries arising from pulmonary artery and rejoin to form pulmonary vein.

Respiratory membrane – consists of alveolar epithelium, epithelial basement membrane, a thin interstitial space, capillary basement membrane and capillary endothelial membrane (total thickness= 0.3μm). Hence, diffusion of gases between the blood

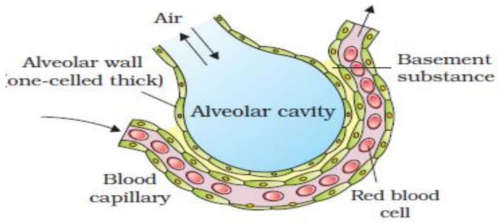
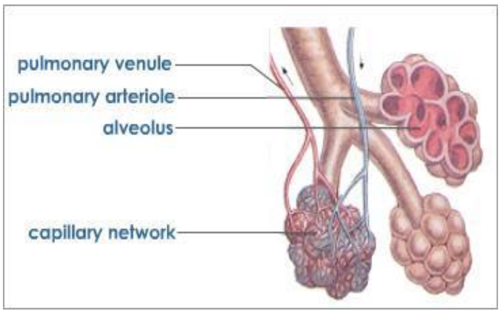


Figure 17.4 A Diagram of a section of an alveolus with a pulmonary capillary.



and alveolar air occurs easily and quickly.	

Advantages of nasal breathing over mouth breathing

Air passing through nasal chambers is subjected to warming, moistening, sterilization and cleaning specially by virtue of the presence of hair and mucus which holds the dust particles and bacteria of the passing air, which are absent

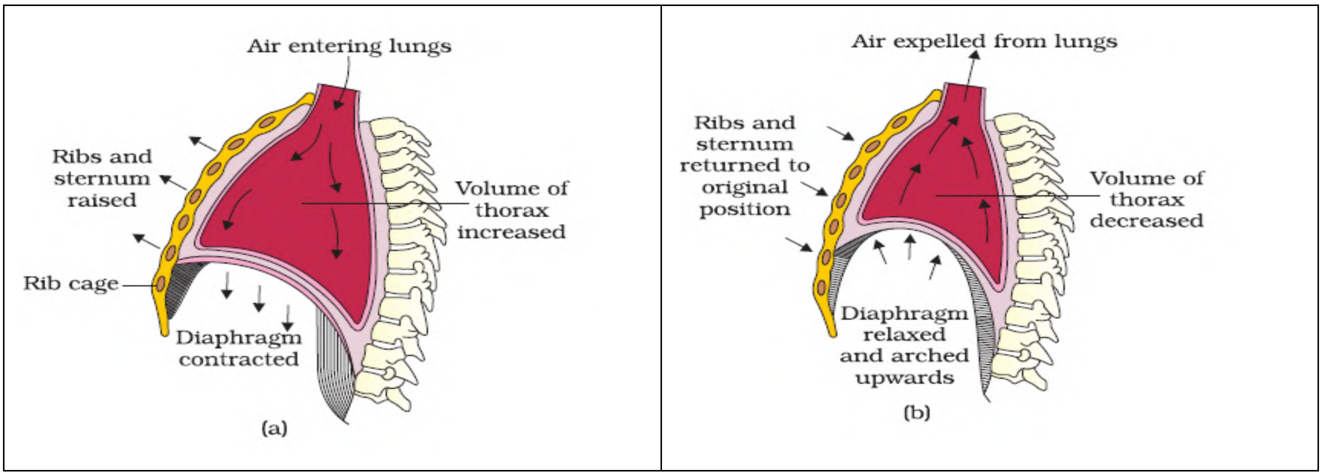
Advantages of lung breathing – Lungs lie within the body, hence respiratory surface can be kept moist.

- Air less dense than water, hence requires less energy to move the air to and from the respiratory surface.
- A tidal flow (in and out) sufficient to ventilate lungs.

BREATHING MECHANISM –

Breathing is brought about by alternate expansion and contraction of the thoracic cavity wherein the lungs lie.

Inspiration/ Inhalation/ Breathing in	**Expiration/ Exhalation/ Breathing out**
When air is breathed in, the diaphragm and muscles attached to the ribs contract due to which there occurs expansion of chest cavity, it results increase in volume of chest cavity thus the air pressure decreases and air from outside rushes into the lungs and alveolar sacs get filled with air containing oxygen. The oxygen present in air diffuses into the blood and CO2 from blood diffuse out into alveolar sac	(ii) Exhalation : When air is breathed out the diaphragm and muscles attached to ribs relax, which brings about contraction in chest cavity, its volume gets reduced and CO2 is pushed out from lungs into the air through trachea and nostrils.



<u>Functions of lungs</u> – to oxygenate the blood and to remove waste carbon dioxide.

<u>Partial pressure</u> – of a gas is the pressure it exerts in a mixture of gases.

<u>Gaseous exchange</u> – In alveoli

- is due to higher partial pressure of oxygen in alveoli than in blood, hence oxygen diffuses from alveoli into the blood through respiratory membrane.
- Oxygen combines with haemoglobin in red blood cells to form **oxyhaemoglobin**.
- Carbon dioxide in lung capillaries has higher partial pressure than that in the alveoli, hence it diffuses from blood into alveoli.
- Alveolar air thus becomes foul and is renewed.
- When the blood leaves the alveolus, it has almost the same partial pressure of O_2 and CO_2 as the alveolar air.

– In tissues

- Exchange occurs between blood and tissue cells via tissue fluid. Blood in tissue capillaries has partial pressure of oxygen higher than that in the tissue cells.
- Partial pressure of carbon dioxide is lower than that in the tissue cells.
- Tissue cells constantly use oxygen in oxidation that produces carbon dioxide, hence, here partial pressure of O_2 is lower and partial pressure of CO_2 is higher than the blood coming to them.
- Due to these differences in the partial pressures of CO_2 and O_2 between blood and tissue cell, O_2 separates from oxyhaemoglobin and diffuses from the blood into the tissue fluid and then into the tissue cells and CO_2 diffuses from the tissue cells into the tissue fluid and thence into the blood.
- Deoxygenated blood by this respiration returns to the right side of the heart that sends it to lungs for reoxygenation.

GASEOUS TRANSPORT IN BLOOD

Oxygen transport –

- **As solution –** 3% of O_2 is transported in dissolved state in plasma.

- **As oxyhaemoglobin –** 97% of oxygen diffuses from plasma into the R.B.Cs. An oxyhaemoglobin molecule may carry 1 to 4 oxygen molecules of O_2.

➢ **Oxygenation -** Hb loosely joins with Fe^{++} ions of Hb to form bright red oxyhaemoglobin.

In lungs

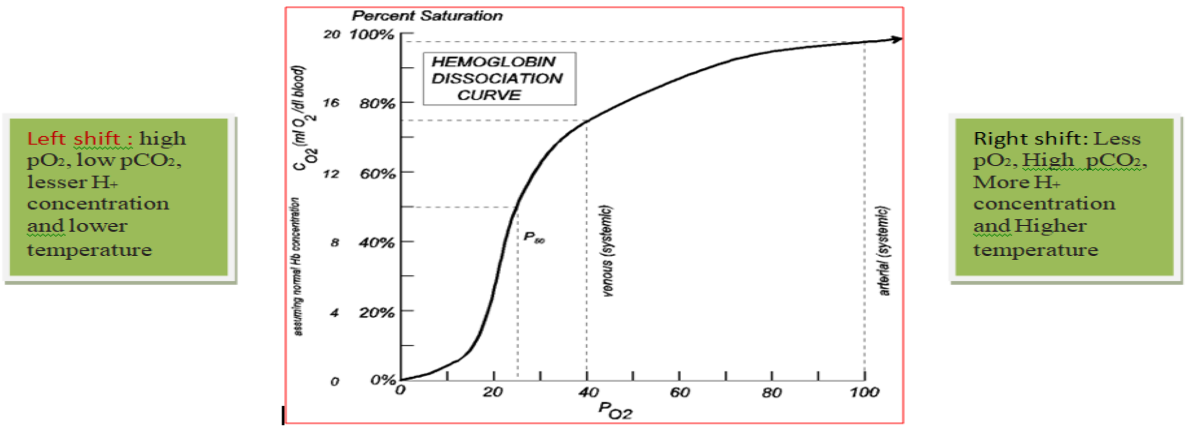
$$\underset{\text{(Haemoglobin)}}{Hb_4 + 4O_2} \underset{\text{In tissues}}{\overset{\text{In lungs}}{\rightleftharpoons}} \underset{\text{(Oxyhaemoglobin)}}{Hb_4\,O_8}$$

A fully saturated oxyhaemoglobin molecule carries 4 oxygen molecules.

- **Haemoglobin** – A fall in the p CO_2. of blood due to its diffusion in the alveoli and when exposed to high p O_2 in the respiratory organs haemoglobin readily combines with oxygen and -

➢ Releases oxygen equally readily when exposed to low p O_2 in the tissues and high p CO_2 favour dissociation of oxyhaemoglobin to purplish red reduced haemoglobin and molecular oxygen. Haemoglobin is returned to lungs for reuse in oxygen transport.

<u>Oxygen dissociation curve of haemoglobin</u> – The sigmoid curve showing relationship between the percentage saturation of haemoglobin in blood and the pO_2 of the blood.



➢ When fully saturated, each gram of haemoglobin combines with nearly1.34ml of oxygen.

➢ H+ concentration, CO_2 tension, temperature affect the curve. Increase in their concentration decreases the affinity of haemoglobin for oxygen.

Carbon Dioxide Transport

- As Solution- 7% of the CO_2 dissolves and is carried in the plasma.
- As bicarbonate ions – 70% of CO_2 into the R.B.Cs. Here it combines with water to form carbonic acid in the presence of enzyme carbonic anhydrase.
  Carbonic acid dissociates into bicarbonate and H^+.
- As carbaminohaemoglobin – 23% of CO_2 entering the R.B.Cs. loosely combines with the amino group ($-NH_2$) of the reduced haemoglobin (Hb) to form carbaminohaemoglobin. The reaction releases oxygen from oxyhaemoglobin.
- Every 100 ml of deoxygenated blood delivers approximately 4ml of CO_2 to the alveoli.

Vital capacity is higher in athletes and sportsmen.

Higher in males than in females.

In young man than in old man.

Smoking reduces the vital capacity of the lungs and decreases the capacity for strenuous muscular activity.

Pulmonary air volumes and capacities

Pulmonary / Lung volumes – The quantities of air the lungs can receive, hold or expel under different conditions.

Pulmonary capacity – refers to a combination of two or more pulmonary volumes.

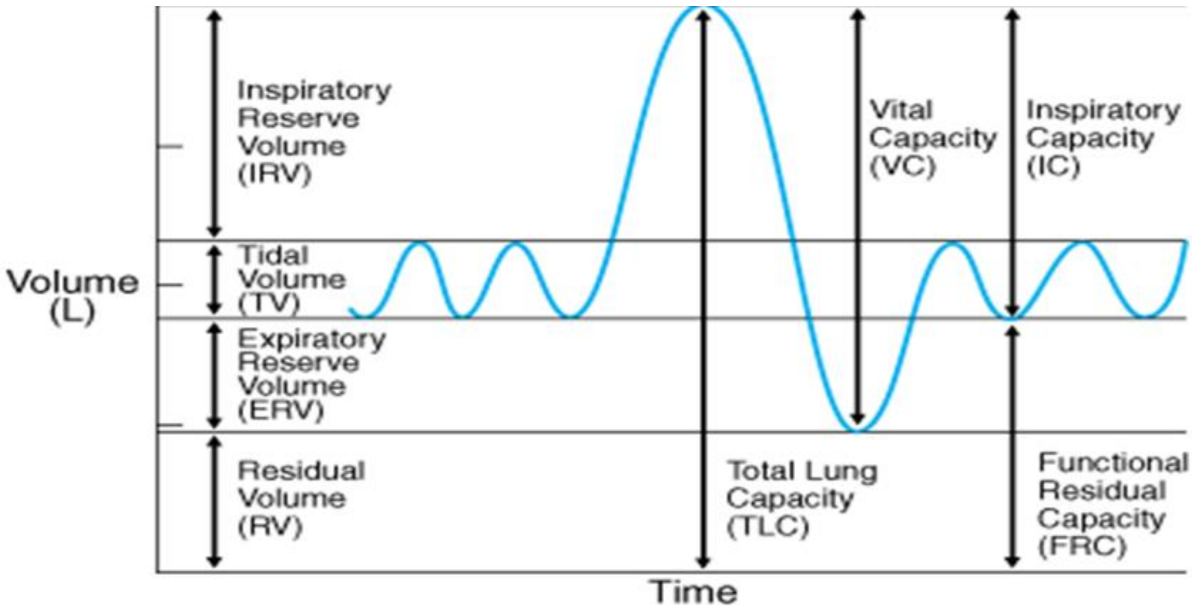
Tidal volume – Volume of air normally inspired or expired in one breath without any effort (500ml for an average adult human male).

Inspiratory reserve volume (IRV) –extra amount of air which can be inhaled forcibly after a normal inspiration (2000-2500 ml).

Expiratory reserve volume (ERV) – the extra amount of air which can be exhaled forcibly after a normal expiration (1000 -1500 ml).

Vital capacity (VC) – Amount of air which one can inhale with maximum effort and also exhale with maximum effort (3.5 – 4.5 litres in normal adult).

TV+ IRV+ ERV = VC

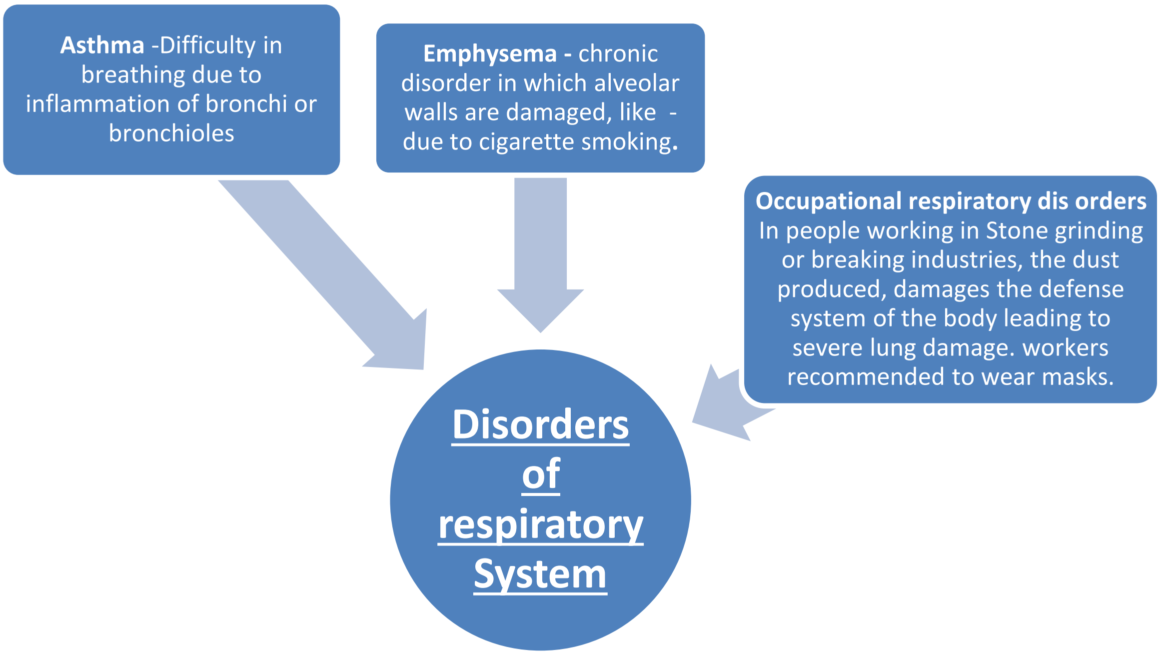


Graphical Representation of Pulmonary Volumes and Pulmonary Capacities

Residual volume (RV) – the air that always remains in the lungs even after forcible expiration. It enables lungs to continue exchange of gases even after maximum exhalation or on holding the breath.
Inspiratory capacity (IC) – Total volume of air which can be inhaled after a normal expiration(IC = TV + IRV = 2500 – 3000 ML).
Functional residual capacity (FRC) – FRC=RV + ERV = 2500 to 3000 ml.
Total lung capacity (TLC) – TLC =VC+ RV (5000 -6000ml).

Regulation of respiration

- Respiratory rhythm centre in the medulla of brain - mainly responsible for this regulation.
- Pneumotaxic centre in pons region of the brain moderates functions of respiratory rhythm centre.
- A chemosensitive area, adjacent to rhythm centre is highly sensitive to CO^2 and H^+ ions. Increase in them activates this centre, which in turn signal the rhythm centre to make necessary adjustments in the respiratory process by which these substances can be eliminated.
- Receptors associated with aortic arch and carotid artery- also sensitive to CO^2 and H^+ ion concentrations and send signals to rhythm centre for remedial action.



MULTIPLE CHOICE QUESTIONS

Q1. Which of the following part(s) of respiratory system is affected in asthma -

a) Lungs b) Trachea c) Bronchi and bronchioles d) alveoli

Q2. Excessive cigarette smoking causes which of the following respiratory disorders-

a) Emphysema b) Asthma c) Bronchitis d) All of the above

Q3. What is the amount of O_2 supplied to tissues through every 100 mL of oxygenated blood under normal physiological conditions?

a) 5 mL of oxygen/100 mL of oxygenated blood. b) 4 mL of oxygen/100 mL of oxygenated blood.
c) 6 mL of oxygen/100 mL of oxygenated blood. d) It varies from individual to individual.

Q4.What is the amount of C02 supplied to tissues through every 100 mL of deoxygenated blood under normal physiological conditions?

a) 5 mL of carbon dioxide /100 mL of oxygenated blood.
b) 4 mL of carbon dioxide /100 mL of oxygenated blood.
c) 6 mL of carbon dioxide /100 mL of oxygenated blood.
d) It varies from individual to individual

Q5. What will happen if CO2 level increases in blood?

a. Respiration rate become faster to compensate oxygen requirement.
b. Chemo sensitive area adjacent to respiratory rhythm centre gets activated.
c. Respiratory rhythm centre in medulla gets activated to regulate the breathing rate.
d. All the above

Q6.CO2 is transported in blood by-

a) Dissolving in plasma. b) haemoglobin as Carb amino haemoglobin
c) as bicarbonate ions in RBC and plasma d) All the above

Q7.Match the followings correctly

Column-I –Animals		Column-II	
(A)	Eartworm	I	Lungs
(B)	Most aquatic arthropods	II	Trachea
(C)	Fishes	III	Gills
(D)	Birds/ Reptiles	IV	Moist cuticle
(E)	Insects		

(a) A-IV, B and C-III, D-I, E-II (b) A- IV, B - III C and D -I, E - III
(c) A-II, B and C - III, D - I, E - IV (d) A-III, B and C-I, D-II, E-IV

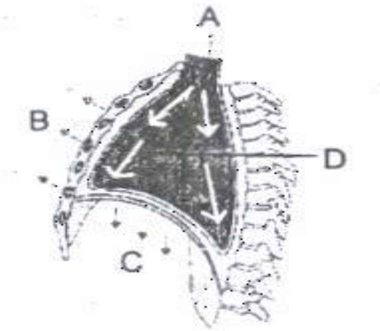
Q8.Respiration involves following steps –

I) Diffusion of gases $O2$ and $CO2$ across alveolar membrane II) Transport of gases by blood III) Utilization of $O2$ by cell for catabolic reactions and resultant release of $CO2$ IV) Pulmonary ventilation by

which atmospheric air is drawn in and $CO2$ rich alveolar air is released out V) Diffusion of $O2$ and $CO2$ between blood and tissues.

The correct sequence of steps is –
(a) I)→ II)→III)→ IV)→V) (b) V)→ IV)→III)→ II)→I)
(c) IV)→ I)→II)→ V)→III) (d) III)→II)→ V)→I)→ IV)

Q9. Following illustration depicts the mechanism of breathing. In which of the following option all the parts A. B, C and D are correctly labelled?



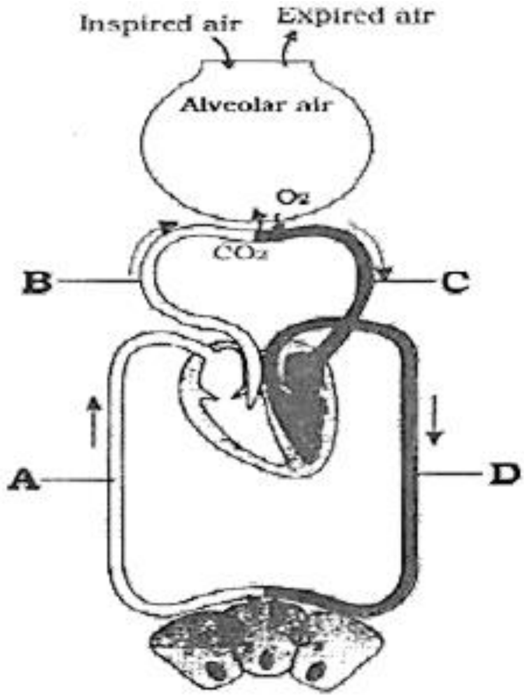
(a) A-Air entering into lungs; B- Ribs and sternum raised; C-Diaphragm contracted; D-Volume of thorax raised
(b) A - Air expelled from lungs; B - Ribs and sternum return to original position; C - Diaphragm relaxed; D - Volume of thorax decreased
(c) A-Air expelled from lungs; B- Ribs and sternum raised; C - Diaphragm relaxed; D -Volume of thorax decreased
(d) A-Air expelled from lungs; B- Ribs and sternum raised; C-Diaphragm

Q10.Match the following –

Column-I		Column-II	
1	Tidal Volume	(A)	Tidal volume and inspiratory reserve volume and expiratory reserve volume
2	Residual Volume	(B)	Additional amount of air inhaled beyond tidal volume when taking a very deep breath
3	ERV	(C)	Amount of air remaining in lungs after expiratory reserve volume is expelled
4	IRV	(D)	Tidal volume and inspiratory reserve volume
5	IC	(E)	Volume of air in one breath
6	VC	(F)	Amount of air exhaled in forced exhalation

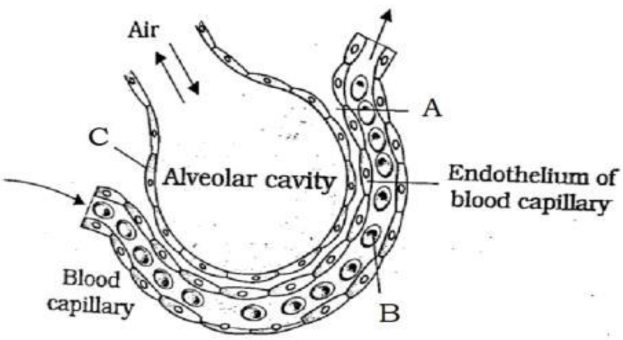
(a) 1 - C, 2 - E, 3 - B, 4 - F, 5 - D, 6 -A (b) 1 - E, 2 - F, 3 - C, 4 - B, 5 -A, 6 - D
(c) 1 - E, 2 - C, 3 - F, 4 - B, 5 - D, 6 -A (d) 1 - E, 2 - C, 3 - B, 4 - F, 5 -A, 6 – D

Q11. Name the blood vessels A to D-



	A	B	C	D
a)	Systemic vein	Pulmonary artery	Pulmonary vein	Systemic artery
b)	Systemic artery	Pulmonary artery	Pulmonary vein	Systemic vein
c)	Pulmonary artery	Systemic vein	Pulmonary vein	Systemic artery
d)	Systemic vein	Pulmonary vein	Pulmonary artery	Systemic artery

Q12.Study the given figure and identify A to C.



	A	B	C
a)	Basement membrane	RBC	Alveolar wall
b)	O2	CO2	Alveolar O2
c)	Pleura	RBC	Pericardium
d)	Pleura	WBC	Pulmonary vein

Q13.Which of the following factors favour the formation of oxyhaemoglobin in lungs?

(a) pO2 ↓, pCO2↑ , H+↑ , Temperature↑ (b) pO2 ↑, pCO2↑ , H+↓ , Temperature↑
(c) pO2 ↑, pCO2↓ , H+↓ , Temperature↓ (d) pO2 ↓, pCO2↑ , pH↑ , Temperature↓

Q 14. Which of the following is incorrect about the given graph.

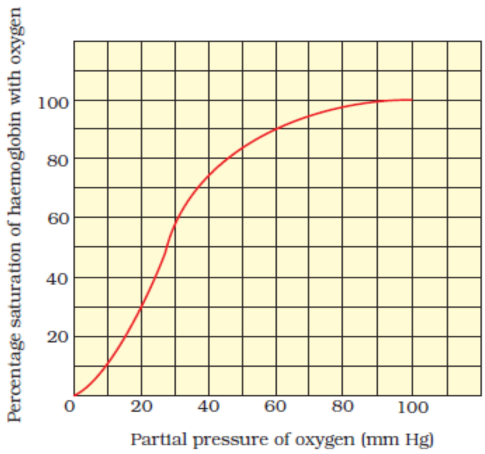


Figure 17.5 Oxygen dissociation curve

(a) Increase in partial pressure of CO_2 shift the curve to right. (b) At low temperature the curve shifts to left. (c) At high pH the curve shifts to right. (d) Decrease in partial pressure of oxygen shifts the curve to right.

Q15. Emphysema is characterised by –

(a) Permanent enlargement and destruction of alveolar area leading to reduction in respiratory surface
(b) Inhibition of respiratory centre (c) Accumulation of fluid in lungs
(d) Spasm of muscles of trachea

Q16. Why do human beings have difficulty breathing at high elevations?

(a) O_2 makes up lower percentage of air there (b) The temperature is lower there
(c) The barometric pressure is higher there (d) pO_2 is lower there

Q17. Which of the following diseases are occupational respiratory disorder?

(a) Silicosis, Fibrosis and asbestosis (b) Emphysema and mountain sickness
(c) Asthma and Emphysema (d) Asthma and Hepatitis

Q18. If an injury tore a small hole in the membrane surrounding lungs, what effect on lung function would you expect?

(a) Pneumothorax with lung collapse (b) Pneumothorax without lung collapse
(c) Silicosis with lung collapse (d) Silicosis without lung collapse

Q19. Assertion - A drop in the blood pH causes an increase in heart rate.

Reason- Increased Heart Rate increases the rate at which CO_2 is delivered to the lungs, where CO_2 is removed.

a) Both assertion and reason are true and reason is correct explanation of assertion.
b) Both assertion and reason are true and reason is not correct explanation of assertion.
c) Assertion is true but reason is false.
d) Both assertion and reason are false.

Q20. Assertion- The maximum pO_2 in alveoli is considerably less than in the atmosphere.

Reason- Lungs in mammals do not completely empty with each breath and inhalation occurs through the same airways as exhalation, so each inhalation mixes fresh air with oxygen depleted residual air.

a) Both assertion and reason are true and reason is correct explanation of assertion.
b) Both assertion and reason are true and reason is not correct explanation of assertion.

c) Assertion is true but reason is false.
d) Both assertion and reason are false.

ANSWER KEY
MULTIPLE CHOICE QUESTION BANK

Chapter -17 Name of Chapter-Breathing and Exchange of Gases

Q.1	**Q.2**	**Q.3**	**Q.4**	**Q.5**	**Q.6**	**Q.7**	**Q.8**	**Q.9**	**Q.10**
c	a	a	b	d	d	a	C	a	c
Q.11	**Q.12**	**Q.13**	**Q.14**	**Q.15**	**Q.16**	**Q.17**	**Q.18**	**Q.19**	**Q.20**
a	a	c	d	a	d	a	a	a	b

SA-I (2marks)

Q21. Arrange the following parts of the human respiratory system in a proper sequence starting from the nose- Nasal cavity, alveolus, trachea, bronchioles, bronchi

Ans: Nasal cavity, trachea, bronchi, bronchioles.

Q22. Write the appropriate volumes of the following respiratory volumes-

Inspiratory Reserve Volume (IRV), Expiratory Reserve Volume (ERV), tidal volume (TV),
Residual Volume (RV)

Ans: IRV (2500 mL to 3000 mL), ERV (1000 mL to 1100 mL), TV (500mL), RV (1100mL to 1200mL)

Q23. Distinguish between Inspiratory Capacity and Expiratory Capacity.

Ans: Inspiratory capacity: It is the volume of air that can be inhaled after a normal expiration.

IC = TV + IRV

Expiratory capacity: It is the volume of air that can be exhaled after a normal inspiration.

EC = TV + ERV

Q24. Distinguish between Vital Capacity and Total Lung Capacity.

Ans: Vital capacity: It is the maximum volume of air that a person can breathe in after forced expiration.

VC=ERV+TV+IRV

Total lung capacity: The total volume of air accommodated in the lungs at the end of a forced
Inspiration.

TLC= VC+RV

Q25. **What is chloride shift? Explain.**

Ans : The diffusion of chloride ions from blood plasma into RBS's is known
as chloride shift.
a) Occurs from plasma to RBC's in human body.
b) It maintains ionic balance and electrochemical neutrality.

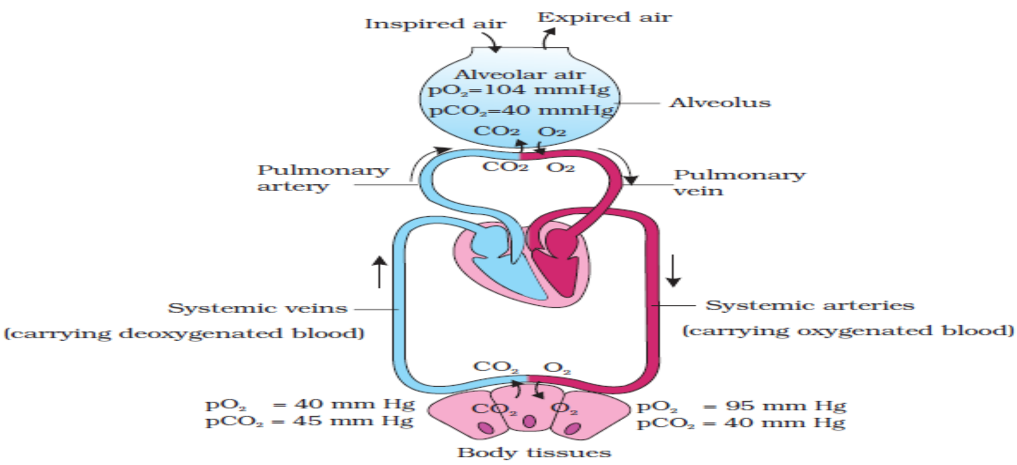
SA-II (3 marks)

Q26.-A. Explain the oxygen dissociation curve. Briefly explain how H+ ion and CO2 concentration affects the binding of oxygen to haemoglobin in lungs and in tissues.
B. Diagrammatically represent the exchange of gases (O2 and CO2) at the alveolus and the body tissues with blood.

Ans:-A. When the partial pressure of oxygen is plotted against percentage saturation of haemoglobin with oxygen, sigmoid shaped curve is obtained. This is termed as oxygen dissociation curve In alveoli, high O2, low temperature, lowCO2 and low H+ ion concentration favours binding of oxygen to haemoglobin.

In tissues, low O2, high temperature, high CO2 and high H+ ion concentration favours dissociation of oxygen from haemoglobin.

Ans:-B.

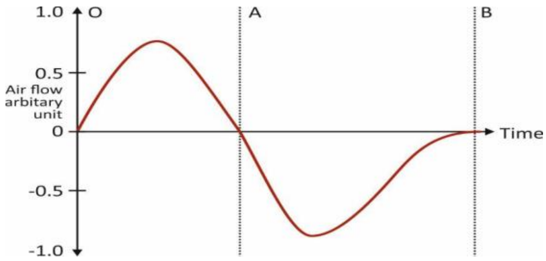


Q27. What is the role of the carbonic anhydrase enzyme in the transport of gases during respiration?

Ans: Carbon dioxide produced by the tissues diffuses into the bloodstream and passes into the red blood corpuscles where it reacts with water to form carbonic acid (H_2CO_3) catalysed by carbonic anhydrase found in the erythrocytes and plasma.

Carbonic acid dissociates into hydrogen (H+) and bicarbonate (HCO_3^-) ions.
Thus, CO_2 is transported in blood as bicarbonate ions and it also acts as a source of H+ ions which affects the transport of oxygen in blood.

Q28. The graph represents airflow in and out of the lungs during a normal breath.



A. Which parts of the graph represent inspiration and expiration?
B. How does the relationship between the pressure in the lungs and the atmospheric pressure vary between phases OA and AB?
C. How is the pressure gradient generated in different phases of breathing?

Ans:

A. OA represents inspiration and AB represents expiration.
B. In phase OA (inspiration), the pressure within the lungs (intra-pulmonary pressure) is less than the atmospheric pressure, and in phase AB (expiration), the pressure within the lungs is slightly above the atmospheric pressure.
C. During inspiration, the diaphragm and the external intercostal muscles contract, lifting the ribs and the sternum. This increases the volume of the thoracic chamber and, thereby, the pulmonary volume and leads to a decrease in intra-pulmonary pressure.
During expiration, the diaphragm and the intercostal muscles relax, which returns the diaphragm and sternum to their normal positions and reduces the thoracic volume, which thereby reduces the pulmonary volume and leads to an increase in intra-pulmonary pressure.

Case Study based Questions (4 marks)

Q29. A yogi does pranayama every day. His strength of breathing increases. Deep breaths fill the lungs with oxygen which makes him feel young and energetic.

a) How can we increase the strength of inspiration and expiration?

b) How many times does a healthy human adult breathe in one minute?

c) Name the instrument which is used to measure volume of air involved in breathing movements.

d) Lungs are situated in the thoracic chamber which is anatomically an air tight chamber. Explain and highlight its importance in breathing.

Ans: a) By using additional muscles of abdomen. b) 12-16 times/ minute c) Spirometer

d) In our body, the lungs are situated in an air-tight chamber called the thoracic chamber. This chamber consists of the vertebral column at the back, sternum in the front, ribs on the sides and diaphragm on the lower side. This setup of the lungs is such that any change in the volume of the thoracic cavity will affect the lung cavity. This is very important for inspiration and expiration.

Q30. Breathing is a physical phenomenon where oxygen from the atmosphere is exchanged with the carbon dioxide produced by the cells. Various organisms have different mechanisms for breathing depending upon their needs and habitat. For example, lower invertebrates like sponges exchange gases by simple diffusion while earthworms use cuticle and insects have a network of tubes to transport atmospheric air within the body. Special vascularized structures called gills are used by aquatic arthropods and molluscs whereas vascularised bags called lungs are used by terrestrial forms for the exchange of gases. Fishes use gills while birds and mammals have lungs and amphibians use their moist skin to exchange gases.

(i) . **Assertion (A) :** Breathing is different from respiration.
Reason (R) : Breathing is physical and respiration is biochemical.
(a) If both (A) and (R) are correct and (R) is the correct explanation of (A)
(b) If both (A) and (R) are true, but (R) is not the explanation of (A)
(c) If (A) is true but (R) is false
(d) If both (A) and (R) are false

(ii). Why is the mechanism of breathing different for different organisms?
(a) To meet their needs
(b) To help them adapt to their environment
(c) To suit their mode of life
(d) All of the above

(iii). What special name is given to the vascularised bags of terrestrial animals and vascularised structures of aquatic arthropods and molluscs?

(a) Gills and lungs respectively (b) Lungs and trachea respectively
(c) Lungs and gills respectively (d) Gills and trachea respectively

(iv). How do lower invertebrates like sponges exchanges gases?

(a) Diffusion (b) Osmosis (c) Breathing (d) Cuticle exchange

(v). Assertion : The larynx is called the sound box.

Reason : The larynx is a cartilaginous box that helps in sound production.

(a) If both (A) and (R) are correct and (R) is the correct explanation of (A)
(b) If both (A) and (R) are true, but (R) is not the explanation of (A)
(c) If (A) is true but (R) is false
(d) If both (A) and (R) are false

Ans:- (i)-a , (ii)-d , (iii)-c ,(iv)-a ,(v)-a

LA (5 marks)

Q31. (a)Name the muscles involved in breathing. Explain the mechanism of inspiration and expiration.

(b) Describe how is respiration regulated in humans

Ans: (a)The diaphragm and external and intercostal muscles between the ribs aid in the generation of pressure gradient which helps in inhalation and exhalation.

INSPIRATION: The contraction of the diaphragm muscles and external intercostal muscles pull the ribs and sternum upwards and outwards. This increases the thoracic volume and the pulmonary volume. The increase in pulmonary volume and decrease in the intrapulmonary pressure force the air from outside to enter the air passages into the lungs.

EXPIRATION: Relaxation of the diaphragm allows the diaphragm and sternum to return to its original shape and the internal intercostal muscles contract, pulling the ribs downward reducing the thoracic volume and pulmonary volume. This results in an increase in the intrapulmonary pressure slightly above the atmospheric pressure causing the expulsion of air from the lungs.

(b)Ans: Respiratory rhythm centre situated in medulla region of brain regulate and maintain respiratory rhythm.
Pneumotaxic centre in pons region can alter the rate of respiration.

This process is also assisted by a chemo sensitive area is situated adjacent to the rhythm centre .
The receptors associated with aortic arch and carotid artery which are highly sensitive to CO_2
and hydrogen ions.
Pneumotaxic centre, chemo sensitive area and receptors associated with arteries get activated when CO_2 and H^+ concentration is high in blood and signals respiratory rhythm centre for remedial action.

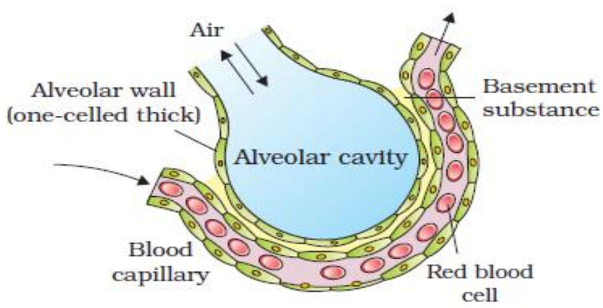
Q32. (a) How is oxygen transported by blood from the lungs to the tissues?
(b) How is oxygen released from blood in tissues?
(c) Name at least four factors which favours formation of oxyhaemoglobin.
Ans: a) 97% of the oxygen is transported from the lungs to the tissues in form of oxyhaemoglobin and 3% is transported in dissolved condition by the plasma.

b) When the oxygenated blood reaches the tissues, the partial pressure of oxygen is low in tissues (40 mm of Hg) and the bonds holding oxygen to haemoglobin become unstable. As a result, oxygen is liberated which diffuses out of walls of capillaries.

c) High pO_2, low pCO_2, lesser H^+ concentration, and lower temperature.

Q33. a) Mention three layers through which act as diffusion surface between alveoli and blood.
b) What are the factors that affect the rate of diffusion between the blood and tissues?

c) Draw a neat and well labelled diagram of a section of an alveolus with a pulmonary capillary.
Ans: a) Squamous epithelium of alveoli, endothelium of alveolar capillaries and the basement substance.
   b) pressure/concentration gradient, solubility of gases, thickness of membranes involved.



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CHAPTER-18 Body fluid & Circulation

Need – Body fluids need to be circulated constantly to supply nutrients, oxygen and other essential substances and for simultaneous removal of the wastes, for the healthy functioning of a living organism.

Circulatory system – Blood vascular system and lymphatic system are together referred to as Circulatory system in vertebrates.

Blood vascular system – Has blood as the circulating fluid.

Lymphatic system – Has lymph as the circulating fluid.

Types of fluid circulation –

<table>
<tr><th>S. No.</th><th>Animal groups</th><th>Type of fluid circulation</th><th>Description</th></tr>
<tr><td>1</td><td>Sponges and Coelenterates</td><td>Water circulation</td><td>Circulate water from their surroundings through their body cavities to facilitate the cells to exchange substances.</td></tr>
<tr><td>2</td><td>Flat worms</td><td>Body fluid (Parenchymal fluid) circulation</td><td rowspan="4">Body fluid circulation – more active animals have higher metabolic rates. Need a quicker supply of food and oxygen to their tissues and equally quicker removal of waste materials. Hence, they have developed special body fluids which circulate within the body.</td></tr>
<tr><td>3</td><td>Round worms</td><td>Body fluid (pseudo coelomic fluid) circulation</td></tr>
<tr><td>4</td><td>Higher invertebrates (Annelida - Echinodermata) and chordates</td><td>Body fluid circulation (specialized circulating fluid – blood pumped by heart and circulated through tubes called blood vessels)</td></tr>
<tr><td>5</td><td>All vertebrates</td><td>Body fluid circulation (Lymph through lymphatic vessels, capillaries and lymph nodes)</td></tr>
</table>

BLOOD VASCULAR SYSTEM –

Heart- Special contractile blood pumping organ. **Blood vessels –** Tubes associated with heart into which the blood is pumped and circulated. **Blood -** Fluid connective tissue, consists of a fluid matrix, plasma and formed elements.	**Blood is a safer circulating fluid than environmental water because it is not affected by external changes like temperature variation, pollution etc.** **Blood contains carrier molecules (haemoglobin, haemocyanin, plasma proteins) that can transport much larger amounts of nutrients and gases than water.**

	Open system of circulation		Closed system of circulation
1.	In this system, blood is pumped by the heart, through large vessels, into body cavities called sinuses.	1.	In this system, blood is pumped by the heart, through a closed network of vessels.
2.	The body tissues are in direct contact with blood.	2.	The body tissues are not in direct contact with blood.
3.	Blood flows at low pressure. Hence, it is a slower and less efficient system of circulation.	3.	Blood flows at high pressure. Hence, it is a faster and more efficient system of circulation.
4.	The flow of blood is not regulated through the tissues and organs.	4.	The flow of blood can be regulated by valves.
5.	This system is present in arthropods and molluscs.	5.	This system is present in annelids, echinoderms, and vertebrates.

BLOOD

Plasma

- Plasma is a straw coloured, viscous fluid constituting nearly 55 per cent of the blood.
- 90-92 per cent of plasma is water and proteins contribute 6-8per cent of it.
- Fibrinogen, globulins and albumins are the major proteins.
- Plasma without the clotting factors is called serum.
- Fibrinogens are needed for clotting or coagulation of blood.
- Globulins -primarly are involved in defense mechanisms of the body
- Albumins - help in osmotic balance.
- Glucose, amino acids, lipids, etc., are also present in the plasma as they are always in transit in the body.
- Plasma also contains small amounts of minerals like Na+, Ca++, Mg++, HCO_3^- etc.
- Factors for coagulation or clotting of blood are also present in the plasma in an inactive form.

Formed Elements

(Erythrocytes, leucocytes and platelets -They constitute about 45

Erythrocytes or red blood cells (RBC) - most abundant of all

- The cells in blood. **Erythrocytes** or red blood cells (RBC) -most abundant of all the cells in blood.
- A healthy adult man has, on an average, 5 millions to 55 millions of RBCs mm-3 of blood. RBCs are formed in the red bone marrow in the adults. RBCs are devoid of nucleus in most of the mammals and are biconcave in shape.They have a red coloured, iron containing complex protein called haemoglobin, hence the colour and name o f these cells. A healthy individual has 12-16 gms of haemoglobin in every 100 ml of blood. These molecules play a significant role in transport of respiratory gases. RBCs have an average life span of 120 days after which they are destroyed in the spleen (graveyard of RBCs).

Leucocytes are also known as white blood cells (WBC) as they are colourless due to the lack of haemoglobin.

- They are nucleated and are relatively lesser in number which averages 6000-8000 mm-3 of blood.
- Leucocytes are generally short lived.
- We have two maincategories of WBCs
- Agranulocytes and granulocytes.

Blood Platelets also called **thrombocytes**, are cell fragments produced from megakaryocytes (special cells in the bone marrow). Blood normally contains 1,500,00-3,500,00 platelets mmñ3. Platelets can release a variety of substances most of which are involved in the coagulation or clotting of blood. A reduction in their number can lead to clotting disorders which will lead to excessive loss of blood from the body.

Agranulocyte

Monocytes (6-8 per cent) are phagocytic cells which destroy foreign organisms entering the

Lymphocytes (20-25 per cent) are of two major types Band T forms.

- Both B and T lymphocytes are responsible for immune responses of the body.

Granulocyte

Neutrophils are the most abundant cells (60-65 per cent) of the total WBCs are phagocytic.

Eosinophils (2-3 per cent) resist infections and are also associated with allergic reactions.

Basophils are the least (0.5-1 per cent) among them.

- **Basophils** secrete histamine, serotonin, heparin, etc., and are involved in inflammatory reactions.

Blood Groups

- Two groupings are ABO and Rh.

ABO grouping

- ABO grouping is based on the presence or absence of two surface antigens (chemicals that can induce immune response) on the RBCs namely A and B.
- Plasma of different individuals contains two natural antibodies (proteins produced in response to antigens).
- During blood transfusion, any blood cannot be used.
- Blood of a donor has to be carefully matched with the blood of a recipient before any blood transfusion to avoid severe problems of clumping (destruction of RBC).

Combinations of antigens and antibodies in different blood groups

Blood group	Antigen (on the surface of R.B.Cs)	Antibody (in plasma)	Alleles
A	A	anti B	I^AI^A, I^Ai
B	B	anti A	I^BI^B, I^Bi
AB	A and B	None	I^AI^B
O	None	anti A and anti B	i i

- Blood group O can be donated to persons with any other blood group - hence called universal donors.
- Persons with AB group can accept blood from persons with AB as well as from people with other groups of blood- hence called universal recipients.

Blood Groups and Donor Compatibility

Donor	Recipients agglutinating blood of O A B AB	Possible recipients having blood group	Prospective donors having blood group	Remarks
O	− − − −	O, A, B, AB	O	Donor
A	+ − + −	A, AB	O, A	−
B	+ + − −	B, AB	O, B	−
AB	+ + + −	AB	O, A, B, AB	Universal recipient

Rh grouping

- **Rh positive** (Rh+ve) - Rh antigen similar to one present in Rhesus monkeys (hence Rh), observed on the surface of RBCs of majority (nearly 80 per cent) of humans.
- **Rh negative** (Rh-ve) - those in whom this antigen is absent .

- An Rh-ve person, if exposed to Rh+ve blood, will form specific antibodies against the Rh antigens.
- Blood transfusion - Rh group should also be matched before transfusions.
- ***Erythroblastosis foetalis*** - A special case of Rh incompatibility (mismatching) observed between the Rh-ve blood of a pregnant mother with Rh+ve blood of the foetus.
- **First pregnancy** - Rh antigens of the foetus do not get exposed to the Rh-ve blood of the mother as the two bloods are well separated by placenta.
- During delivery of first child, there is a possibility of exposure of the maternal blood to small amounts of Rh+ve blood from the foetus.
- The same mother starts preparing antibodies against Rh antigen in her blood.
- **Subsequent pregnancies** - the Rh antibodies from the mother (Rh-ve) can leak into the blood of the foetus (Rh+ve) and destroy the foetal RBCs.
- Could be fatal to the foetus or could cause severe anaemia and jaundice to the baby- *erythroblastosis foetalis*.
- Can be avoided by administering anti-Rh antibodies to the mother immediately after the delivery of the first child.

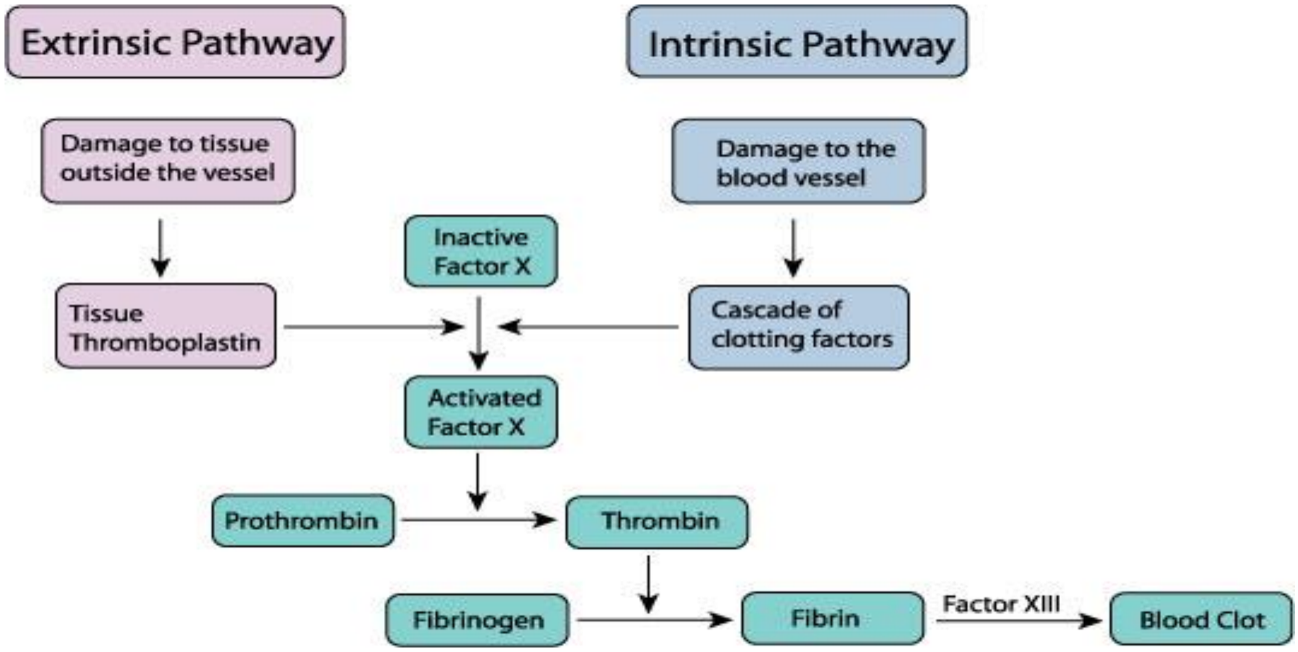
<u>Coagulation of Blood</u>

- Usually the blood stops flowing after sometime after an injury or trauma due to coagulation or clotting.
- Mechanism to prevent excessive loss of blood from the body.
- A dark reddish brown scum formed at the site of a cut or an injury over a period of time - clot or coagulum .
- Calcium ions play a very important role in clotting.

LYMPH (TISSUE FLUID)

Lymph
- is a colourless fluid containing specialised lymphocytes .
- responsible for the immune responses of the body.
- Lymph is also an important carrier for nutrients, hormones, etc.
- Fats are absorbed through lymph in the lacteals present in the intestinal villi

- **TISSUE FLUID** - When blood passes through capillaries in tissues, some water along with many small water-soluble substances move out into spaces between the cells of tissues leaving larger proteins and most of the formed elements in blood vessels.
- It has same mineral distribution as that in plasma.
- Exchange of nutrients, gases, etc., between the blood and cells always occur through this fluid.



- An elaborate network of vessels called **lymphatic system** collects this fluid and drains it back to major veins.
- **Lymph** –Fluid present in the lymphatic system.

CIRCULATORY PATHWAYS

Types of blood vascular system

Open circulatory system – The main blood vessels arising from the heart pour the blood into tissue spaces called sinuses.
-The blood comes in direct contact with the tissue cells thus exchanging respiratory gases, food materials and waste products directly between blood and tissue cells.
-Blood flows slowly through the open sinuses because of lack of enough blood pressure.
-Respiratory pigment, if any, is dissolved in blood plasma and red corpuscles are absent.
-Found in some arthropods and most molluscs.

Haemolymph – No distinction between blood and tissue fluid in animals with open circulatory system. Hence, blood / body fluid is appropriately called haemolymph.
-Serves to circulate the absorbed food and hormones to different body parts and collects nitrogenous wastes and sends it to excretory organ for elimination and helps in transport of gases.
Haemocoel –tissue spaces through which the blood flows are referred to as haemocoel.
Closed circulatory system –blood remains in blood vessels while circulating through the body and never comes in direct contact with the tissue cells.
-Blood is distinct from the body fluid.

<u>Course of blood circulation</u> –

Heart → Aortic arch → Arteries → Arterioles → Capillaries

-Materials like nutrients, respiratory gases, waste products, hormones are exchanged between the blood and the surrounding tissue cells across the thin and permeable capillary wall, through tissue fluid present in intercellular spaces.
-Tissue cells pass the wastes into the tissue fluid and thence into the capillaries which unite to form venules → vein → vena cava → open into heart.
-More efficient, as it generates sufficient blood pressure to maintain rapid flow of blood, quickening the blood circulation and supply of useful materials to tissues and removal of wastes from them.
-Regulated blood flow to the organs according to their needs because of the arterial musculature and pre- capillary sphincters.

Human Circulatory System

- Human circulatory system/ blood vascular system comprises **Heart (**a muscular chambered organ**)**, **blood vessels** (a network of closed branching vessels) and **blood**(the fluid which is circulated).

- **Heart-** situated in the thoracic cavity, in between two lungs, slightly tilted to left, size of a clenched fist.

  -pericardium - double walled membranous bag, protects heart, encloses pericardial fluid.

  -has four chambers- **atria -** small upper chambers, **ventricles** - two larger lower chambers

  - **interatrial septum** - A thin, muscular wall, separates the right and the left atria.

  - **inter-ventricular septum** - thick-walled, separates left and right ventricles.

  -atrio-ventricular septum- a thick fibrous tissue that separates atrium and ventricle of same side, each of these septa are provided with an opening through which the two chambers of the same side remain connected.

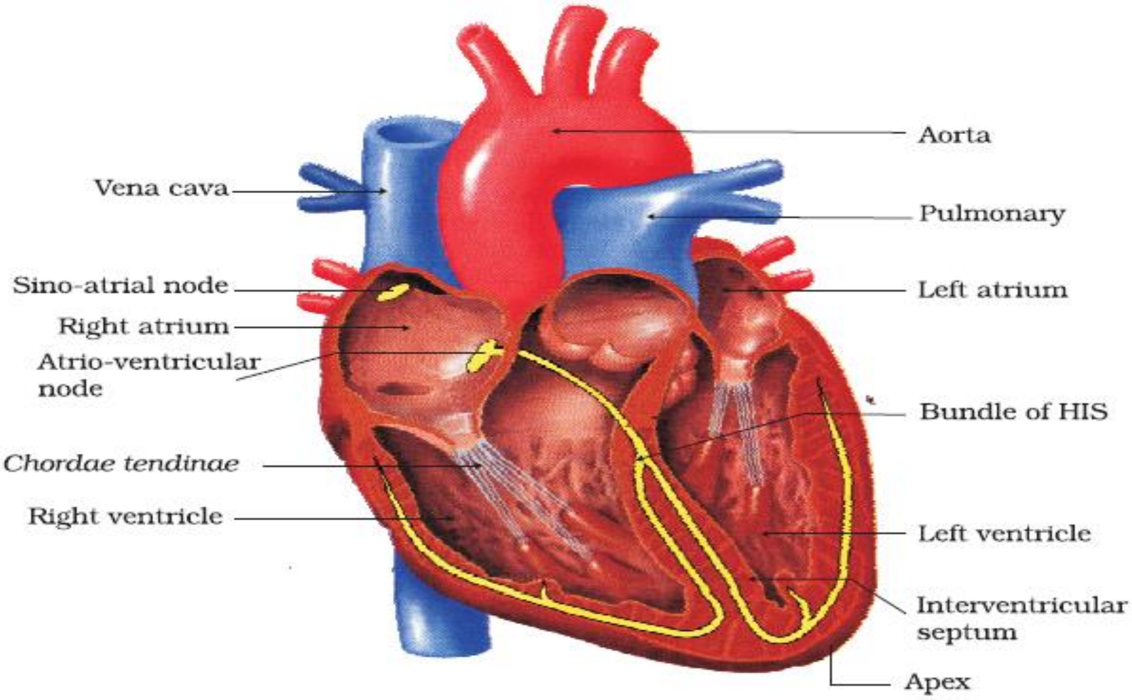


Figure 18.2 Section of a human heart

INTERNAL STRUCTURE OF HUMAN HEART

-tricuspid valve - opening between right atrium and right ventricle is guarded by this valve formed of three muscular flaps or cusps,

-bicuspid or mitral valve - guards opening between left atrium and left ventricle, allows flow of blood only in one direction, i.e., atria ventricles, valves prevent any backward flow.

Cardiac Cycle / Functioning of heart

- **Joint diastole** - all the four chambers of heart are in a relaxed state.

  - the tricuspid and bicuspid valves are open,

  - blood from pulmonary veins and vena cava flows into the left and right ventricle, respectively through the left and right atria.

  - semilunar valves are closed at this stage.

- **Atrial systole** -The SAN now generates an action potential which stimulates both atria to undergo a simultaneous contraction.
  This increases the flow of blood into the ventricles by about 30 per cent.
- **ventricular systole** - action potential is conducted to the ventricular side by the AVN and AV bundle from where the bundle of His transmits it through the entire ventricular musculature.

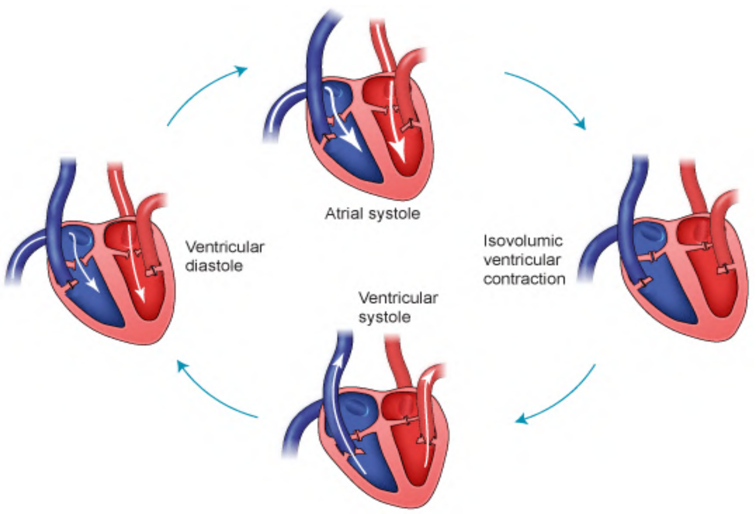
-This causes the ventricular muscles to contract - ventricular systole.

- **Atrial diastole** -

- relaxation (diastole) of the atria.
- coincides with the ventricular systole.

- **Closure of tricuspid and bicuspid valves** - Ventricular systole increases the ventricular pressure causing the closure of tricuspid and bicuspid valves due to attempted backflow of blood into the atria.

CARDIAC CYCLE



- **Opening of semilunar valves** -As the ventricular pressure increases further, the SL valves guarding the pulmonary artery (right side) and aorta (left side) are forced open, allowing the blood in the ventricles to flow through these vessels into the circulatory pathways.
- **ventricular diastole** –Now the ventricles relax (diastole)
- **Closure of semilunar valves** - ventricles relax
  - ventricular pressure falls
  - causing the closure of semilunar valves which prevents the backflow of blood into the ventricles.
- **Opening of tricuspid and bicuspid valves -** As the ventricular pressure declines further,
  the tricuspid and bicuspid valves are pushed open by the pressure in the atria exerted by the blood which was being emptied into them by the veins.
  The blood now once again moves freely to the ventricles.
- **Joint diastole** -The ventricles and atria are now again in a relaxed (joint diastole) state, as earlier.
- **Cardiac cycle** - Soon the SAN generates a new action potential and the events described above are repeated in that sequence and the process continues.

This sequential event in the heart which is cyclically repeated is called the **cardiac cycle**

-it consists of systole and diastole of both the atria and ventricles.

-the heart beats 72 times per minute, i.e., that many cardiac cycles are performed per minute.

-From this it could be deduced that the duration of a cardiac cycle is 0.8 seconds.

- **Stroke volume** - During a cardiac cycle, each ventricle pumps out approximately 70 ml of blood.
- **Cardiac output-** stroke volume multiplied by the heart rate (no. of beats per min.) gives the cardiac output.

-volume of blood pumped out by each ventricle per minute and averages 5000 mL or 5 litres in a healthy individual.

-The body has the ability to alter the stroke volume as well as the heart rate and thereby the cardiac output.

For example, the cardiac output of an athlete will be much higher than that of an ordinary man.

Pacemaker (SAN)

- **Auto-excitable** - The nodal musculature has the ability to generate action potentials without any external stimuli.
- the number of action potentials that could be generated in a minute vary at different parts of the nodal system.
- SAN can generate the maximum number of action potentials, i.e., 70-75 min^{-1}, and is responsible for initiating and maintaining the rhythmic contractile activity of the heart.
- Therefore, SAN is called the pacemaker.
- Our heart normally beats 70-75 times in a minute (average 72 beats min^{-1}).

- **Heart sounds** - During each cardiac cycle two prominent sounds are produced which can be easily heard through a stethoscope. These sounds are of clinical diagnostic significance.
- **First heart sound (lub)** is associated with the closure of the tricuspid and bicuspid valves
- **Second heart sound (dub)** is associated with the closure of the semilunar valves.

Electrocardiogram (ECG)

- Graphical representation of the electrical activity of the heart during a cardiac cycle is called as ECG & machine used to obtain an ECG is called as electrocardiograph.
- To obtain a standard ECG (a patient is connected to the machine with three electrical leads (one to each wrist and to the left ankle) that continuously monitor heart activity.

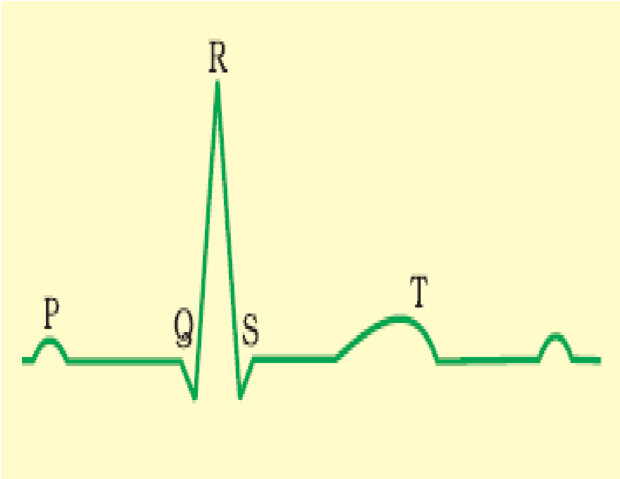


Figure 18.3 Diagrammatic presentation of a standard ECG

Electrocardiogram

A standard ECG-

- Each peak in the ECG is identified with a letter from P to T that corresponds to a specific electrical activity of the heart.
- **P-wave** - represents electrical **excitation (or depolarisation) of the atria**,which leads to the contraction of both the atria.
-The QRS complex represents the **depolarisation of the ventricles**, which initiates the ventricular contraction.
- The contraction starts shortly after Q and marks the beginning of the systole.
- The T-wave represents the return of the ventricles from excited to normal state (**repolarisation**).
- The end of the T-wave marks the end of systole.
- Obviously, by counting the number of QRS complexes that occur in a given time period, one can determine the heart beat rate of an individual.
- Since the ECGs obtained from different individuals have roughly the same shape for a given lead configuration, any deviation from this shape indicates a possible abnormality or disease.

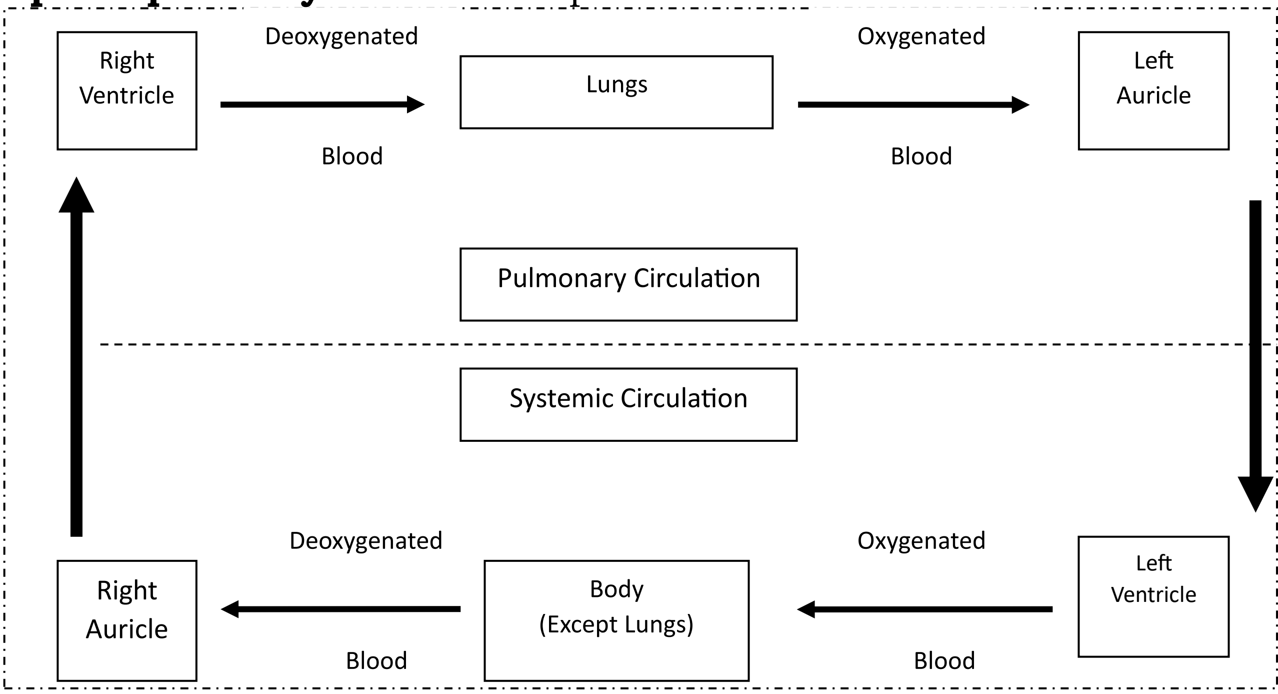
DOUBLE CIRCULATION

- Blood passes through the heart twice in each complete circuit round the body.
- Blood pumped by the right ventricle enters the pulmonary artery, whereas the left ventricle pumps blood into the aorta.
- **Pulmonary circulation** -deoxygenated blood pumped into the pulmonary artery is passed on to the lungs from where oxygenated blood is carried by the pulmonary veins into left atrium.
- **Systemic circulation** - oxygenated blood entering the aorta is carried by a network of arteries, arterioles and capillaries to tissues from where the deoxygenated blood is collected by a system of venules, veins and vena cava and emptied into right atrium.

- The systemic circulation provides nutrients, O_2 and other essential substances to the tissues and takes CO_2 and other harmful substances away for elimination.

- Avian and mammalian heart is completely four chambered having right and left ventricles.
- The deoxygenated and oxygenated blood remain fully separate and there is a complete double circulation.
- Supplies more oxygen per gram of body weight than other vertebrates of equal size.

Hepatic portal system- A unique vascular connection exists between the digestive tract and liver.



- The hepatic portal vein carries blood from intestine to the liver before it is delivered to the systemic circulation.
- Coronary circulation - special coronary system of blood vessels is present in our body exclusively for the circulation of blood to and from the cardiac musculature.

REGULATION OF CARDIAC ACTIVITY

- **Myogenic heart** - Normal activities of the heart are regulated intrinsically, i.e., auto regulated by specialised muscles (nodal tissue).
- A special neural centre in the medulla oblangata can moderate the cardiac function through autonomic nervous system (ANS).
- Neural signals through the sympathetic nerves (part of ANS) can increase the rate of heart beat, the strength of ventricular contraction and thereby the cardiac output.
- Parasympathetic neural signals (another component of ANS) decrease the rate of heart beat, speed of conduction of action potential and thereby the cardiac output.
- Adrenal medullary hormones can also increase the cardiac output.

DISORDERS OF CIRCULATORY SYSTEM

- **High Blood Pressure (Hypertension):** blood pressure higher than normal i.e. (120/80 where, 120 mm Hg (millimetres of mercury pressure) is the systolic, or pumping pressure and 80 mm Hg is the diastolic, or resting pressure.
  -If repeated checks of blood pressure of an individual is 140/90 (140 over 90) or higher, it shows hypertension.
  -High blood pressure leads to heart diseases and affects vital organs like brain and kidney.
- **Coronary Artery Disease (CAD)/ Atherosclerosis:** affects the vessels that supply blood to the heart muscle.
  -caused by deposits of calcium, fat, cholesterol and fibrous tissues, which makes the lumen of arteries narrower.
- **Angina / Angina pectoris**- acute chest pain appears when no enough oxygen is reaching the heart muscle.
  -occur in men and women of any age, but is more common among the middle-aged and elderly.
  - occurs due to conditions that affect the blood flow.
- **Heart Failure / congestive heart failure:** state of heart when it is not pumping blood effectively enough to meet the needs of body.
  -main symptom - congestion of the lungs.
  -Heart failure is not same as cardiac arrest (when the heart stops beating) or heart attack (when the heart muscle is suddenly damaged by an inadequate blood supply).

MULTIPLE CHOICE QUESTIONS

Q 1. I. Proteins contribute 6 - 8% of the blood plasma

II. Plasma contains very high amount of minerals

Ill. Plasma without the clotting factors is called serum

IV Glucose, amino acids, lipids, etc., are also present in the plasma as they are always in transit in the body. Of the above statements –

(a) All are correct (b) Only II is false (c) Only I, III, IV is correct (d) All are false

Q2. Match List I with List II and select the correct option.

	List I (Plasma Protein)	List II (Functions)	
I	Fibrinogen	A	Defence mechanism
II	Globulins	B	Osmotic balance
III	Albumins	C	Coagulation of blood

(a) I-C, II -A, III- B (b) I-A, II - C, III- B (c) I-C, II - B, III -A (d) l-B, II-A, III-C

Q3. Match list I with list II correctly –

	List I (Types of leucocytes/ WBCs)		List II (Their % (of total WBC)
I	Neutrophils	A	20 – 25
II	Basophils	B	2 – 3
III	Monocyte	C	6 – 8
IV	Eosinophils	D	0.5 – 1
V	Lymphocytes	E	60 – 65

(a) I - E, II - D, III - C, IV -A, V - B (b) I -A, II - B, III - C, IV - E, V - D
(c) I - E, II - D, III - C. IV - B, V –A (d) I - B, II - D, III -A, IV - C, V –A

Q4. A doctor suggested to a couple not to have more than one child because of –

(a) Rh+ male and Rh- female (b) Rh- male and Rh+ female
(c) Rh- male and Rh- female (d) Rh+ male and Rh+ female

Q5. In case of emergency which blood group could be safely transfused?

(a) AB Rh- (b) AB Rh+ (c) O Rh- (d) O Rh+

Q6. Which of the following is expected if husband is Rh+ and wife is Rh-?

(a) No problem with 1st pregnancy (b) Problem would be expected with future pregnancies
(c) Both (d) No problem could be expected in any pregnancy

Q7. Which of the following statement are correct?

I. Ca+2 is necessary for blood coagulation
II. Coagulation in blood vessel is prevented during normal condition by heparin III. Clotting of blood involves changes of fibrinogen to fibrin by thrombin IV. Blood clotting involves cascading process involving a number of factors present in the active form always

(a) I, Ill, IV (b) II, IV (c) I, II, Ill (d) Ill, IV

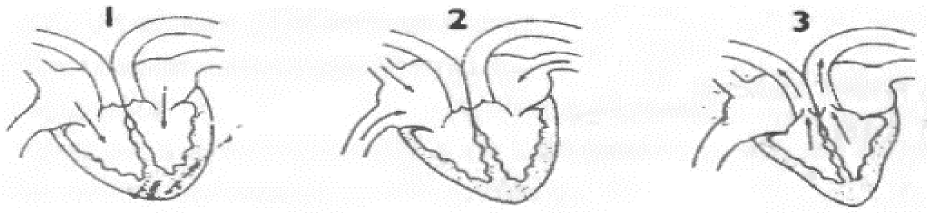
Q8. Origin of heart beat and its conduction is represented by –

a) SA-node → Purkinje fibres → AV-node→ Bundle of His
b) AV-node→ Bundle of His→ SA-node→ Purkinje fibres
c) Purkinje fibres→ AV-node→ SA-node→ Bundle of His
d) SA-node→ AV-node→ Bundle of His→ Purkinje fibres

Q9. Sino-atrial node (SAN) can generate impulses –

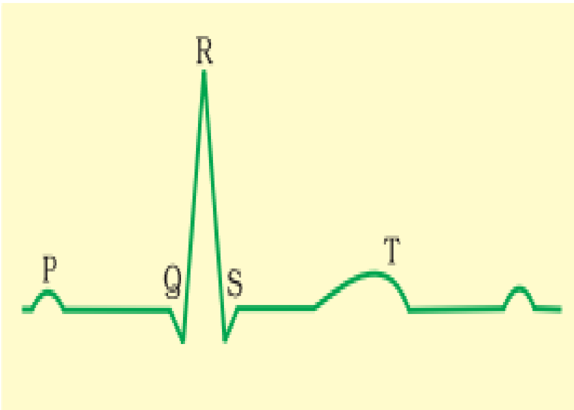
(a) 70 - 75 min-1 (b) 50 - 55 min-1 (c) 35 - 40 min-1 (d) 100-150 min-1

Q 10. The accompanying diagram shows three stages in the cardiac cycle- Which of the following sequence is correct?



(a) 2,3, 1 (b) 1,2, 3 (c) 2, 1, 3 (d) 3,1, 2

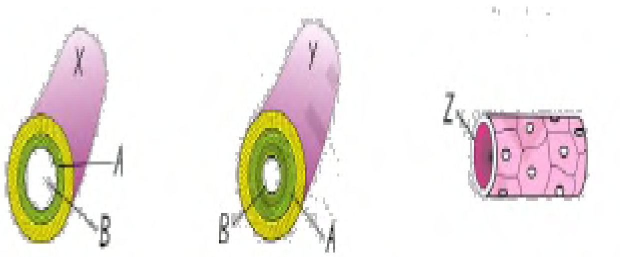
Q11. The below figure is the diagrammatic representation of standard ECG.



	Column I		Column II
A	P- wave	I	Ventricular depolarization followed by ventricular contraction
B	QRS Complex	II	Atrial depolarization followed by systole of both atria
C	T- wave	III	Ventricular repolarization followed by ventricular relaxation

(a) A-I, B-II, C-III (b) A-III, B -II, C-I (c) A-II, B – I. C - III (d) A-II, B-III, C – I

Q12. Identify X, Y and Z?



	X	Y	Z
a	Vein	Artery	Capillary
b	Capillary	Artery	Vein
c	Artery	Capillary	Vein
d	Vein	Capillary	Artery

Q13. The hepatic-portal vein carries blood from to the ____ before it is delivered to the systemic circulation-

(a) Liver, intestine (b) Pancreas, intestine (c) Intestine, liver (d) Hepatic artery, hepatic vein

Q14. A special coronary system of blood vessels present in our body exclusively for the circulation of blood to and from the-

(a) Corneocytes (b) Cornea (c) Cori cycle (d) Heart/Cardiac musculature

Q15. Parasympathetic neural signal decreases cardiac output by –

(a) Decreasing the rate of heart beat (b) Decreasing the speed conduction of action potential

(c) Both (d) Increasing adrenal medulla hormones secretion

Q16. Heart beat increases –

(a) On stimulation of sympathetic nerves (b) On stimulation of vagus nerve (para sympathetic nerve) (c) By adrenaline secreted by adrenal medulla (d) Both a and c

Q17. Assertion – A physician might order a white cell count for a patient with symptoms of an infection.

Reason- An increase in the number of white blood cells (leukocytes) may indicate that the person is combating an infection.

a) Both assertion and reason are true and reason is correct explanation of assertion.

b) Both assertion and reason are true and reason is not correct explanation of assertion.

c) Assertion is true but reason is false.

d) Both assertion and reason are false.

Q18. Assertion- If you trace the path of a molecule of carbon dioxide that starts in an arteriole in the right thumb and leaves the body in exhaled air, the minimum number of capillary beds the molecule encountered is 2.

Reason- The molecule of carbon dioxide would need to enter a capillary bed in the thumb before returning to the right atrium and ventricle, then travel to the lung and enter a capillary from which it would diffuse into an alveolus and be available to be exhaled.

a) Both assertion and reason are true and reason is correct explanation of assertion.

b) Both assertion and reason are true and reason is not correct explanation of assertion.

c) Assertion is true but reason is false.

d) Both assertion and reason are false.

Q19.Assertion - The AV node delay the electrical impulse moving from the SA node and the atria to the ventricles.

Reason- The delay allows the atria to empty completely, filling ventricles fully before they contract.
a) Both assertion and reason are true and reason is correct explanation of assertion.
b) Both assertion and reason are true and reason is not correct explanation of assertion.
c) Assertion is true but reason is false.
d) Both assertion and reason are false.

Q20. Assertion - After exercising regularly for several months, our resting heart rate decreases, but our cardiac output at rest is unchanged.

Reason- The heart, like any other muscle, becomes stronger through regular exercise. The stronger heart would have a lesser stroke volume, which would allow for the decrease in heart rate.
a) Both assertion and reason are true and reason is correct explanation of assertion.
b) Both assertion and reason are true and reason is not correct explanation of assertion.
c) Assertion is true but reason is false.
d) Both assertion and reason are false.

ANSWER KEY
MULTIPLE CHOICE QUESTION BANK

Chapter -18 Name of Chapter-Body Fluid and Circulation

Q.1	**Q.2**	**Q.3**	**Q.4**	**Q.5**	**Q.6**	**Q.7**	**Q.8**	**Q.9**	**Q.10**
c	a	c	a	c	c	c	d	a	c
Q.11	**Q.12**	**Q.13**	**Q.14**	**Q.15**	**Q.16**	**Q.17**	**Q.18**	**Q.19**	**Q.20**
c	a	c	d	b	d	a	a	a	c

SA-I (2marks)

Q21.Distinguish between mitral and tricuspid value?

Ans:-

	Mitral Value	Tricuspid value
1.	It is called bicuspid value	It lies in the region of right atrioventricular aperture.
2.	All the two flaps are of almost equal size.	All the three flaps are different in size.
3.	There are two flaps in this flap.	There are three flaps in this flap.
4.	Check back flow of oxygenated blood into left auricle.	Check back flow of the deoxygenated blood into right auricle.

Q22. Write a note on coagulation of blood.

Ans: i. Conversion of liquid blood into semisolid jelly is called blood coagulation

ii. Platelets and injured tissues releases thromboplastin, that initiates the formation of enzyme **prothrombinase** in the blood.

iii. Prothrombinase in presence of Ca++ ions converts inactive plasma protein prothrombin into active **thrombin.**

iv. Thrombin converts soluble fibrinogen into fibrin.

v. **Fibrin** fibres entraps the platelets, blood cells and plasma to form a blood clot.

vi. The normal clotting time is 2 to 8 minutes.

Q23. Name the different types of granulocytes. Give the function of the one which constitutes maximum percentage of total leucocytes.

Ans:- Different types of granulocytes are:

(i) Neutrophils – 62%

(ii) Acidophils (eosinophils) – 3%

(iii) Basophils - 0.5% to 1%

Neutrophils are phagocytic i.e, responsible for protection against infection.

Q24.Explain when and how the two sounds of heart are produced.

Ans:- (i) 'Lubb' the first sound which is low pitched, is caused by the closure of bicuspid and tricuspid valves.

(ii) 'Dub' the second sound which is high pitched, is caused by the closure or semilunar valves.

Q25.Define joint diastole. What are constituents of the conducting system of human heart?

Ans:- In a cardiac cycle when both atria and ventricles are in a diastole and are relaxed simultaneously is called a joint diastole.

Conducting system constitutes: SA node → AV node → Bundle of His → Purkinje fibres.

SA-II (3 marks)

Q26.A.Write a note on "Regulation of cardiac activity"? B.What is stroke volume ? What is its relation with cardiac output ?

Ans:-A (i) The special neural centre located in medulla oblongata of brain can moderate cardiac function through autonomic nervous systems. Therefore, help in controlling heart regulation.

(ii) The parasympathetic neural signals, (component of ANS) decrease rate of heart beat, speed of conduction of action potential and also the cardiac output.

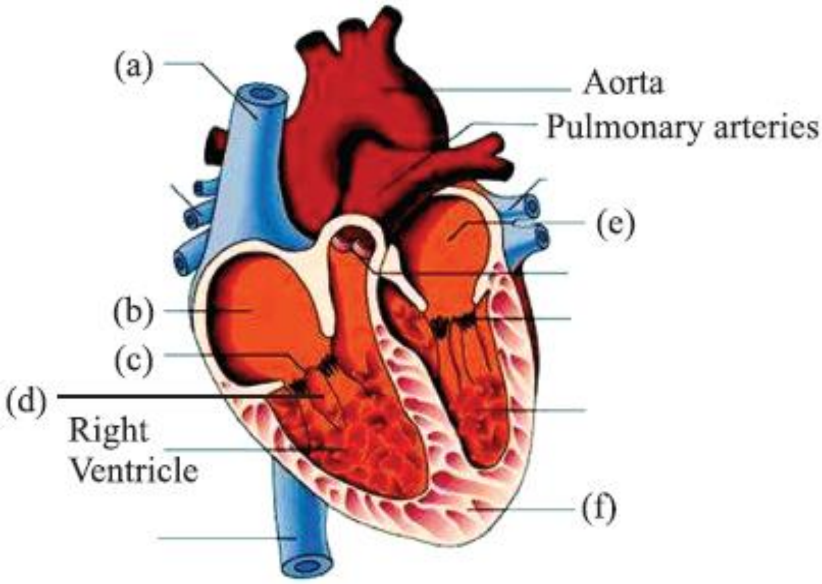
(iii) The adrenal medullary hormones enhance cardiac output (C.O).

(iv) The neural signals through sympathetic nerves may increase heart beat rate and the strength of ventricular contraction and also cardiac output.

Ans:-B During one cardiac cycle or one heart beat the volume of blood pumped by the heart is called stroke volume. This is normally 70 mL.

In one minute the heart beats about 72 times and the amount of blood pumped per minute is called cardiac output. This is usually 4900 mL. or 5 litres.

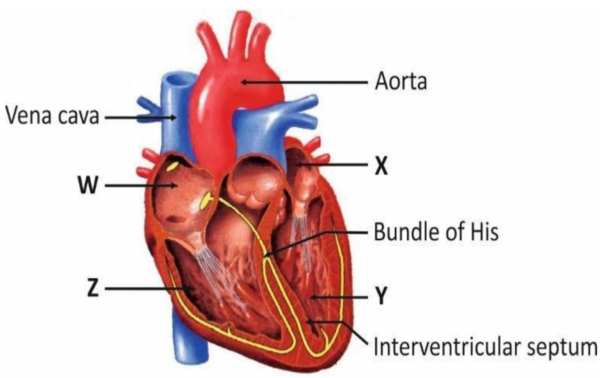
Q27. In the following diagram of section of a human heart, label a, b, c, d, e and f.



Ans:-a.-Superior Venacava b. Right atrium c. AV Valve d. Chordae Tendinae e. Left atrium f. Purkinje Fibre

Q28. Look at the diagram:

1. Name the structures labelled W--Z.
2. Explain the sequence of 3 events in a cardiac cycle of the heart.
3. A baby is born with a small hole in the wall between the structures Y and Z.How might this affect the oxygen content of the blood pumped out of the heart?



Ans:- 1.A. W-Right Atrium X- Left Atrium Y- Left Ventricle Z- Right Ventricle

2.-(i) Atrial and Ventricular diastole: chambers are relaxed and atria are filling in with blood

(ii)Atrial systole: atria contract and remaining blood is pushed into ventricles

(iii)Ventricular systole: ventricles contract and push blood out through the aorta and pulmonary artery .

3.Oxygen content is reduced as oxygen-poor blood returning to the right ventricle from the systemic circuit mixes with oxygen-rich blood of the left ventricle.

Case Study based Questions(4 marks)

Q29. Blood is a fluid connective tissue made up of fluid matrix plasma, and formed elements, Red blood cells, (erythrocytes) white blood cells (leukocytes), and platelets (thrombocytes) constitute the formed elements. The blood of humans is grouped into A, B, AB and O systems based on the presence or absence of two surface antigens A, B

on the RBCs. Another blood grouping is also done based on the presence or absence of another antigen called Rhesus factor (Rh) on the surface of RBCs. The spaces between cells in the tissues contain a fluid derived from the blood called tissue fluid this fluid called lymph is almost similar to blood except for the protein content and the formed elements.

(i). Why is blood called a fluid connective tissue?

(a) Because of fluid matrix plasma (b) Because of osteocytes
(c) Because of the solid matrix (d) None of the above

(ii). Name the formed elements of blood.

(a) RBCs, WBCs only (b) Platelets only (c) Plasma only (d) RBCs, WBCs and Platelets

(iii). Which blood group is considered a universal donor and why?

(a) A (b) B (c) AB (d) O

(iv). Name the complication which arises when a Rh+foetus is developing the womb of a Rh-mother.

(a) Erythroblastosis foetalis (b) Angina (c) Cardiac arrest (d) None of the above

(v). Give the basic difference between tissue fluid and blood.

(a) Tissue fluid has no proteins (b) Tissue fluid has no RBCs
(c) Tissue fluid has no WBCs and platelets (d) All of the above

Ans:- (i). (a) (ii). (d) (iii). (d) (iv). (a) (v). (d)

Q30. Neena is having blood group A-ve while her husband's blood group is O +ve. Their first child is having blood gp. A +ve. Her second child was born with severe anemia and jaundice. What could be the reason? How this situation could have been avoided?

Ans:- During her first pregnancy after exposure with blood of her first Rh +ve child, her body prepared antibodies against Rh antigen in her blood. In second pregnancy these Rh antibodies from mother leaked into the blood of foetus (Rh+) and destroyed foetus RBCs. It could cause of severe anaemia and Jaundice could be fetal to the foetus.

This situation could have been avoided if she had got herself administered anti Rh antibodies, immediately after first delivery to kill Rh antibodies entered in mother's blood from foetus.

LA-I (5 marks)

Q31. What is lymphatic system? Discuss its importance.

Ans:- Lymph is a colourless tissue fluid resembling the blood except that it has no haemoglobin and RBCs. In comparison to blood, lymph contains less blood proteins, more of waste matter, increased amount of food material and a large number of WBC's The tissue fluid is filtered from the blood plasma through the walls of capillaries some WBC also come out from there capillaries Now this tissue fluid enters into lymphatic capillaries as is known as lymph so the tissue fluid is converted into lymph.

Circulation of lymph:

Lymph vessels : Almost all of the body organs have a large number of lymph vessels and lymph capillaries. The walls of lymph vessels have valves (like veins). They form the network in the organs – one is superficial and other is deep seated. The flow of lymph in these vessels is only one side i.e., from the organs but never to the organs. In human body the following two large lymph vessels are present.

Ductus Thoracious – It start from the abdominal cavity with a dilation called receptaculum chyli. Then it passes into the thoracic cavity then to the left of the neck region. It receives the lymph from the following organs – lower extremities, region of the true pelvis, abdominal region, left upper extremities the left half of the thorax, head, face & neck.

Lymph nodes – These are small globular masses of lymphatic tissue and these arranged in groups from each region organs of the body the lymph flows into definite lymph nodes. The nodes are called regional nodes.

Function of lymph:

(i) It serves to return interstitial fluid into blood.
(ii) It allows plasma proteins macromoleclues to diffuse through the lymph vessels.
(iii) It transport digested fat through lacteals in villi of intestine.

Q32.Explain double circulation with the help of diagram.

Ans:- The heart is the pumping organ. It pumps blood to the various body organs, through closed vessels. Form the left ventricle blood goes with aorta which send it to arteries for supplying the body organs. From the body tissues blood is returned to the right atrium through two veins superior and inferior vena cava. This type of circulation is known as systemic circulation. From the right ventricle blood is pumped into the pulmonary trunk which divides into the pulmonary arteries each of which goes to the lung. Here the blood is oxygenated. The oxygenated blood is returned to left atrium through pulmonary veins. This is called pulmonary circulation.

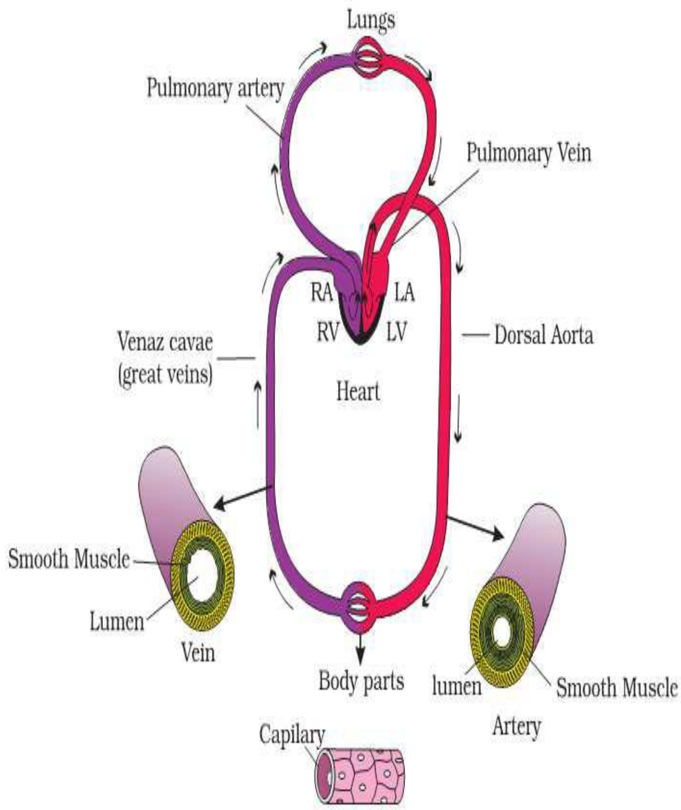


Figure 18.4 Schematic plan of blood circulation in human

Q33.With the help of neat and labelled diagram, describe the internal structure of human heart.

Ans:- Internal structure of human heart:

There is no connection/communication at all between the right and left sides of the heart. The right and left sides of the heart are separated by a partition called **septum** formed of myocardium covered by endocardium.

Interauricular septum is relatively thin while **interventricular septum** is thick.

Human heart is four chambered. It has two atria towards the base and two ventricles towards the apex. **Atria/ Auricles:** These are receiving chambers. These are thin walled, upper chambers of the heart. There are two atria viz, right atrium and left atrium separated from each other by means of a thin partition called **inter atrial**

septum. Inter atrial septum bears a oval shaped depression called **fossa ovalis.**

Fossa ovalis is remnant of an embryonic aperture **foramen ovale** between the two atria in the foetus. It closes at the time of birth.

Right atrium:

It receives deoxygenated blood by three veins

A. The superior vena cava (precaval) B. The inferior vena cava (post caval)

C. Coronary sinus

Coronary sinus carries blood from wall of the heart.

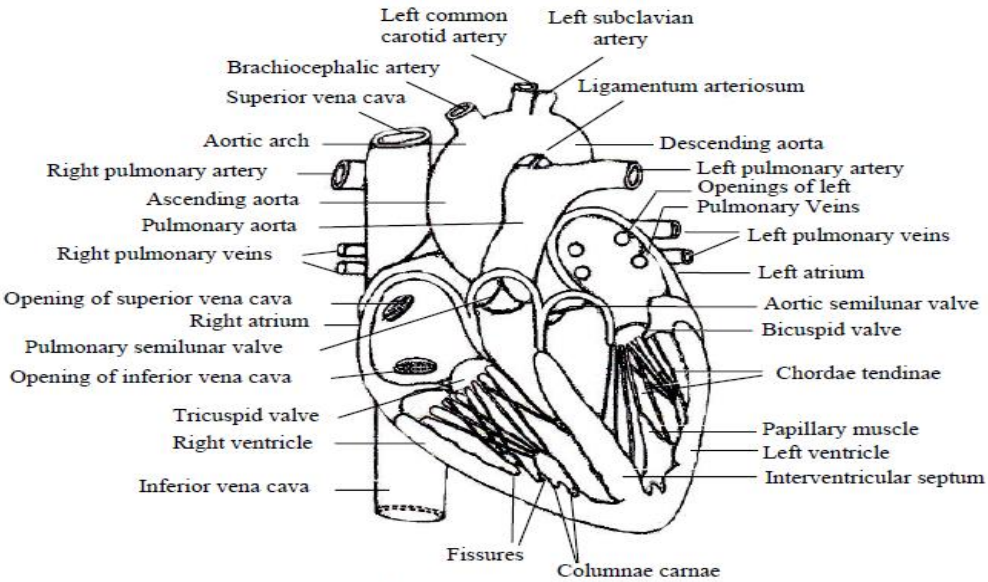
Openings of these blood vessels are present in right atrium.

The opening of inferior vena cava is guarded by a muscular flap, the **Eustachian valve.**

Opening of coronary sinus is guarded by valvular fold called valve of **Thebesius** or **Thebesian valve.**

The right atrium opens in right ventricle by means of an opening called **right atrio ventricular opening.**

It is guarded by a valve made up of connective tissue. This valve has three flaps hence called **Tricuspidvalve.**



Internal structure of human heart

Left atrium:-It is upper left chamber of the heart.

It is comparatively smaller and thick walled than right atrium.

It receives oxygenated blood from lungs by four pulmonary veins two from each lung.

The left atrium opens into left ventricle by means of **left atrio–ventricular opening.**

The left atrio–ventricular opening is guarded by two flexible flaps or cups called **bicuspid valve.**

Ventricles:

The ventricles are lower or inferior chambers of the heart.
Ventricles are thick walled and are distributing chambers.
There are two ventricles viz, right ventricle and left ventricle.
Right ventricle is separated from the left ventricle by means of thick slightly curved partition called
interventricular septum.
It prevents mixing of oxygenated and deoxygenated blood in the ventricular part of heart.
Both ventricles are **rough walled** and have **ridges and grooves.**

CHAPTER-19 Excretory Products and their Elimination

Excretory products:

Products (like- ammonia, urea, uric acid, carbon dioxide, water and ions like Na^+, K^+, Cl^-, phosphate, sulphate, etc.) get accumulated in animals either due to metabolic reactions or by other means and need to be eliminated totally or partially from the body, as they may prove harmful for the body.

Nitrogenous excretory wastes:

Ammonia, **urea** and **uric acid** are the major forms of nitrogenous wastes excreted by the animals.

Ammonia - most toxic form and animal requires large amount of water for its elimination.

Urea – is less toxic than ammonia but more toxic than uric acid and animal requires less amount of water for its elimination.

Uric acid- least toxic, can be removed with a minimum loss of water by the animal.

Excretion:The process of removal of waste products from the body is called as excretion.

Excretion

On the basis of type of excretory products

Ammonotelism

- Excretion of ammonia.
- Bony fishes,aquatic amphibians and aquatic insects.

Ureotelism

- Excretion of urea.
- Mammals, many terrestrial amphibians and marine fishes mainly excrete urea.

Uricotelism

- Excretion of Uric acid.
- Reptiles, birds, land snails and insects excrete nitrogenous wastes as uric acid in the form of pellet or paste with a minimum loss of water.

Nephridia

- are the tubular excretory structures of earthworms and other annelids.
- They help to remove nitrogenous wastes and maintain a fluid and ionic balance.

Protonephridia/ flame cells

- are the excretory structures in Platyhelminthes (Flatworms, e.g., *Planaria*),rotifers, some annelids and the cephalochordate – *Amphioxus*.
- They are primarily concerned with ionic and fluid volume regulation, i.e., osmoregulation.

Excretory organs in

Antennal glands or green glands

- Perform the excretory function in crustaceans like prawns.

Malpighian tubules

- are the excretory structures of most of the insects including cockroaches.
- They help in the removal of nitrogenous wastes and osmoregulation.

Excretory organs in vertebrates → Vertebrates have complex tubular organs called **kidneys**.

Human Excretory System

- In humans, the excretory system consists of – kidneys (a pair),- ureters(one pair) ,- a urinary bladder
  - a urethra

Kidneys

are reddish brown, bean shaped structures situated between the levels of last thoracic and third lumbar vertebra close to dorsal inner wall of abdominal cavity.

Each kidney of an adult human measures 10-12 cm in length, 5-7 cm in width, 2-3 cm in thickness with an average weight of 120- 170 g.

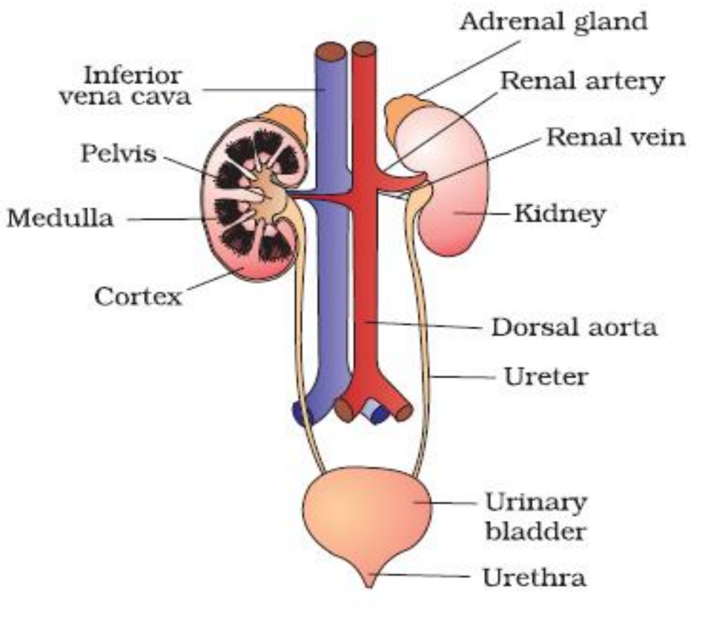
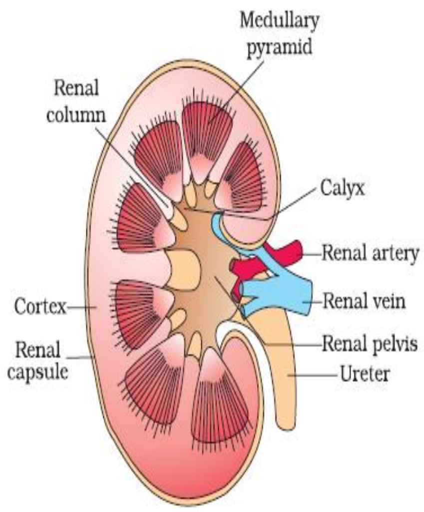


Figure 19.1 Human Urinary system

Internal Structure of Kidney	
Hilum – a is a notch towards the centre of inner concave surface of kidney. Through it ureter, blood vessels and nerves enter. **Renal pelvis-** a broad funnel shaped space inner to hilum. **Calyces-** are projections in the renal pelvis called calyces. **Capsule -** is a tough outer layer of kidney. **Cortex-**There are two zones inside the kidney. The outer zone is called cortex . **Medulla** - The inner zone inside the kidney is called medulla. **Medullary pyramids-** are conical masses in medulla which project into the calyces (sing.: calyx). • **Columns of Bertini -** The cortex extends in between the medullary pyramids as renal columns called **Columns of Bertini.**	 **Figure 19.2** Longitudinal section (Diagrammatic) of Kidney

- **Nephrons** – **Cortical nephrons -** the nephrons (majority) in which, the loop of Henle is too short and extends only very little into the medulla.
- **Juxta medullary nephrons-** the nephrons (some) in which the loop of Henle is very long and runs deep into the medulla.

CORTICAL	JUXTA MEDULLARY
Glomeruli are in the outer cortex.	**Glomeruli are close to inner margin of the cortex.**
Short loops of Henle.	**Long loops of Henle**
Henle's loops extend only to a short distance in the medulla.	**Henle's loops are found deeper in the medulla.**
Vasa rectae are absent.	**Vasa rectae are present**
They are more common (85%)	**They are less common (15%)**

complex tubular structures, which form the structural and functional units of kidney.

- Each kidney has nearly one million **nephrons.**
- Each nephron has two parts – the **glomerulus** and the **renal tubule**.

Afferent arteriole - a fine branch of renal artery entering Bowmen's capsule carrying blood to the glomerulus.

Glomerulus - a tuft of capillaries formed by the afferent.

Efferent arteriole- Blood from the glomerulus is carried away by an efferent arteriole.

Bowman's capsule - renal tubule begins with a double walled cup-like structure called **Bowman's capsule**, which encloses the glomerulus.

Malpighian body or Renal corpuscle- Glomerulus along with Bowman's capsule.

Proximal convoluted tubule (PCT) **-** The renal tubule continues further to form a highly coiled network – **proximal convoluted tubule** (PCT).

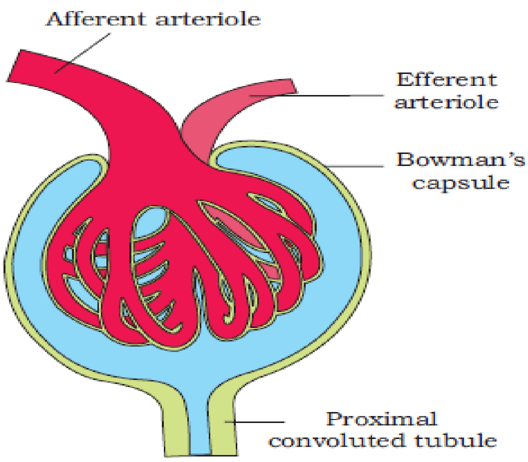
Henle's loop - A hairpin shaped, next part of the tubule which has a descending and an ascending limb.

Distal convoluted tubule (DCT) – The ascending limb continues as another highly coiled tubular region called **distal convoluted tubule** (DCT).

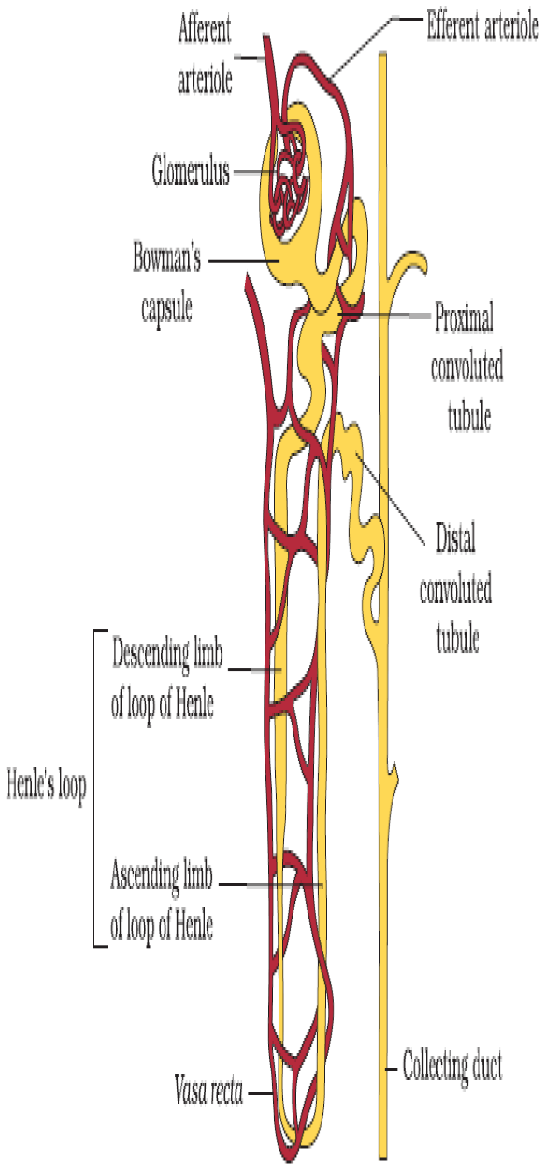
Collecting duct- a long, straight tube which extends from cortex of the kidney to the inner parts of medulla and DCTs of many nephrons open into it.

Renal pelvis - many collecting ducts converge and open into the renal pelvis through medullary pyramids in the calyces.

Malpighian corpuscle, PCT and DCT



Malpighian body

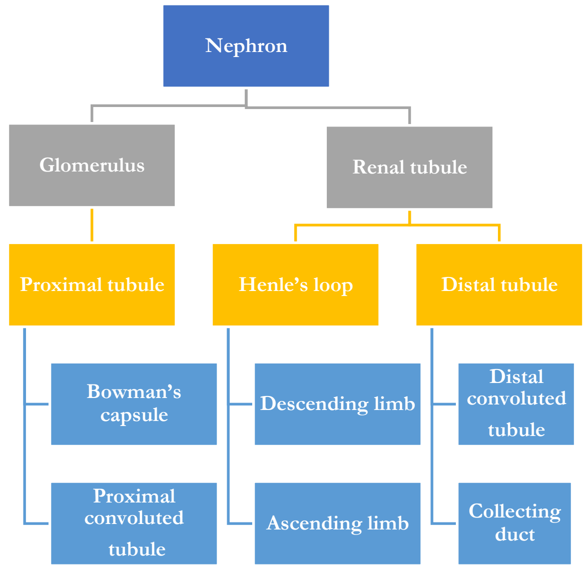


of the nephron are situated in the cortical region of the kidney whereas the loop of Henle dips into the medulla.

Peritubular capillaries- The efferent arteriole emerging from the glomerulus forms a fine capillary network around the renal tubule called the peritubular capillaries.

Vasa recta - A minute vessel of peritubular capillary network runs parallel to the Henle's loop forming a 'U' shaped *vasa recta*.

- *Vasa recta* is absent or highly reduced in cortical nephrons.



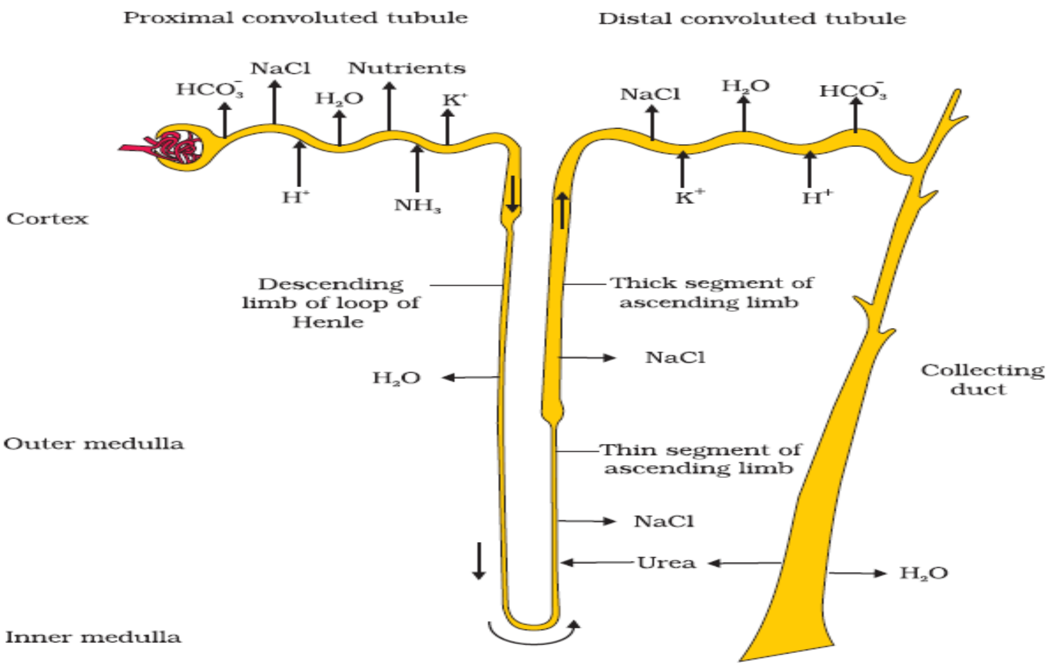
<u>Urine formation</u>

- It involves three main processes which takes place in different parts of the nephron -
  1) Glomerular filtration
  2) Reabsorption and
  3) Secretion

1) Glomerular filtration / ultra filtration

- First step in urine formation, is the filtration of blood, which is carried out by the glomerulus and is called **glomerular filtration**.
- On an average,1100-1200 ml of blood is filtered by kidneys per minute which constitute roughly 1/5th of the blood pumped out by each ventricle of the heart per minute.
- The glomerular capillary blood pressure causes filtration of blood through 3 layers, i.e., the endothelium of glomerular blood vessels, the
- epithelium of Bowman's capsule and a basement membrane between these two layers.
- **Podocytes**– are epithelial cells of Bowman's capsule which are arranged in an intricate manner so as to leave some minute spaces called filtration slits or slit pores.
- **Ultra filtration** - Blood is filtered so finely through these membranes, that almost all the constituents of the plasma except the proteins pass onto the lumen of the Bowman's capsule. Hence, considered as a process of **ultra filtration.**
- **Glomerular filtration rate** (GFR) -The amount of the filtrate formed by the kidneys per minute.
- GFR in a healthy individual is approximately 125 ml/minute, i.e., 180 litres per day.

- **Regulation of glomerular filtration rate -** The kidneys have built-in mechanisms for regulation of glomerular filtration rate.



By juxta glomerular apparatus (JGA) –

- is a special sensitive region formed by cellular modifications in the distal convoluted tubule and the afferent arteriole at the location of their contact.
- efficient mechanism of regulation of GFR.
- A fall in GFR activates the JG cells to release **renin** which can stimulate the glomerular blood flow and thereby the GFR back to normal.

2) Reabsorption

- **Reabsorption-**is the process in which nearly 99 per cent of the filtrate has to be reabsorbed by the renal tubules.
- **Tubular epithelial cells-** present in different segments of nephron perform this either by **active or passive mechanisms**.
- **Active mechanism** – When the substances are absorbed against their concentration gradient by the expenditure of energy.
- Substances like glucose, amino acids, Na+, etc., in the filtrate are reabsorbed actively.
- **Passive mechanism -** When the substances are absorbed along their concentration gradient. Their is no expenditure of energy.
- The nitrogenous wastes are absorbed by passive transport. -
- Reabsorption of water also occurs passively in the initial segments of the nephron .

3) Tubular secretion

- During urine formation, the tubular cells secrete substances like H^+, K^+ and ammonia into the filtrate.

- an important step in urine formation as it helps in the maintenance of ionic and acid base balance of body fluids.

FUNCTION OF THE TUBULES

Proximal Convoluted Tubule (PCT):

- **Reabsorption**- PCT is lined by simple cuboidal brush border epithelium which increases the surface area for reabsorption.
- Nearly all essential nutrients, and 70-80 per cent of electrolytes and water are reabsorbed by this segment.
- **Maintenance of pH and ionic balance of body fluids-** by selective secretion of hydrogen ions, ammonia and potassium ions into the filtrate and by absorption of $HCO3^-$ from it.

Henle's Loop:

- Reabsorption in this segment is minimum.
- **Maintenance of high osmolarity of medullary interstitial fluid** this region plays a significant role in it.
- The **descending limb of loop of Henle is permeable to water but almost impermeable to electrolytes**.
- This concentrates the filtrate as it moves down.
- The **ascending limb is impermeable to water but allows transport of electrolytes actively or passively**. Therefore, as the concentrated filtrate pass upward, it gets diluted due to the passage of electrolytes to the medullary fluid.

Distal Convoluted Tubule (DCT):

- **Conditional reabsorption of Na^+ and water** takes place in this segment.
- **Reabsorption of $HCO3^-$**.
- **Maintenance the pH and sodium-potassium balance in blood** by selective secretion of hydrogen and potassium ions and NH3.

Collecting Duct:

- Long duct, extends from the cortex of the kidney to the inner parts of the medulla.
- **Concentration of urine** - Large amounts of water is reabsorbed from

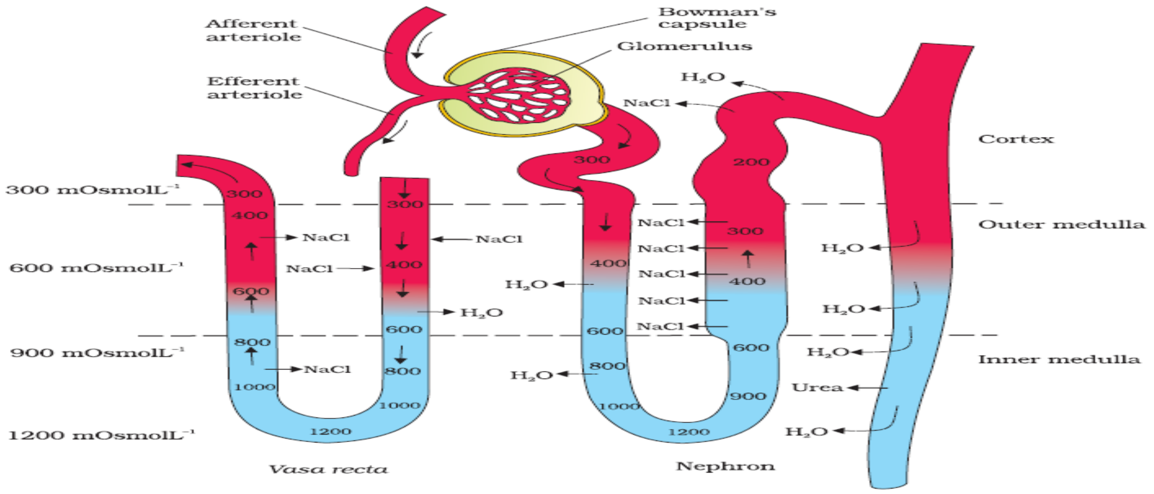
- This mechanism helps to maintain a concentration gradient in the medullary interstitium.
- Presence of such interstitial gradient helps in an easy passage of water from the collecting tubule thereby concentrating the filtrate (urine).
- Human kidneys can produce urine nearly four times concentrated than the initial filtrate formed.

this region to produce a concentrated urine.

- **Maintenance of osmolarity**- It allows passage of small amounts of urea into the medullary interstitium to keep up the osmolarity.
- **Maintenance of pH and ionic balance of blood** - by the selective secretion of H^+ and K^+ ions.

Mechanism of concentration of the filtrate /Counter current mechanism:

- Mammals produce **concentrated urine**.
- The **Henle's loop** and ***vasa recta***play a significant role in this.
- **Counter current** - Flow of filtrate in the two limbs of Henle's loop is in opposite directions and thus forms a counter current.
  The flow of blood through the two limbs of *vasa recta* is also in a counter current pattern.
- The proximity between the Henle's loop and *vasa recta*, as well as the counter current in them help in maintaining an increasing osmolarity towards the inner medullary interstitium, i.e., from 300 $mOsmolL^{-1}$ in the cortex to about 1200 $mOsmolL^{-1}$ in the inner medulla.
- This gradient is mainly caused by **NaCl** and **urea.**

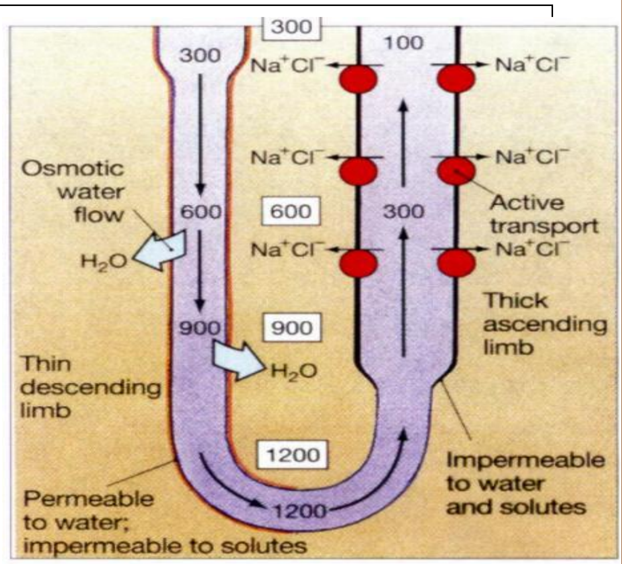


counter current mechanism

NaCl is transported by the ascending limb of Henle's loop which is exchanged with the descending limb of *vasa recta*.

NaCl is returned to the interstitium by the ascending portion of *vasa recta*. Similarly, small amounts of urea enter the thin segment of the ascending limb of Henle's loop which is transported back to the interstitium by the collecting tubule.

This transport of substances facilitated



by the special arrangement of Henle's loop and *vasa recta* is called the **counter current mechanism.**	

Regulation of kidney function

- The hypothalamus, JGA and the heart efficiently regulate the functioning of kidneys
- Osmoreceptors in the body are activated by changes in blood volume, body fluid volume and ionic concentration.
- **Hypothalamus**

- Excessive loss of fluid from the body activates these receptors which stimulate hypothalamus to release **antidiuretic hormone (ADH) or vasopressin** from **neurohypophysis**.
- ADH facilitates water reabsorption from DCT thereby preventing diuresis (excessive loss of water from the body).
- **Increase in body fluid volume** can switch off the osmoreceptors and suppress the ADH release thus retaining the required water in the body.
- ADH constrics blood vessels causing an increase in blood pressurewhich increases the glomerular blood flow and thereby the GFR.

- **JGA (Juxtaglomerular apparatus) and Renin-Angiotensin mechanism**

- A fall in glomerular blood flow / glomerular blood pressure/GFR - activates JG cells to release **rennin.**

RAAS Mechanism

Effect of Renin	Effect of Aldosterone
Angiotensinogen (blood) ↓ Angiotensin I → AngiotensinII (powerful vasoconstrictor) ↓ Increases Glomerular blood pressure and GFR	Angiotensin II → Adrenal cortex Aldosterone (released) ↓ reabsorption of Na+ and water from distal part of the tubule ↓ Increase in blood pressure and GFR

- **Heart**

- Increase in blood flow to atria of heart causes release of **Atrial Natriuretic Factor** (ANF).
- ANF causes vasodilation (dilation of blood vessels) and thereby decreases blood pressure.
- ANF mechanism acts as a check on the renin-angiotensin mechanism.

MICTURITION

Urine formed gets stored in urinary bladder till a voluntary signal is given by the central nervous system (CNS) for contraction of smooth muscles of bladder and simultaneous relaxation of the urethral sphincter causing the release of urine character.

Role of other organs in excretion:

- **Lungs** - remove large amounts of CO_2 (18 litres/day) and also significant quantities of water every day.
- **Liver-** secretes bile-containing substances like bilirubin, biliverdin, cholesterol, degraded steroid hormones, vitamins and drugs. Most of these substances ultimately pass out along with digestive wastes.

Sweat	Sebum
Secreted by Sweat glands.	Secreted by sebaceous glands.
Sweat is a watery fluid containing NaCl, small amounts of urea, lactic acid, etc.	It is an oily secretion composed of complex mixture of lipids having triglycerides, free fatty acids, cholesterol and its esters.
It cools body surface and helps in the removal of some wastes	It lubricates the hair and prevents wetting of hair and drying up of skin.

Disorders of the excretory system

- **Uremia** - Malfunctioning of kidneys leading to accumulation of urea in blood and may lead to kidney failure.
- In such patients, urea can be removed by a process called **hemodialysis**.
- - Blood drained from a convenient artery is pumped into a dialysing unit after adding an anticoagulant (heparin).

- The unit contains a coiled cellophane tube surrounded by a fluid (dialysing fluid) having the same composition as that of plasma except the nitrogenous wastes.
- The porous cellophane membrane of the tube allows the passage of molecules based on concentration gradient.
- As nitrogenous wastes are absent in the dialysing fluid, these substances freely move out, thereby clearing the blood. The cleared blood is pumped back to the body through a vein after adding anti-heparin to it.

- **Kidney transplantation** - ultimate method in the correction of acute **renal failures** (kidney failure).
- A functioning kidney is used in transplantation from a donor, preferably a close relative, to minimise its chances of rejection by the immune system of the host.
- **Renal calculi:** Stone or insoluble mass of crystallised salts (oxalates, etc.) formed within the kidney.
- **Glomerulonephritis:** Inflammation of glomeruli of kidney.

MULTIPLE CHOICE QUESTIONS

Q1.What is the excretory unit of Prawns :-

a. Protonephridia b. Malpighian Tubule c. Kidney d. Green Gland

Q2.Which is the osmoregulator organ of human being :-

a. Lungs b. Liver c. Kidney d. Heart

Q3.which one of the following is Ammonotelic animal :-

a. Human being b. Bony fishes c. Terrestrial Amphibians
b. d. Marine Fishes

Q4. Which molecule being excreted by reptiles, birds and terrestrial insects :-

a. Ammonia b. Urea c. Uric Acid d. Ammonium salts

- An adult human excretes, on an average, 1 to 1.5 litres of urine per day.
- The urine formed is a light yellow coloured watery fluid which is slightly acidic (pH-6.0) and has a characteristic odour. On an average, 25-30 gm of urea is excreted out per day. Various conditions can affect the characteristics of urine.
- Analysis of urine helps in clinical diagnosis of many metabolic disorders as well as malfunctioning of the kidney.
- For example, presence of glucose (Glycosuria) and ketone bodies (Ketonuria) in urine are indicative of diabetes mellitus (due to lack of insulin secretion from Pancreas).

Q5. Uric Acid is eliminated in the form of :-

a. Urine b. Faecal Material c. Pellet d. none of the above

Q6. Which structure is found in Planaria for excretion :-

a. Flame Cells b. Nephidia c. Mapighian Tubule d. Antennal Gland

Q7. There is a notch found at the ventral surface of kidney, what is the term given to it :-

a. Funiculus b. Hilum c. Cortex d. Medulla

Q8.What is the projections called , which found inside of human kidney :-

a. Cortex b. Medulla c. Medullary Pyramids d. Column of Bertini

Q9.Which blood vessels carry impure blood to the kidney :-

a. Renal Artery b. Renal Vein c. Glomerulus d. Renal tubule

Q10.How much GFR is the filtrate formed by both kidneys in a minute :-

a. 25 ml/min. b. 125 ml/min. c. 225 mi/min. d. none of the above

Q11.Where the Juxta Glomerular Apparatus is located :-

a.Proximal Convoluted Tubule b.Loop of HENLE

c.Distal Convoluted Tubule d.Collecting Duct

Q12.During tubular secretion , which ions are secreted in the filtrate :-

a. H+ ion b. K+ ion c. Ammonia + ion d. All of the above

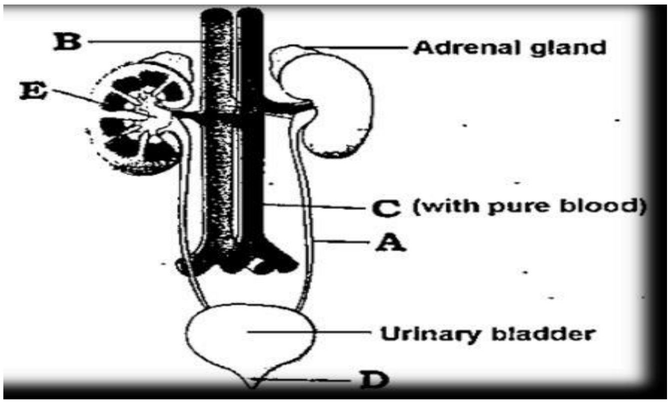
Q13. Match the terms given in Column I with their physiological processes given in Column II and choose the correct answer .

Column I	Column II
A. Proximal convoluted tubule	i. Formation of concentrated urine
B. Distal convoluted tubule	ii. Filtration of blood
C. Henle's loop	iii. Reabsorption of 70-80% of electrolytes
D. Counter-current mechanism	iv. Ionic balance
E. Renal corpuscle	v. maintenance of concentration gradient in medulla

a. A-iii, B-v, C-iii, D-ii, E-I b. A-iii, B-iv, C-i, D-v, E-ii

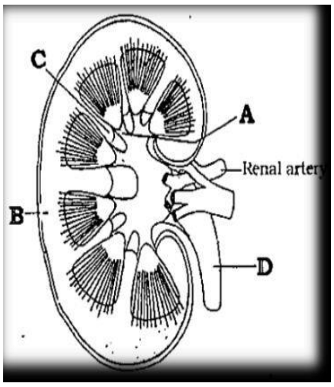
c. A-i, B-iii, C-ii, D-v, E-iv d. A-iii, B-i, C-iv, D-v, E-ii

Q14.Observe the following figure.



	A	B	C	D	E
a	Superior vena cava	Inferior vena cava	Dorsal Aorta	Urethra	Pelvis
b	Inferior vena cava	Superior vena cava	Dorsal Aorta	Urethra	Pelvis
c	Ureter	Inferior vena cava	Dorsal Aorta	Urethra	Pelvis
d	Dorsal Aorta	Inferior vena cava	Urethra	Cortex	Pelvis

Q15.Go through the following figure-



Identify A to D-

	A	B	C	D
a	Cortex	Calyx	Renal Column	Ureter
b	Calyx	Cortex	Renal Column	Ureter
c	Medulla	Cortex	Renal Column	Urethra
d	Calyx	Cortex	Renal Column	Urethra

Q16.Assertion :- Human beings are ureotelic organisms.

Reason :- Being terrestrial human have evolved in such a way that ammonia now converted to urea.

a) Both assertion and reason are true and reason is correct explanation of assertion.
b) Both assertion and reason are true and reason is not correct explanation of assertion.
c) Assertion is true but reason is false.
d) Both assertion and reason are false.

Q17.Assertion :-ANF (Anti Natriuretic Factor) act as strong vasodilator.
Reason :-It is a fall of glomerular filtrate that induced by ANF.

a) Both assertion and reason are true and reason is correct explanation of assertion.
b) Both assertion and reason are true and reason is not correct explanation of assertion.
c) Assertion is true but reason is false.
d) Both assertion and reason are false.

Q18.Assertion :- A counter current system operates between loop of Henle and vasa recta
Reason :-Nephrons filtrate poured in the collecting duct .

a) Both assertion and reason are true and reason is correct explanation of assertion.
b) Both assertion and reason are true and reason is not correct explanation of assertion.
c) Assertion is true but reason is false.
d) Both assertion and reason are false.

Q19.Assertion :-JG cells act as osmoreceptor for the releasing of ADH / Vasopressin.
Reason :-ADH or Vasopressin act upon the water reabsorption at PCT parts of nephron .

a) Both assertion and reason are true and reason is correct explanation of assertion.
b) Both assertion and reason are true and reason is not correct explanation of assertion.
c) Assertion is true but reason is false.
d) Both assertion and reason are false.

Q20.Assertion :-Diabetes mellitus arises due to more concentration of glucose in the urine.
Reason :-ketone bodies are the indicative of ketonuria .

a) Both assertion and reason are true and reason is correct explanation of assertion.

b) Both assertion and reason are true and reason is not correct explanation of assertion.
c) Assertion is true but reason is false.
d) Both assertion and reason are false.

ANSWER KEY
MULTIPLE CHOICE QUESTION BANK

No. of Chapter -19

Name of Chapter- Excretory Products and their Elimination

Q.1	**Q.2**	**Q.3**	**Q.4**	**Q.5**	**Q.6**	**Q.7**	**Q.8**	**Q.9**	**Q.10**
d	c	b	c	c	a	b	d	a	b
Q.11	**Q.12**	**Q.13**	**Q.14**	**Q.15**	**Q.16**	**Q.17**	**Q.18**	**Q.19**	**Q.20**
c	d	b	c	b	a	a	a	d	a

SA-I (2marks)

Q21.What is GFR? What is the value of GFR for a healthy individual ?

Ans:- The amount of filtrate formed by the kidneys per minute is called glomerular filtrate rate or GFR. The value of GFR in a healthy individual is approximately 125 ml per minute that means 180 litres per day.

Q22.Which animals have protonephridia as a means of excretion ?

Ans:-in some Annelids and the cephalochordates like Amphioxus , the protonephridia are primary concerned with ionic and fluid volume regulation that means osmoregulation

Q23.Where you can found the malpighian tubule and green glands as a means of excretion?

Ans:- Most of the Arthropod animals like cockroaches and other insects, the malpighian tubule is the main excretory structure and the green gland are basically found among the aquatic Arthropods like crustaceans or prawns as a means of excretory organ.

Q24.Which animals are usually ammnotelic animals?

Ans:-Mostly the aquatic animals like fishes are ammonotelic and animals they used to eliminate ammonium ions by the help of surface of the Gills. They don’t use the kidney for the removal of ammonia.

Q25.From which part of the kidney the ureter, blood vessels and neurons enter inside it?

Ans:- The ureter, blood vessels and the neurons enter into the kidney by a projected part at its concave surface is called **hilum**, inside of the hilum there is a broad funnel shape space called renal pelvis with a projection called calyces.

SA-II (3marks)

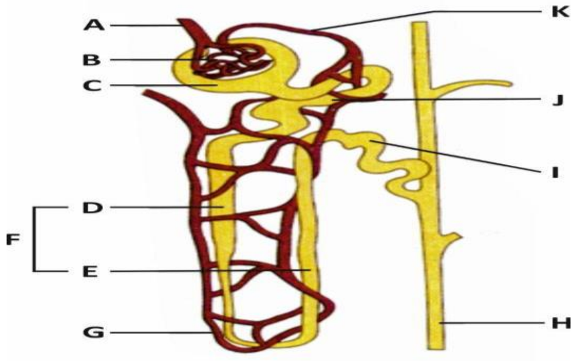
Q26.A.What is the contribution of loop of Henle in the making of urine?

Ans:- The loop of Henle pays a significant role as it divided into descending limb of loop of Henle and ascending limb of loop of Henle. The descending limb of loop of Henle, is permeable to water but almost impermeable to electrolyte. This concentrates the filtrate as it moves down. The ascending limb is impermeable to water but allow transport of electrolytes actively or passively therefore as the filtrate moves to upper direction, concentrate will treat us upward it get diluted due to the passage of electrolytes into the medullary fluid.

B.What is the contribution of distal convoluted tubule in the formation of urine ?

Ans:- Distil convoluted tubule provide a conditional reabsorption of sodium and water into the medullary fluid. Distil convoluted tubule is also capable of reabsorption of bicarbonate and selective secretion of hydrogen, potassium and ammonia to maintain the pH and sodium and potassium balance in the blood.

Q27. Study the diagram and answer the questions:



A. Explain how an increase in blood pressure in area (B) would affect the functioning of the
nephron.
B. Explain why proteins and blood cells are found in area (B) but not in area (J).
C. Write the steps of urine formation in the nephron. Write in 7 steps.

Ans:-

A. Area (B) is the glomerular capillary. The increase in blood pressure caused in glomerular capillary will cause the filtration of blood as it passes into the lumen of the Bowman's capsule through 3 layers, i.e., the endothelium of glomerular blood vessels, the epithelium of Bowman's capsule and a basement membrane between these two layers.

B. Blood is filtered so finely when passing through the glomerular capillary into the lumen of the Bowman's capsule, that almost all the constituents of the plasma, except the proteins and cells, pass through. So, the glomerular capillary (Area B) has protein and blood cells, but PCT (Area J) doesn't.

C.

1. Blood moves through the afferent arteriole into the glomerulus.
2. Molecules except plasma protein and blood cells don't enter the nephron.

3. In PCT, Na+ is actively transported out of the nephron, followed by Cl- and HCO3, and water moves from the nephron.
4. Water moves out of the filtrate by osmosis, concentrating salt in the filtrate.
5. Salt diffuses out from the filtrate into the interstitial fluid.
6. Nitrogen-containing wastes, excess H+ ions, and minerals such as K+ ions are secreted into the filtrate in DCT.
7. Water, salt, and minerals in the collecting duct.

Q28.What is counter current mechanism?

Ans:-There is an opposite direction of the flow of filtrate and the blood is found in the two different tubes. The filtrate flow from left to right within the loop of Henley whereas the blood flow from right to left in the tube which is called Vasa recta. This special arrangement of Henle's loop and Vasa recta is called counter mechanism. This mechanism helps to maintain the concentration gradient in the medullary fluid .

Case Based Study Questions (4marks)

Q29.Case study based questions

Urine formation involves three main processes namely **glomerular filtration, reabsorption and secretion**. That takes place in different parts of the nephron. The first step is in urine formation is the **filtration** of the blood which is carried out by the glomerulus and is called **glomerular filtration** on an average 1100 to 1200 ml of blood is filtered by the kidneys per minute which constitute of 1/5 of the blood pump out by each ventricle of the heart in a minute. In the glomerular capillary blood pressure causes filtration of blood through three layers, that are the endothelium of glomerular blood vessels, the epithelium of Bowman's capsule and a basement membrane between the two layers the endothelium cells and epithelial cells of Bowman's capsule called **podocytes** are arranged in and intrinsic manner so as to leave some minute space called filtration slits.

Blood is filter so finely through membrane that almost all the constituents of the plasma except the proteins pass on to the lumen of Bowman's capsule therefore it is considered as a process of ultra filtration.

1. Which cells arranged in a such a way that lead to making the filtration splits?

Ans:-The cells are called **podocytes**, which found in the epithelium cells of Bowman's capsule and arranged in an intrinsic manners , so as to leave some minute space called filtration slits.

2. How many layers are found between glomerulus and Bowman's capsule ?

Ans:-There are three layers found between the glomerulus and Bowman's capsule and they are called as endothelium of glomerulus blood vessel the epithelium of Bowman's capsule and basement membrane between these two layers.

3. How much blood is filtered by the kidney per minute?

Ans:-About 1100 to 1200 ml of the blood is filtered by the kidney per minute.

4. What is the first stage of urine formation

Ans:-ultra filtration.

Q30.Case study based question

Other than the kidneys, lungs, liver and skin also help in the elimination of excretory waste. Our lungs remove large amount of carbon dioxide approximately 200 ml per minute and also significant quantities of water everyday. Liver the largest gland in our body secrets bile containing substance like bilirubin and biliverdin , cholesterol, degraded steroid hormones, vitamins and drugs. Most of the substance ultimately pass out along with digestive waste. The sweat and sebaceous glands in the skin, can eliminate certain substances through their creations. Sweat product produced by the sweat glands is a watery fluid containing sodium chloride, the small amount of urea, lactic acid. Primary function of sweat is to facilitate the cooling effect on the body surface, it also helps in the removal of some of the waste mentioned above. Sebaceous glands eliminate certain substances like steroids, hydrocarbons and waxes. Such secretion provides a protective oily covering for the skin. Saliva also help to eliminate the nitrogenous waste in the form of urea and uric acid.

1. How the Saliva act as the excretory fluid?

Answer :-the Saliva used to eliminate the nitrogenous waste like urea and uric acid, by this way it act as the excretory fluid.

2. How the liver is responsible for the excretion ?

Ans:-Major substances like cholesterol, degraded steroid hormones, the drugs even the bilirubin and biliverdin are being eliminated in the digestive tract and by the help of digestive wastes the substances are also get released out.

3. How the lungs act as excretory organ ?

Ans:-From lungs a major amount of carbon dioxide approximately 200 ml per minute, remove d out, so by the elimination of carbon dioxide the lungs act as the excretory organ.

4. How the sweat act as a means of excretion?

Ans:-The sweat act as a means of excretion because it releases the sweat along with sodium chloride small amount of urea and the lactic acid.

LA-I (5marks)

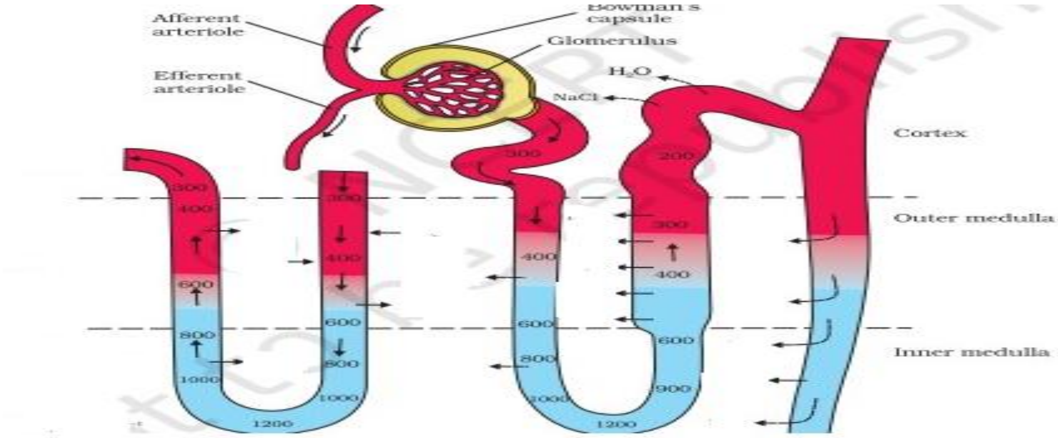
Q31.**When there is a limited availability of water is found in the body how the human body help to retain the water in such condition**?

Ans:-Osmoreceptors in the body are activated by changes of the blood volume and body fluid volume and ionic concentration and excessive loss of fluid from the body can activate these receptors which stimulate the hypothalamus to release ADH or anti diuretic hormone or vasopressin from the neurohypophysis. ADH facilitates water reabsorption from the nephron there by preventing diuresis. And increase in the body fluid volume can switch off the receptors and suppress the ADH release to complete the feedback. ADH can also affect the kidney function by its constrictory effects of blood vessels this causes and increase the blood pressure and increase the blood pressure can increase the glomerular filtrate blood flow and there by the GFR.

Q32.What is the role of juxta glomerular apparatus in the regulation of the kidney function?

Ans:-The Juxta glomerular apparatus plays a complex regulatory role of fall in glomerular blood flow or glomerular blood pressure, can activate the JG cells to release **RENIN** which converts angiotensinogen in the blood to Angiotensin-I and further to Angiotensin-II. Angiotensin II being a powerful vasoconstrictor increase in the glomerular blood pressure and their by GFR, Angiotensin-II also activate the adrenal cortex to release the Aldosterone causes reabsorption of sodium ion and water from the distal parts of the tubule, this also leads to an increase in the blood pressure and GFR. This complex mechanism is generally known as Renin Angiotensin mechanism.

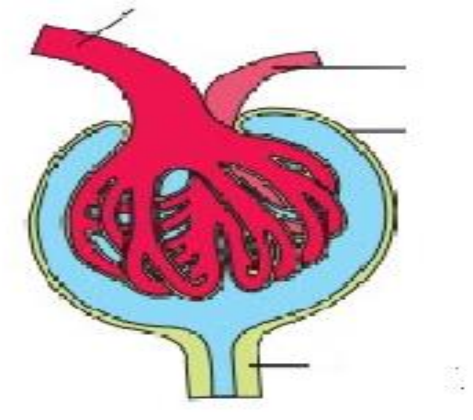
Q33.Observe the diagram and answer the following questions :-



Name the tube drawn in the left side.

Answer :- vasa recta

1. **Which substance reabsorbed at descending and ascending loop of Henle?**
   Ans. At descending loop of Henle – water and at ascending loop of Henle – sodium chloride
2. **What will be the osmolarity of filtrate in the ascending vasa recta ?**
   Answer :- as the filtrate proceed upwards, osmolarity get decreased.
3. **For what purpose , nephron and vasa recta given together ?**
   Ans. to depict Counter Current System.
4. **Answer the questions based on the diagram given below.**



(i) There are two blood capillaries represented in the diagram, what are their names?

Answer :- Afferent arteriole and Efferent arteriole

(ii) What represented in the overall diagram?

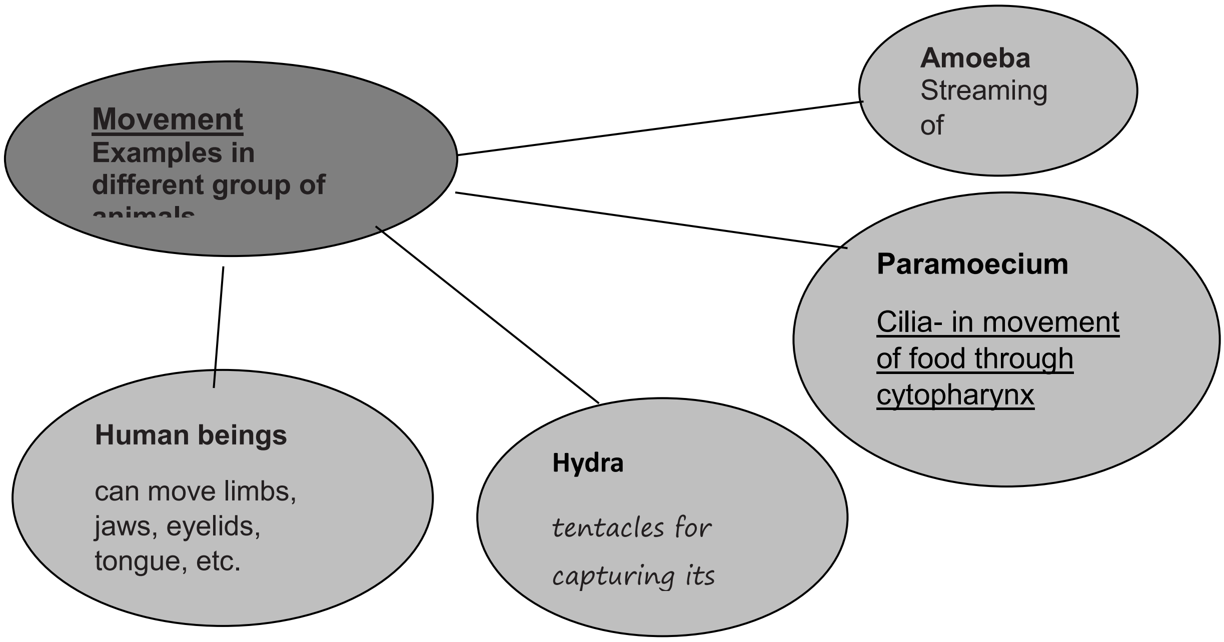
Ans. Malpighian capsule

(iii) Which tube represented at the bottom?

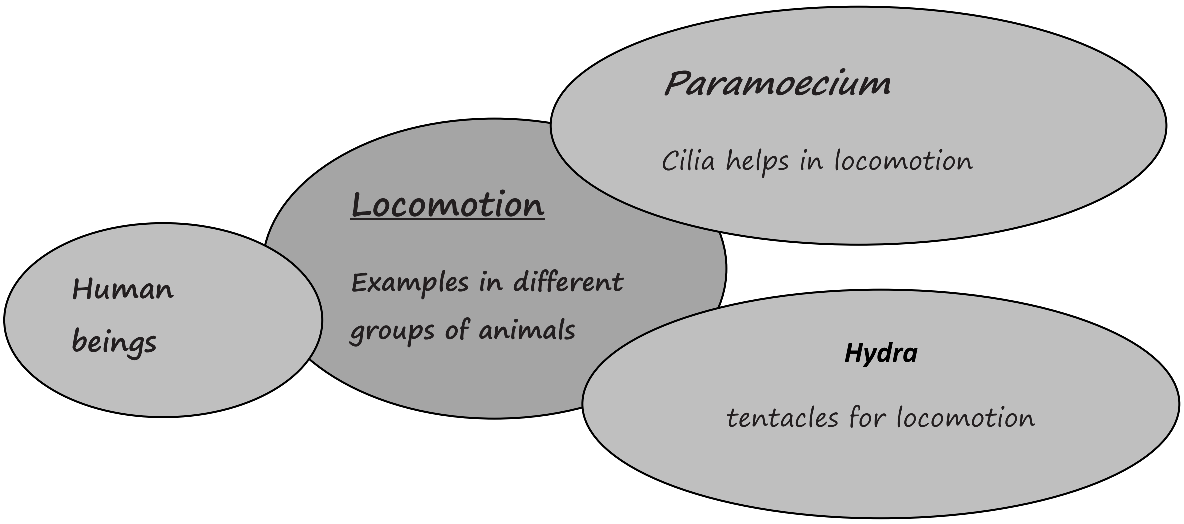
Ans .Proximal Convoluted Tubule.

CHAPTER -20 Locomotion and Movement

Movement - one of the significant features of living beings.



- **Locomotion -** Some voluntary movements result in a change of place or location. Walking, running, climbing, flying, swimming are some forms of locomotory movements.



- Hence, all locomotions are movements but all movements are not locomotions.
- Methods of locomotion performed by animals vary with their habitats and the demand of the situation.

- Locomotion is generally for search of food, shelter, mate, suitable breeding grounds, favourable climatic conditions or to escape from enemies/predators.
- Locomotion requires a perfect coordinated activity of muscular, skeletal and neural systems.
-

TYPES OF MOVEMENT IN HUMAN BODY

Amoeboid Movement

- macrophages leucocytes in blood.
- is effected by pseudopodia formed by the streaming of

Ciliary Movement

- Occurs in most of our internal tubular organs which are lined by ciliated epithelium.
- Coordinated movements of cilia in the trachea help us in removing dust particles and some of the foreign substances inhaled alongwith the atmospheric air.
- Passage of ova through the female reproductive tract is also facilitated by the ciliary movement.

Muscular Movement

- Eg.- Movement of our limbs, jaws, tongue, etc.
- Contractile property of muscles are effectively used for locomotion and other movements by human beings and majority of multicellular organisms.

Muscle

- Muscle - specialised tissue of mesodermal origin.
- They have special properties like excitability, contractility, extensibility and elasticity.
- Based on their location, three types of muscles are identified:
(i) Skeletal (ii) Visceral (iii) Cardiac.

- **Skeletal muscles**

- associated with the skeletal components of body.
- **Striated muscles** -They have a striped appearance under the microscope
- **Voluntary muscles** - As their activities are under the voluntary control of the nervous system.

-They are primarily involved in locomotory actions and changes of body postures.

•**Visceral muscles**

- located in the inner walls of hollow visceral organs of the body like the alimentary canal, reproductive tract, etc.

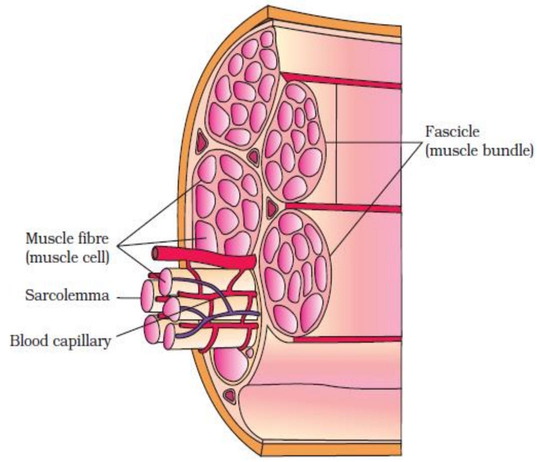
- **Non-striated muscle** - do not exhibit any striation.
- **Smooth muscles -** are smooth in appearance.
- **Involuntary muscles-** Their activities are not under the voluntary control of the nervous system.
-They assist in transportation of food through the digestive tract and gametes through the genital tract.

•**Cardiac muscles**

-are muscles of heart.
- Many cardiac muscle cells assemble in a branching pattern to form a cardiac muscle.
-Appearance - striated.
-are involuntary in nature as the nervous system does not control their activities directly.

Structure of a skeletal muscle:

- **Muscle bundles** or **fascicles-** Many such fascicles are held together by a common collagenous connective tissue layer called **fascia** to form a skeletal muscle in our body.



- **Sarcolemma** – Plasma membrane lining each muscle fibre which encloses sarcoplasm.
- **Sarcoplasm** – Cytoplasm of a muscle cell. Muscle fibre is a syncitium as the sarcoplasm contains many nuclei.
- **Sarcoplasmic reticulum** -Endoplasmic reticulum of the muscle fibres which is the store house of calcium ions.
- **Myofilaments** or **Myofibrils** - a large number of parallelly arranged filaments in the sarcoplasm.

-Each myofibril has alternate dark and light bands on it.
-Striated appearance of myofibril is due to the distribution pattern of two important proteins – **Actin** and **Myosin**. -**Light band** contains actin and is called **I-band** or **Isotropic band**.
-**Dark band** called **'A' or Anisotropic band** contains myosin.
-Both proteins are arranged as rod-like structures, parallel to each other and also to longitudinal axis of the myofibrils.
-**Actin filaments** are thinner as compared to myosin filaments, hence are commonly called thin filaments.
-**Myosin filaments** are thick filaments.
-**'Z' line** - an elastic fibre called 'Z' line which bisects 'I' band.
-Thin filaments are firmly attached to the 'Z' line.

- **‘M’ line**- A thin fibrous membrane that holds together the thick filaments in the middle of ‘A’ band.
-The ‘A’ and ‘I’ bands are arranged alternately throughout the length of the myofibrils.
- **Sarcomere** - Portion of myofibril between two successive ‘Z’ lines.
- is the functional unit of contraction.
-**‘H’ zone** - In resting state, central part of thick filament, not overlapped by thin filaments.

Structure of contractile proteins

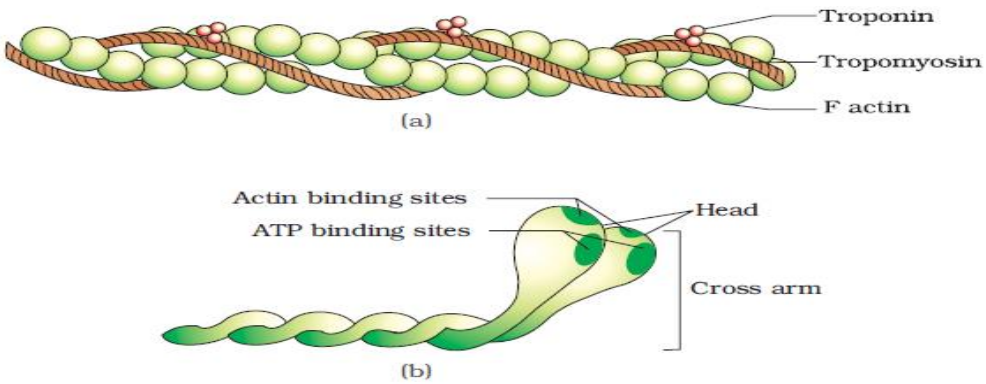


Figure 20.3 (a) An actin (thin) filament (b) Myosin monomer (Meromyosin)

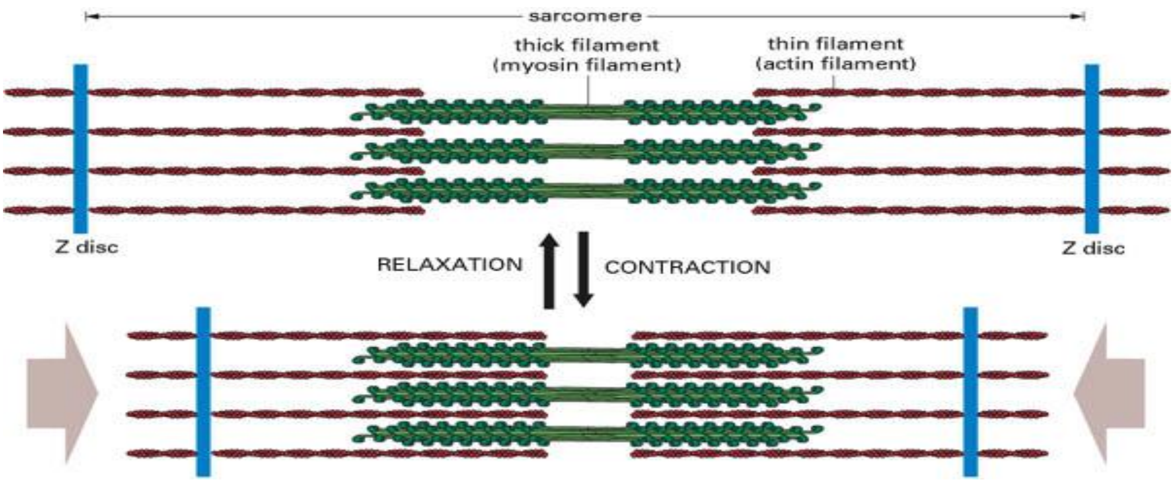
- **Actin (thin) filament**- each made of two ‘F’ (filamentous) actins helically wound to each other.

-**‘F’ actin –** each is a polymer of monomeric ‘G’ (Globular) actins.
-**Tropomyosin** -Two filaments of this protein, also run close to the ‘F’ actins throughout the length of actin filament.
-**Troponin** - A complex protein which is distributed at regular intervals on the tropomyosin.
-In resting state a subunit of troponin masks the active binding sites for myosin on the actin filaments.

- **Myosin (thick) filament-** Each myosin filament is also a polymerised protein. – **Meromyosins-** monomeric proteins.

- Many such proteins constitute one thick filament.
- Each meromyosin has two
important parts, a globular head with a short arm (heavy meromyosin - HMM) and a tail (light meromyosin -LMM).
- **Cross arm -** HMM component, i.e. the head and short arm projects outwards at regular distance and angle from each other from the surface of a polymerised myosin filament and is known as cross arm.
-Globular head is an active ATPase enzyme and has binding sites for ATP and active sites for actin.

Mechanism of muscle contraction



- **Sliding filament theory** - states that contraction of a muscle fibre takes place by the sliding of the thin filaments over the thick filaments.

  - **A motor unit** - A motor neuron along with the muscle fibres.

  - **Neuromuscular junction or motor-end plate** - The junction between a motor neuron and sarcolemma of muscle fibre.

  - Muscle contraction is initiated by a signal sent by the central nervous system (CNS) via a motor neuron.

  - A neural signal reaching this junction releases a neurotransmitter (Acetyl choline) which generates an action potential in the sarcolemma.

  -This spreads through the muscle fibre and causes the release of calcium ions into the sarcoplasm.

  - Increase in Ca^{++} level causes binding of calcium with a subunit of troponin on actin filaments thus removing the masking of active sites for myosin.

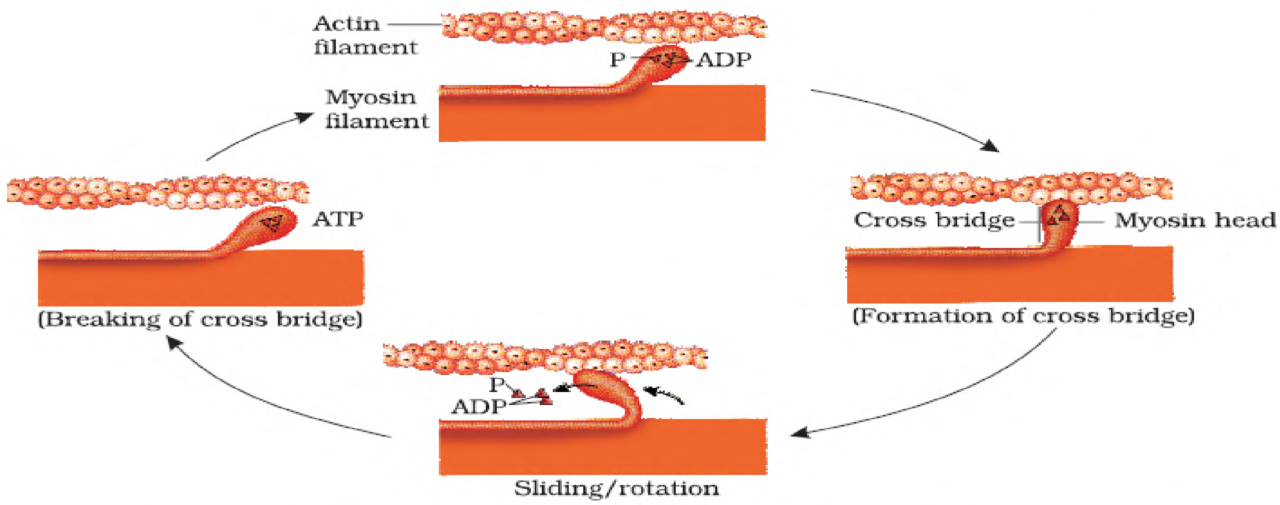


Figure 20.4 Stages in cross bridge formation, rotation of head and breaking of cross bridge

Formation and Breaking Of Cross Bridge

Cross bridge - Utilising the energy from ATP hydrolysis, the myosin head now binds to the exposed active sites on actin and forms a cross bridge.

-This pulls the attached actin filaments towards the centre of 'A' band.

-The 'Z' line attached to these actins are also pulled inwards thereby causing a shortening of the sarcomere (contraction).

-Hence, during shortening of muscle (contraction), the **'I' bands get reduced, whereas the 'A' bands retain the length**.

-Myosin, releases ADP + Pi and goes back to its relaxed state.

-A new ATP binds breaking the cross-bridge .

-ATP is again hydrolysed by myosin head and the cycle of cross bridge formation and breakage is repeated causing further sliding.

-The process continues till the Ca^{++} ions are pumped back to the sarcoplasmic cisternae, resulting in masking of actin filaments.

-Causes the return of 'Z' lines back to their original position(relaxation).

- **Fatigue** - Repeated activation of the muscles can lead to the accumulation of lactic acid due to anaerobic breakdown of glycogen in them, causing fatigue.
- **Myoglobin** - A Red coloured oxygen storing pigment present in muscle, which gives a reddish appearance to them.
- **Red fibres/ Aerobic muscles -** Myoglobin content is high in some muscles which gives them a reddish appearance. Such muscles are called the Red fibres.

-They also contain plenty of mitochondria which can utilise large amount of oxygen stored in them for ATP production. Hence, also called aerobic muscles.

-**White fibres**- Some of the muscles possess very less quantity of myoglobin and therefore, appear pale or whitish.

-Number of mitochondria - also few in them, but the amount of sarcoplasmic reticulum is high and depend on anaerobic process for energy.

Skeletal System

- Has a significant role in movement shown by the body.
- Consists of a framework of bones (206 bones) and a few cartilages (specialised connective tissues).
- **Bone** - has a very hard matrix due to calcium salts in it.
- **Cartilage -** has slightly pliable matrix due to chondroitin salts.

  is grouped into two principal divisions –
- **Axial skeleton** and **Appendicular skeleton**.

<u>Axial skeleton</u>

_comprises 80 bones distributed along the main axis of the body.

- Constitutes, **the skull**, **vertebral column**, **sternum** and **ribs**.
- **Skull (22 bones)**- composed of two sets of bones :

Skull

- 8 in number- [Frontal (1), Parietal (2),Temporal (2),Occipital (1),Sphenoid (1), Ethmoid (1)].
- form hard protective outer covering- **cranium** for the brain.

- made up of 14 skeletal elements- [Nasals (2), maxillae (2), Palatines (2), Zygomatic (2), Lacrimals (2),, inferior nasal conchae (2), Vomer (1), Mandible (1)].
- form the front part of the skull.

Skull

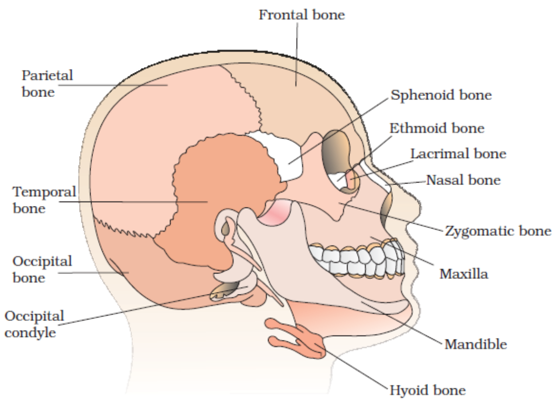


Figure 20.6 Diagrammatic view of human skull

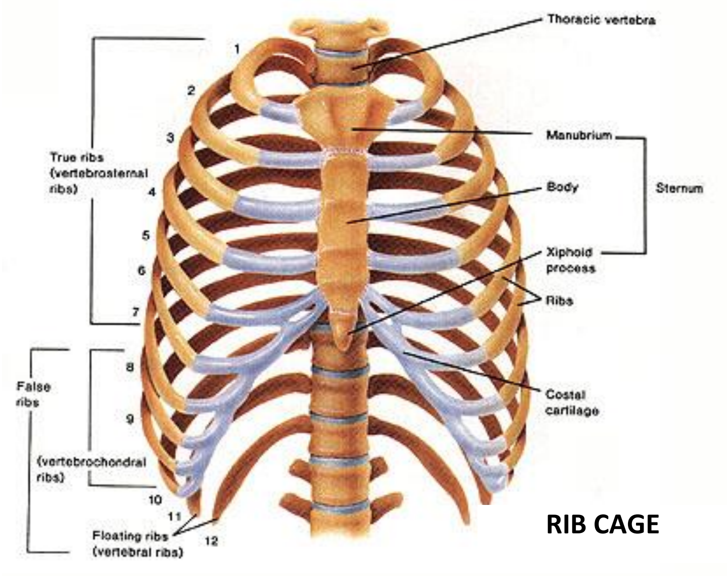
- Skull articulates with vertebral column with the help of two occipital condyles (dicondylic skull).

Vertebral column - is dorsally placed.

- Formed by 26 serially arranged units called vertebrae.
- Extends from the base of the skull and constitutes the main framework of the trunk.
- Each vertebra has a central hollow portion (neural canal) through which the spinal cord passes.

- First vertebra is atlas and it articulates with the occipital condyles.
- Vertebral column is differentiated into cervical (7), thoracic (12), lumbar (5), sacral (1-fused) and coccygeal (1-fused) regions starting from the skull.
- Vertebral column protects the spinal cord, supports the head and serves as the point of attachment for the ribs and musculature of the back.
- **Sternum -** is a flat bone on the ventral midline of thorax.
- **Ribs** -12 pairs of **ribs.**
  Each rib - a thin flat bone connected dorsally to the vertebral column and ventrally to the sternum.

- Has two articulation surfaces on its dorsal end and is hence called bicephalic.
- **True ribs**- First seven pairs of ribs.
- Dorsally, they are attached to the thoracic vertebrae and ventrally connected to the sternum with the help of hyaline cartilage.



RIB CAGE

VERTEBRAL COLUMN

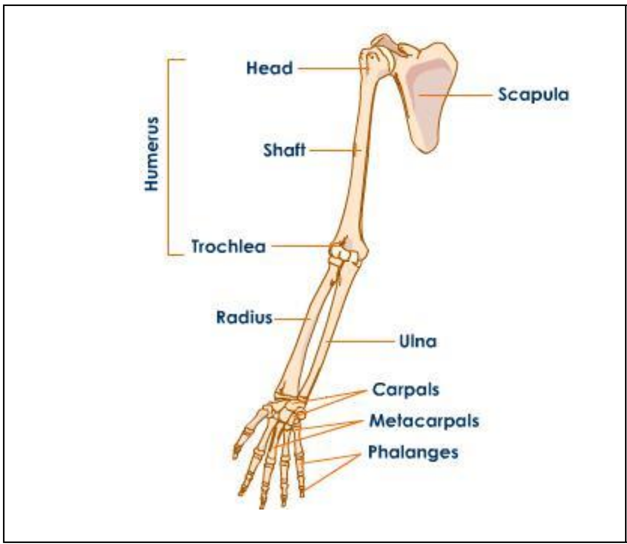
-Vertebrochondral (false) ribs-The 8th, 9th and 10th pairs of ribs do not articulate directly with the sternum but join the seventh rib with the help of hyaline cartilage.

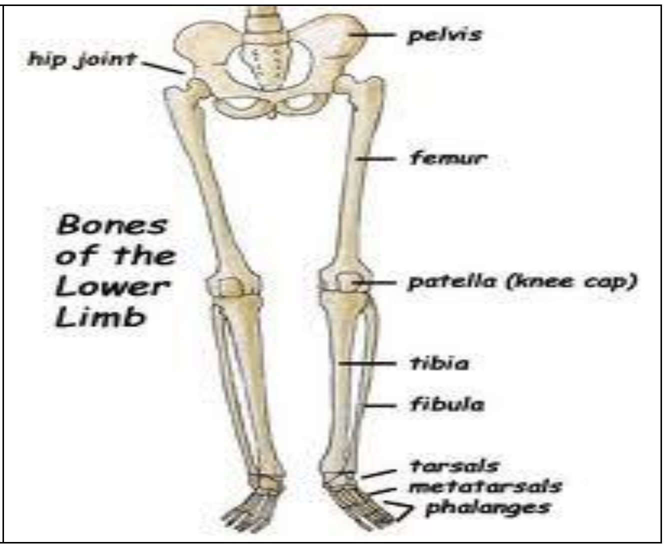
- **Floating ribs -** Last 2 pairs (11th and 12th) of ribs which are not connected ventrally .
- **Rib cage** - Thoracic vertebrae, ribs and sternum together form the rib cage.

Appendicular skeleton

- **Bones of limbs** alongwith their **girdles** constitute the appendicular skeleton.
- **Bones of limbs –**

- Each **limb** is made of 30 bones.
- **Bones of hand** (**fore limb**) - **humerus**, **radius** and **ulna**, **carpals** (wrist bones – 8 in number), **metacarpals** (palm bones – 5 in number) and **phalanges** (digits – 14 in number).
- **Bones of the legs (hind limb)** - **Femur** (thigh bone – the longest bone), **tibia** and **fibula**, **tarsals** (ankle bones – 7 in number), **metatarsals** (5 in number) **phalanges** (digits – 14 in number) and a cup shaped bone called **patella** cover the knee ventrally (knee cap).





Pectoral and **Pelvic girdle** bones help in the articulation of upper and lower limbs, respectively with axial skeleton.

- **Pectoral girdle** - consists of a **clavicle** and a **scapula**.
- **Clavicle / collar bone** – Each clavicle is a long slender bone with two curvatures.
- **Scapula** is a large triangular flat bone situated in dorsal part of thorax between the second and seventh ribs.
- Dorsal, flat, triangular body of scapula has a slightly elevated ridge called - spine which projects as a flat, expanded acromion process.
- Clavicle articulates with this.

Fore Limb and Pectoral girdle

- **Shoulder joint** – Joint at which the glenoid cavity (depression below the acromion) articulates with the head of the humerus. **Pelvic girdle** - consists of two coxal bones.
- **Coxal bones** - Each is formed by the fusion of three bones – **ilium, ischium** and **pubis**.
- **Acetabulum** - cavity formed at the point of fusion of above bones, to which the thigh bone articulates.
- **Pubic symphysis** -The two halves of pelvic girdle meet ventrally to form pubic symphysis containing fibrous cartilage.
- **Pelvic joint** - Joint at which head of femur articulates with the acetabulum.

Joints

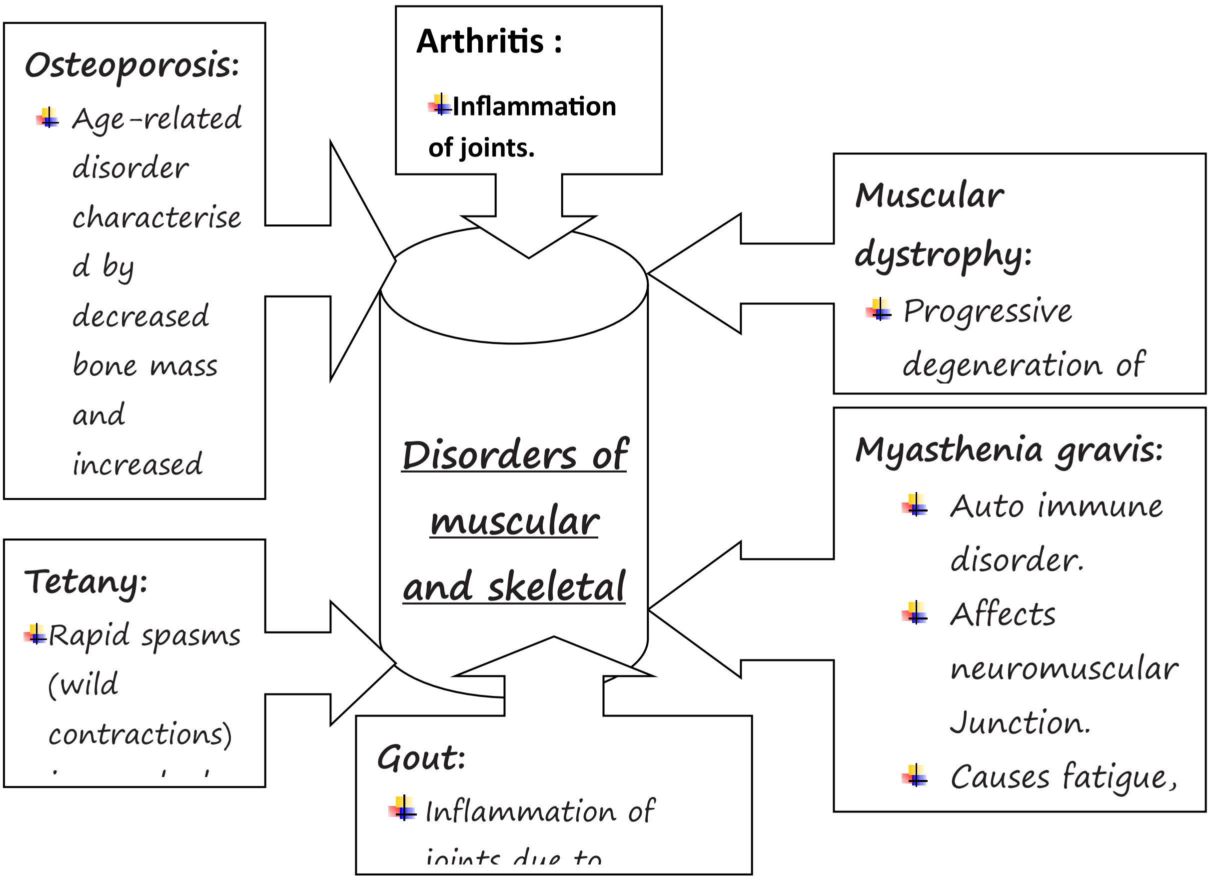
- Joints are points of contact between bones, or between bones and cartilages.
- Joints are essential for all types of movements involving the bony parts of the body.

- Force generated by muscles is used to carry out movement through joints, where the joint acts as a fulcrum.
- Joints have been classified into three major structural forms - **fibrous**, **cartilaginous** and **synovial**.

- **Fibrous joints -** do not allow any movement.
- Eg.- flat skull bones which fuse end-to-end with the help of dense fibrous
connective tissues in the form of sutures, to form the cranium.

- **Cartilaginous joints -** the bones involved are joined together with the help of cartilages.
- Eg.- joint between the adjacent vertebrae in vertebral column is of this pattern and it permits limited movements.

- **Synovial joints** – have a fluid filled synovial cavity between the articulating surfaces of two bones.
- Such an arrangement allows considerable movement.
- These joints help in locomotion and many other movements.
- Eg.- Ball and socket joint (between humerus and pectoral girdle), hinge joint (knee joint), pivot joint (between atlas and axis), gliding joint (between the carpals) and saddle joint (between carpal and metacarpal of thumb).



MULTIPLE CHOICE QUESTIONS

Q1. Which of the following statements about visceral muscles is correct?

(a) They are non-striated muscles (smooth muscles) (b) They are involuntary muscles
(c) They have various functions (d) All

Q2. Cardiac/heart muscles are

(a) Striated and involuntary (b) Not fatigued (c) Branched (d) All

Q3. Which of the following statements is false?

(a) Smooth muscles are found in urinary bladder, alimentary canal and genital tract
(b) A striated muscle is syncytium (multinucleate)
(c) The cytoplasm of striated muscle is called endoplasm
(d) The plasma membrane and ER of striated muscles are called sarcolemma and sarcoplasmic reticulum respectively

Q4. The source of Ca+2 for the muscle is –

(a) T-tubule (b) Sarcosome (c) Sarcolemma (d) Sarcoplasmic reticulum

Q5. Match Column I with Column II –

	Column I		Column II
A	Structural and functional unit of a myofibril	I	H-zone
B	Protein of thin filament	II	Myosin
C	Protein of thick filament	III	Sarcomere
D	The central part of thick filament not overlapped by thin filament	IV	Actin

(a) A-I, B-II, C-III, D-IV (b) A-I, B-III, C-II, D-IV
(c) A- I, B - IV, C - III, D - II (d) A- III, B - IV, C - II, D – I

Q6. Z-line divides the myofibrils into –

(a) Sarcomere (b) Sarcolemma (c) Sarcosome (d) Microtubules

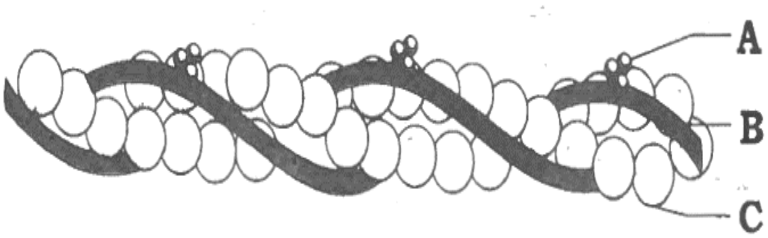
Q7.Sarcomere is the area between –

(a) 2 H-zones (b) 2 Z-lines (c) 2 M-lines (d) 2A-bands

Q8. Light bands (thin filaments) contain actin and are called –

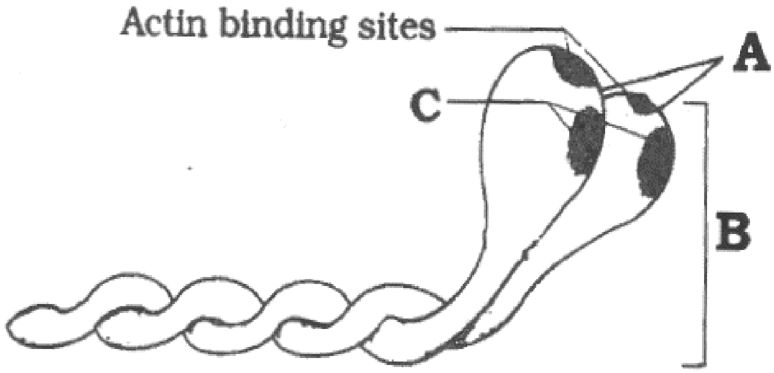
(a) A-bands or Isotropic band (b) A-bands or Anisotropic bands
(c) I-bands or Isotropic bands (d) I-bands or Anisotropic bands

Q9. Following is the figure of actin (thin) filaments. Identify A, Band C.



(a) A- Tropomyosin, B - Troponin, C - F-actin (b) A- Troponin, B - Tropomyosin, C – Myosin
(c) A- Troponin, B - Myosin, C - Tropomyosin (d) A- Troponin, B - Tropomyosin, C - F-actin

Q10.



The above figure is related with myosin monomer (meromyosin). Identify A to C –

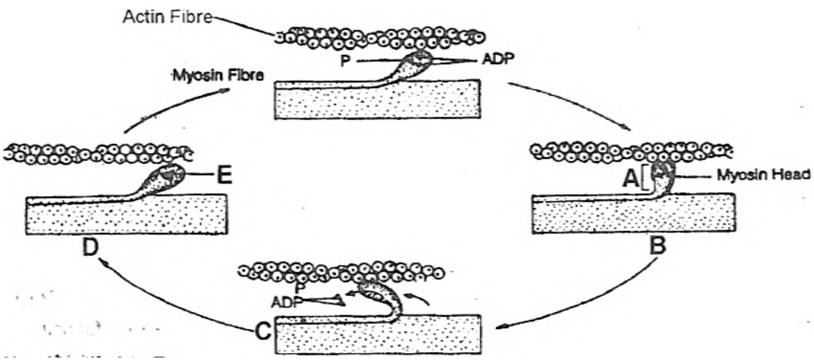
(a) A- head, B - cross arm, C - GTP binding sites (b) A- head, B - cross arm, C - Ca+2 binding sites (c) A- head, B - cross arm, C -ATP binding sites (d) A- cross arm, B - head, C -ATP binding sites

Q11. Put the following phrases in proper order to describe what occurs at the neuromuscular junction to trigger muscle contraction.

I. Receptor sites on sarcolemma. II. Nerve impulse. III. Release of Ca+2 from sarcoplasmic reticulum IV. The neurotransmitter acetylcholine is released V. Sarcomere shorten VI. Synaptic cleft VII. Spread of impulses over sarcolemma on T-tubules

(a) II, IV, I, VI, VII, III, V (b) II, IV, VI, I, VII, III, V
(c) I, II, III, IV, V, VI, VII (d) VII, VI, V, IV, III, II, I

Q12. Go through the following diagram describing muscle contraction



Now identify A to E.

(a) A- Cross bridge, B - Cross bridge formation, C-Breaking of cross bridge, D –Sliding (rotation), E –ATP

(b) A- Cross bridge, B - Cross bridge formation, C – Sliding/rotation, D – Breaking of cross bridge, E -ATP

(c) A- Cross bridge, B - Breaking of Cross bridge, C – Sliding/rotation, D - Cross bridge formation, E -AMP

(d) A- Cross bridge, B - Cross bridge formation, C – Sliding/rotation, D - ADP, E - Breaking of cross bridge

Q13. How does the troponin-tropomyosin complex affect cross-bridge cycling?

(a) When [Ca2+] is low, the troponin-tropomyosin complex blocks actin's binding site for myosin.
When [Ca2+] is high, the complex rolls out of the way, allowing myosin to bind to actin and
initiate the cross-bridge cycle.

(b) The troponin-tropomyosin complex regenerates ATP for the myosin ATPase.

(c) The troponin-tropomyosin complex regulates calcium release from the terminal cisternae.

(d) The troponin-tropomyosin complex binds to the myosin head, facilitating contact with the actin
Filaments

Q14.. Human Cranium has small protuberance(s) at the posterior end called __________ and ____ in number.that articulates with first vertebra (atlas vertebra)-

(a) occipital condyle, 6 (b) occipital condyle, 2 (c) occipital condyle, 4 (d) occipital condyle, 3

Q15. Human skull is - (a) Dicondylic (b) Monocondylic (c) Procoelous (d) Hetercoelous.

Q16. Which of the following statements about human vertebral column is false?

(a) Vertebral column consists of 26 vertebrae (b) It is ventrally placed

(c) It extends from the base of skull and constitutes the main framework of the trunk

(d) Neural canal in vertebra is the passage for spinal cord

Q17. Human adult vertebral formula is-

(b) C4 T8 L4 S8 C8 (b) C7 T8 L5 S6 C7

(c) C7 T12 L2 S1 C2 (d) C7 T12 L5 S1 C1

Q18. Which of the following vertebra in adult human are fused ones?

(a) Thoracic and lumber (b) Thoracic and cervical

(c) Sacral and coccygeal (d) Cervical and coccygeal

Q19. Which of the following is not the function of vertebral column?

(a) Protects spinal cord and supports the head

(b) Serves as the point of attachment for ribs and musculature of the back

(c) Both (d) Supports Tarsals and Metacarpals

Q20. Which of the following is not correct about sternum?

(a) It is commonly called breast bone (b) It is flat bone

(c) It is 2 in number (d) It is located on the ventral mid line of thorax

ANSWER KEY

MULTIPLE CHOICE QUESTION BANK

No. of Chapter -20 Name of Chapter- Locomotion and Movement

Q.1	**Q.2**	**Q.3**	**Q.4**	**Q.5**	**Q.6**	**Q.7**	**Q.8**	**Q.9**	**Q.10**
d	d	c	d	d	a	b	c	d	c
Q.11	**Q.12**	**Q.13**	**Q.14**	**Q.15**	**Q.16**	**Q.17**	**Q.18**	**Q.19**	**Q.20**
b	b	a	b	a	b	d	c	c	c

SA-I (2marks)

Q21.Define a sarcomere. Which filaments are responsible for muscle contraction?

Ans - A portion of myofibril between two successive ‘Z’ lines
-Actin and Myosin

Q22.Wrtie any two difference between cardiac muscle and skeletal muscle.

Ans– Cardiac Muscle – These muscles are found in heart wall. These are involuntary in nature. Skeletal Muscle – These muscles are found in limbs, tongue, pharynx etc.
These are voluntary muscles which are attached to skeleton.

Q23.Name the two types of girdles found in human body and write their role.

Ans – Pectoral Girdles – Composed of two bones clavicle and scapula. Provide support to the arms with ball and socket joint through glenoid cavity.
Pelvic Girdles – Composed of three bones ileum, ischium and pubic. Provide support to the limb with ball and socket joint through acetabulum.

Q24. **Name the bones of fore limb (hand) of human body. Give their number in each limb**.

Ans – 1. Humerus 2. Radius and Ulna 3. Carpals -8
4. Metacarpals - 5 5. Phalanges – 14. Total Number - 30

Q25. **Differentiate between I band and A band in Muscles?**

Ans - I Band	A Band
1. Formed of myosin and actin filament	1. Formed of only actin filament.
2. Give dark appearance	2. Give light appearance
3. In the central zone, it has Hensen's line or H zone	3. In central zone it has Krause membrane or Z line
4. Anisotropic	4. Isotropic

SA-II (3 marks)

Q26. Distinguish between Red Muscle fibre and White Muscle fibre?

Ans - **Red muscle fibres** 1. Thinner in size. 2. These are dark red in colour due to the presence of myoglobin (red haemoprotein). Myoglobin can bind with oxygen to form oxymyoglobin and thus stores oxygen. Oxymyoglobin can release oxygen during muscular contraction. 3. They have a slow rate of contraction. 4. These muscle fibres are rich in mitochondria. 5. These fibres can carry out lot of aerobic metabolism and so, aerobic contraction of the muscles without accumulating much of lactic acid. They can thus contract for a longer time without muscular fatigue. 6. These muscle fibres can do sustained but slower work for a long time. Examples:
Extensor muscles on the back of human body, flight muscles of some birds like kites etc.

White muscle fibres: 1. Thicker in size 2. They are lighter in colour due to the lack of myoglobin (red haemoprotein). 3. They have a fast rate of contraction 4. These muscle fibres are poor in mitochondria 5. These fibres mainly depend upon anaerobic metabolism (glycolysis only) and so, anaerobic contraction of the muscles thus accumulating lot of lactic acid leading to muscular fatigue 6. These muscle fibres can do fast work for a short period only. Examples: Muscles of the eye ball, flight muscles of some birds like sparrow etc

Q27. What are chemical changes taking place in Muscle contraction?

Ans - Chemical changes in muscle contraction:

1. ATP is the immediate source of energy for muscle contraction. Hence, hydrolysis process occurs in the contracting muscle to convert ATP to ADP with the release of inorganic phosphate and energy by myosin ATPase:

   $ATP + H_2O + ATPase \longrightarrow ADP + Pi$ ¬
2. This energy released is used up in muscular contraction. For restoration of ATP, body muscles have also got another compound called Creatine phosphate (CP). This is also an energy rich compound. It helps in the conversion of ADP to ATP again immediately. This happens at the end of muscular contraction.

   $ADP + CP \longrightarrow ATP + Creatine$¬
3. Creatine (C) formed during muscular contraction is again reconverted to Creatine phosphate by the utilisation of ATP generated by carbohydrate oxidation.

   $ATP + C \longrightarrow ADP + CP$ ¬

During muscle contraction, carbohydrates are metabolized through glycolysis in the muscle to produce ATP. This results in the formation of lactic acid from carbohydrates. During recovery after contraction, lactic acid is oxidized aerobically to produce carbon dioxide, water and giving more energy

Q28. Explain the Mechanism of Muscle Contraction?

Ans - A voluntary muscle fibre consists of numerous myofibrils which have their units as sarcomeres. Each myofibril is covered by the cisternae and tubules of sarcoplasmic reticulum at the I-band and at

the junction of A-band and I-band by a T-tubule that communicates with the exterior of cell. A sarcomere consists of a half-light band and a half dark band i.e. the distance between two Z membranes. It also has primary and secondary filaments. The primary filaments are made up of a protein called myosin while secondary filaments are of actin.

As the stimulus is given to the muscle, the secondary filaments slide over to the primary filaments thus shortening the length of the light band or I-band. It is important to note that the length of dark band or A-band does not change. The actual site where sliding of the filaments occur is known as cross bridges. Thus, in response to a stimulus, the overall length of the sarcomere and the myofibril decreases. A muscle never expands to a stimulus but always contracts in its length.

Case Based Study Questions (4marks)

Q29. The muscle fibre is a syncytium. A characteristic feature of the muscle fibre is the presence of a large number of parallelly arranged filaments in the sarcoplasm called myofilaments or myofibril. Each myofibril has alternate dark and light bands on it. Visceral muscles are located in the inner walls of hollow visceral organs of the body. They do not have any striation and are
smooth in appearance. Many cardiac muscle cells assemble in a branching pattern to form cardiac muscle.

(i) Why is muscle fibres called a syncytium?

(a) As it is aseptate (b) As it has more than one nuclei
(c) As it has more than one sarcoplasm (d) As it has dark and light bands

(ii) Give a characteristic feature of muscle fibres.

(a) Presence of myofilaments (b) Absence of myofilaments
(c) Presence of branching pattern (d) Spindle shaped appearance

(iii) Name some visceral organs of the human body.

(a) Femur, legs, arms (b) Oesophagus (c) Stomach (d) Both (b) & (c)

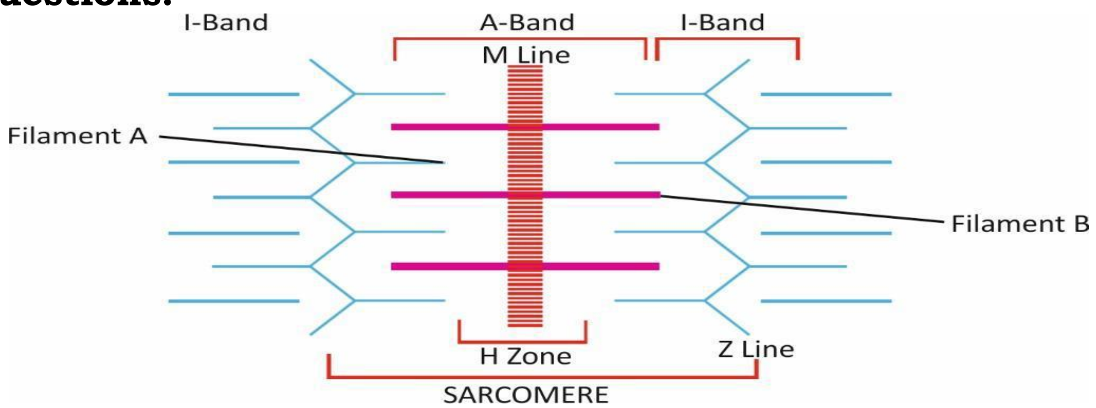
(iv) Which type of muscle are located in the inner walls of hollow visceral organs?

(a) Skeletal muscles (b) Smooth muscles
(c) Cardiac muscles (d) Smooth muscles & cardiac muscles

(v) Skeletal muscles and smooth muscles are -

(a) Involuntary and voluntary respectively (b) Voluntary and involuntary respectively
(c) Both involuntary(d) Both voluntary.

Q30. Look at the diagram of the sarcomere of a muscle and answer the questions:



A. Identify filaments A and B.
B. What happens to each type of filament during contraction?
C. Which of these substances would make the best muscle relaxant, and why?
Chemical A: Blocks acetylcholine receptors on muscle cells.
Chemical B: Floods the cytoplasm of muscle cells with calcium ions

Ans –

A. Filament A: Actin Filament B: Myosin

B. During contraction, actin and myosin filaments slide past each other longitudinally, so that the degree of overlap between the thin and thick filaments increases and the length of the sarcomere decreases.

C. Chemical A would work better because acetylcholine triggers contraction. Blocking it would prevent contraction. Chemical B would actually increase contraction because Ca2+ allows contraction to occur.

LA-I (5marks)

Q31. A. What are functions of Skeletal System in body?
B. Explain process of muscles contraction

Ans–A-a) It provides a kind of framework for the body.
c) It provides shape and posture to the body.
c) It provides protection to some of the inner delicate organs like brain, spinal cord and lungs.
d) It gives rigid surface for the attachment of muscles with the help of tendons.
e) It helps in locomotion.
f) The bone marrow serves as the centre for the production of red blood cells and white blood cells.
g) The movements of ribs and sternum help in breathing.
h) In the ear, the sound vibrations are conveyed from the tympanum to the internal ear by a set of three bones as in man.
i) It helps the body to be an integrated unit.
j) It serves to store various ions like calcium and phosphate which are then released into the body at the time of need. These minerals perform various functions of the body.

Ans–B-1. Central nervous system initiate muscle contraction via motor neuron.

2. stimulate muscle fibre secrete neurotransmitter
3. Generate action potential in sarcolemma
4. Release of Ca^{2+} in sarcoplasm which binds with troponin

5. Unmask active site of Actin
6. Myosin head binds to actin at active site and form cross bridge using ATP
7. Pulls the actin filament towards the centre of A band, shortening of sarcomere i.e. contraction.
8. Cross bridge between actin and myosin break
9. Ca^{2+} pumped back in to sarcoplasmic cisternae and relaxation of A band

Q32. Mention the factor which is responsible for the following:

(i) Tetany (ii) Gout (iii) Osteoporosis

Ans – (i) Tetany : Rapid spasm (Wild contractions) in muscle due to lesser Ca^{2+} in body fluid.
(ii) Gout –Inflammation of joints due to accumulation of uric acid crystals.
(iii) Osteoporosis – Decreased bone mass in old age leading to chance of fracture due to decreased estrogen.

Q33. **What are the different type of movable joints in humans?**

Ans - Freely movable or synovial joints: In this type of joint, there is a fluid filled synovial cavity in between the movably articulated bones. The fluid is called as synovial fluid. A synovial membrane covers this fluid filled synovial cavity forming the capsule.
The articulating bones are provided with cartilage caps. Ligaments are also present to hold the bones. It is of the following types :

• Ball and socket joint : In this, one of the bones forms a globular head while the other forms a cup like socket into which head fits in. It allows a free movement in all directions. E.g.- shoulder girdle and hip girdle joints. Such joints may stretch (extend), fold (flex) and rotate the limb of the body. This may allow the movement of the limb towards the body or away from the body.

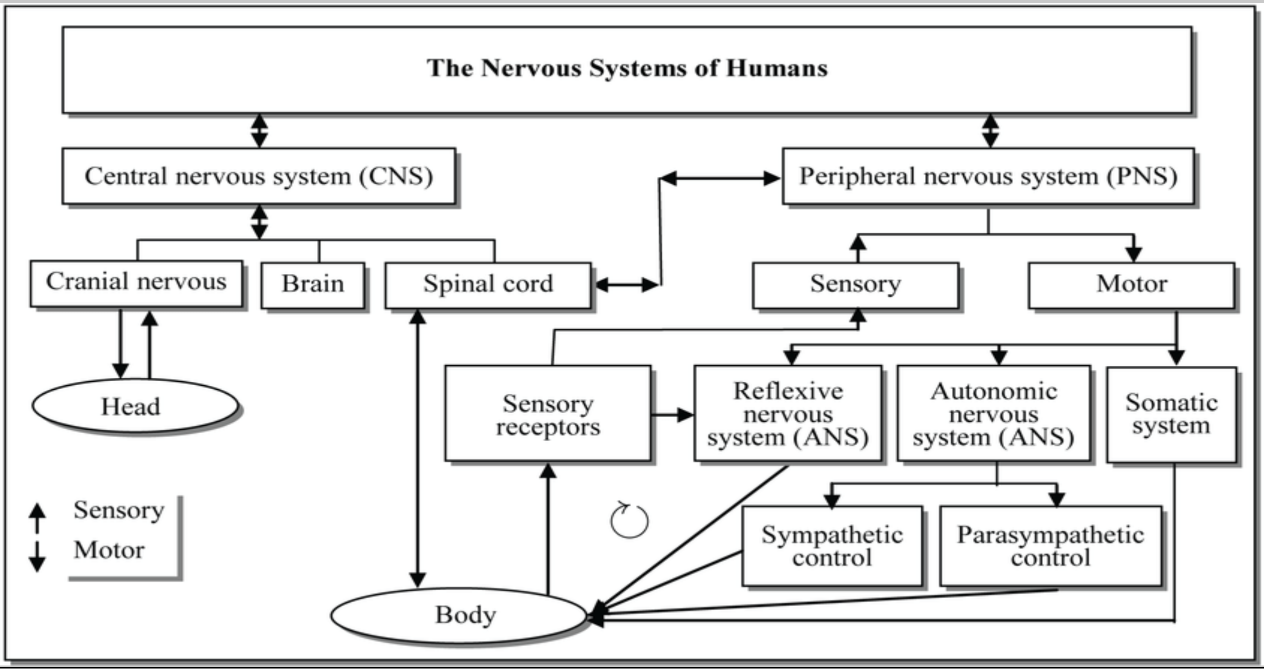
• Hinge joint : Here, the two bones are fitted like the hinge of a door so as to allow 'to and fro' movements in one direction only. These joints are provided with strong ligaments. It is seen in elbow joint, knee joint and joints between phalanges of fingers and toes.

• Pivot joint : In this type of joint, one bone is fixed while the other moves freely over it. The movement is confined to a rotation around a longitudinal axis through the centre of the pivot. E.g.- Movement of the skull over the odontoid processes of the first neck vertebra.

• Gliding joint : It is a biaxial joint. The articulating bones which can glide one above the other. It is seen in wrist bones that can glide over forearm bones. In zygapophysis, vertebrae can glide one above the other. Some of the bones in the palm or in the sole of foot.

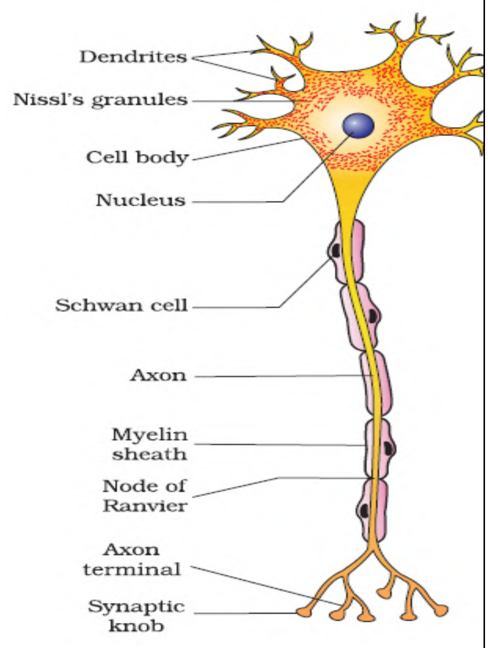
- Ellipsoid joints : They permit movements of articulating bones around two axes. Such joints are formed between the toe bones and some bones in the sole of foot.

CHAPTER-21 Neural Control and Coordination



PARTS OF NEURON: A NEURON

1.Cell body = Cytoplasm with nucleus, cell organelles and Nissl's granules
2. Dendrites = Short fibres which branch repeatedly and project out of cell.
3.Axon = Single, long fibre, branched at distal end.
4. Multipolar Axon = One axon and two or more dendrites. Found in cerebral Cortex.
5. Bipolar Axon = One axon and one dendrite. Found in retina of eye.
6. Unipolar Axon = Cell body with axon only. Found usually in the embryonic stage.



Conduction of nerve impulse along axon:

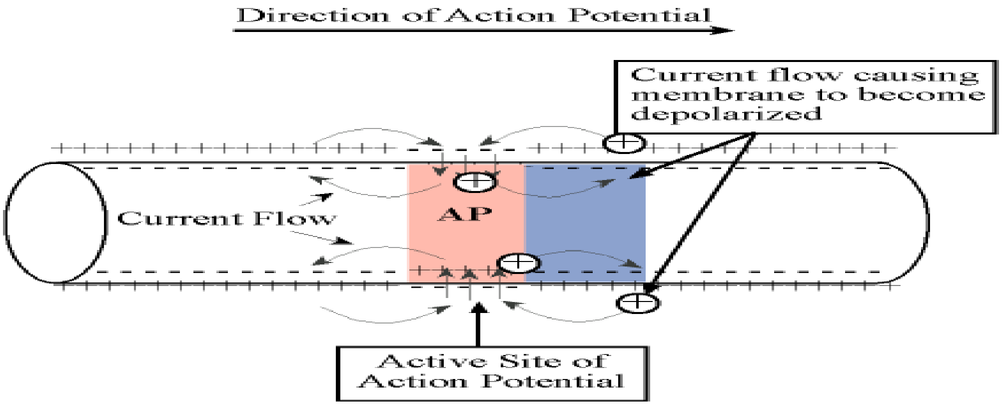
Polarised membrane/Resting Potential-

In resting phase when neuron is not conducting an impulse, the axonal membrane is called polarised.

This is due to difference in concentration of ions across the axonal membrane.

At Rest:

- Axoplasm inside the axon contains high conc. of K^+ and low conc. of Na^+.
- The fluid outside the axon contains low conc. of K^+ and high conc. of Na^+.



CONDUCTION OF NERVE IMPULSE

As a result the outer surface of axonal membrane is positively charged and inner surface is negatively charged. The electric potential difference across the resting plasma membrane is called resting potential.

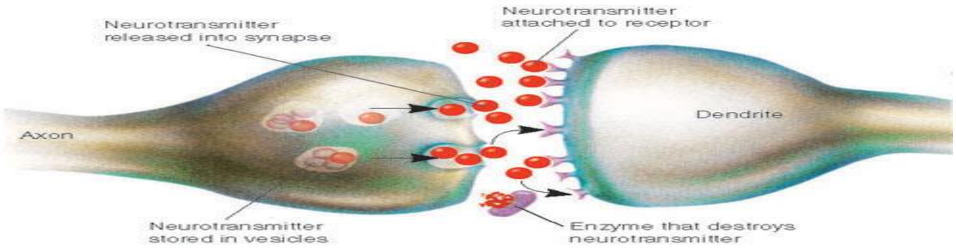
Action Potential: When a nerve fibre is stimulated, the permeability of membrane to Na^+ is greatly increased at the point of stimulus (rapid influx of Na^+) and hence polarity of membrane is reversed and now membrane is said to be depolarised. The electric potential difference across the plasma membrane at that site is called action potential, which infact termed as nerve impulse. Depolarisation is very rapid, so that conduction of nerve impulse along the entire length of axon occurs in fractions of second.

Transmission of Impulses at Synapse:

(i) At electrical synapses: Here the membrane of pre and post-synaptic neuron are in very close proximity. Electric current can flow directly from one neuron into other across these synapses, like impulse conduction along a single axon.

(ii) At chemical synapses: Here the membrane of pre and post-synaptic neuron are separated by fluid filled space called synaptic cleft. Neurotransmitter is involved here. When an impulse arrives at the axon terminal, it stimulates the movement of the synaptic vesicles towards membrane and they fuse with the plasma membrane and release their neurotransmitter in the synaptic cleft. These chemicals bind to specific receptors, present on the post-synaptic membrane. Their bindings open ions channels and allow the entry of ion which generate new potential in post synaptic neuron.

A SYNAPSE

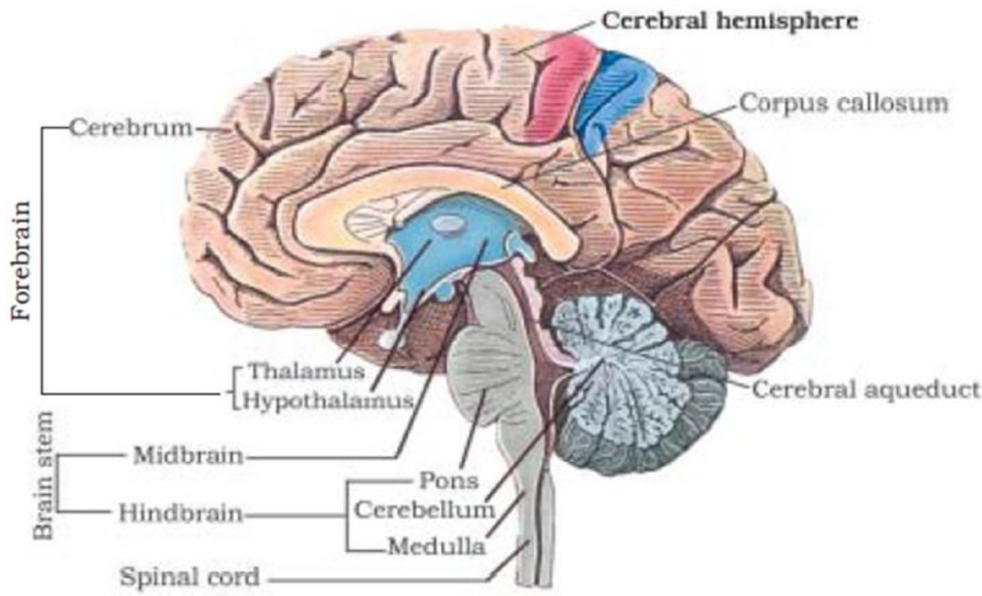


Parts of Brain

Fore brain
(a) Cerebrum
(b) Thalamus
(c) Hypothalamus

Mid brain

Hind brain
(a) medulla
(b) Pons
(c) Cerebellum



Sagittal Section of Human Brain

Functions of parts of brain:

Cerebrum: Centre of intelligence, memory and imagination, reasoning, judgement, expression of will power.

Thalamus: Acts as relay centre to receive and transmit general sensation of pain, touch and temperature.

Hypothalamus: Centre for regulation of body temperature, urge for eating and drinking.

Mid brain: Responsible to coordinate visual reflexes and auditory reflexes.

Cerebellum: Maintains posture and equilibrium of the body as well as coordinates and regulates voluntary movement.

Pons varoli: Relays impulses between medulla oblongata and cerebral hemisphere and between the hemisphere of cerebrum and cerebellum.

Medulla oblongata: Centre that control heartbeat, breathing, swallowing, salivation, sneezing, vomiting and coughing.

MULTIPLE CHOICE QUESTIONS

Q1. Chemicals which are released at the synaptic junction are called

(a) Hormones (b) Neurotransmitters
(c) Cerebrospinal fluid (d) Lymph

Q2. The most appropriate structure that is filled with neurotransmitters in axon terminals when it is in rest: -

(a) Axon terminal (b)Cyton/ cell body
(c) Synaptic vesicles (d) Synaptic cleft

Q3. Potential difference across resting membrane is negative. This is due to differential distribution of the following ions

(a) Na+ and K^+ (b) CO_3^{++} and CI^- (c) Ca^{++} and Mg^{++} (d) Ca^{++} and CI^-

Q4. Resting membrane potential is maintained by

(a) Hormones (b) Neurotransmitters
(c) active transport of ions (d) None of the above

Q5. Resting membrane potential is maintained by

(a) Hormones (b) Neurotransmitters
(c) sodium-potassium pump (d) None of the above

Q6. The function of our visceral organs is controlled by

(a) Sympathetic and somatic neural system
(b) Sympathetic and para sympathetic neural system
(c) Central and somatic nervous system
(d) None of the above

Q7. An area in the brain which is associated with strong emotions is
(a) Cerebral cortex (b) Cerebellum (c) Limbic system (d) Medulla
Q8. The process through which two or more organs interact and complement the functions of one another. Which one of the below given term is most appropriate for the above process?
(a) Association (b) Regulation (c) Coordination (d) Inhibition
Q9. A neuron which has cell body with one axon only is:
(a) Unipolar (b) Bipolar(c (c) Multipolar (d) Apolar
Q10. A neuron found usually in the embryonic stage is:
(a)Apolar (b) Bipolar (c) Multipolar (d) Unipolar
Q11. A neuron with one axon and one dendrite, found in the retina of eye:
(a) Bipolar (b) Unipolar (c) Multipolar (d) Apolar
Q12. The myelinated nerve fibres are enveloped with ...., which form a myelin sheath around the axon.
(a) Neuroglia cell (b) Schwann cells (c) Myelin cell (d) Multipolar cell
Q13. When a neuron is not conducting any impulse, the axonal membrane is:
(a) Permeable to potassium ions (K+) and impermeable to sodium ions (Na+).
(b) Impermeable to potassium ions (K+) and permeable to sodium ions (Na+).
(c) Equally permeable to both the ions
(d) Impermeable to both the ions
Q14. In case of multicellular organisms every cell or its parts is filled and surrounded by a kind of fluid. Similarly, axon of a neuron cell is filled with:
(a) Neuroplasm (b) Cytoplasm (c) Endoplasm (d) Axoplasm
Q15. the axoplasm inside the axon contains high concentration of:
(a) Na^+ and negatively charged proteins and low concentration of K^+
(b) K^+ and negatively charged proteins and low concentration of Na^+
(c) Na^+ and positively charged proteins and low concentration of K^+
(d) K^+ and positively charged proteins and low concentration of Na^+
Q16. The Ionic gradients across the resting membrane are maintained by the active transport of ions by the sodium-potassium pump which transports
a) 2 Na^+ outwards for 2 K^+ into the axoplasm (b) 2 Na^+ outwards for 3 K^+ into the axoplasm.
(c) 3Na^+ outwards for 2 K^+ into the axoplasm. (d) 3 Na^+ outwards for 3 K^+ into the axoplasm.
Q17. A structural and function linkage between two neuron cell for transmitting neural impulses:
(a) Synaptic knob (b) synaptic vesicles (c) Synaptic cleft (d) Synapse

Q18. Neurotransmitters bind to specific receptors and open ion channels to entry of the ions are present on -----------------

(a) Pre-synaptic membrane (b) Axonal membrane

(c) Post-synaptic membrane (d) Neural membrane

Q19. The two halves (left and right) cerebral hemispheres are connected by a tract of nerve fibres called:

(a) Association areas (b) Corpus callosum

(c) Hypothalamus (d) None of the above

Q20. Which one of the following is not a part of brain stem

(a) Mid brain (b) Pons (c) Medulla oblongata (d) Hypothalamus

ANSWER KEY
MULTIPLE CHOICE QUESTION BANK

Chapter -21 -Neural Control & coordination

Q.1	Q.2	Q.3	Q.4	Q.5	Q.6	Q.7	Q.8	Q.9	Q.10
b	c	a	c	c	b	c	c	a	d
Q.11	Q.12	Q.13	Q.14	Q.15	Q.16	Q.17	Q.18	Q.19	Q.20
b	b	a	d	b	c	d	c	b	d

SA-I (2marks)

Q21. What do grey and white matter in the brain represent?

Ans. The cerebral cortex is referred to as the grey matter due to its greyish appearance. The inner part of cerebral hemisphere gives an opaque white appearance to the layer below grey matter and, hence, is called the white matter.

Q22. Where is the hunger centre located in human brain?

Ans. The medulla contains centres which control **respiration, cardiovascular reflexes, appetite/ hunger and gastric secretions.**

Q23. Name the structure involved in protection of brain.

Ans. The human brain is well protected by the

(i) **Skull** (bony cavity). Inside the skull, the brain is covered by

(ii) **Cranial meninges** (consisting of an outer layer called **dura mater**, a very thin middle layer called **arachnoidmater** and an inner layer (which is in contact with the brain tissue) called **pia mater.**

Q24.Complete the statement by choosing appropriate match among the following -

Terms	**Meaning**
a. Resting potential	i. chemicals involved in the transmission of impulses at synapses.
b. Nerve impulse	ii. gap between the pre synaptic and post synaptic neurons
c. Synaptic cleft	iii. electrical potential difference across the resting neural membrane
d. Neurotransmitters	iv. an electrical wave like response of a neuron to a stimulation

Ans. a-iii, b-iv, c-ii, d-i.

Q25. What is the difference between electrical transmission and chemical transmission?

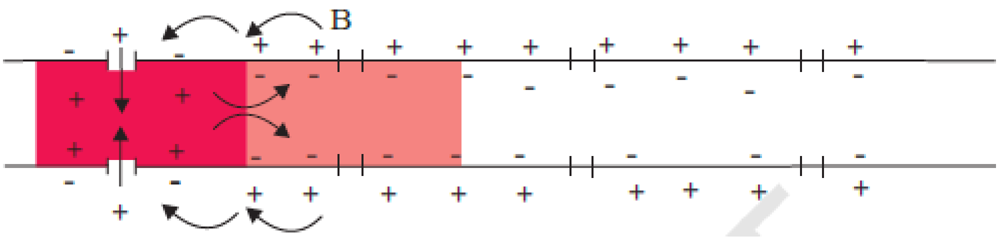
Ans

Electrical transmission	**Chemical transmission?**
Transmission of nerve impulse takes place via electrical synapse.	Transmission of nerve impulse takes place via chemical synapse.
Neurotransmitters does not required.	Neurotransmitters required
It is quick and faster. Nerve impulse transmit like a single neuron	Comparatively it is slower. Nerve impulse transmits from one neuron to next neuron via a synaptic cleft (gap/space between nerve endings of two neuron)

SA-II (3marks)

Q26. What is nerve impulse? How does it conduct and transmit?

Ans. The electrical potential difference across the neural / axonal membrane at its two sites (say A and B) is called the nerve impulse (action potential). The nerve impulse is conducted along the axon membrane in the form of an electrical wave of depolarisation and repolarisation. It gets transmit from a pre-neuron to a post neuron via a synapse.



Q27. What is a synapse?

Ans.

A synapse is the region of physical and chemical association between two neuron cells and formed by the membranes of a pre-synaptic neuron and a post-synaptic neuron in order to transmit neural signals from sense organs to brain and finally to effector organs (muscles). A synapse may or may not be separated by a gap called synaptic cleft.

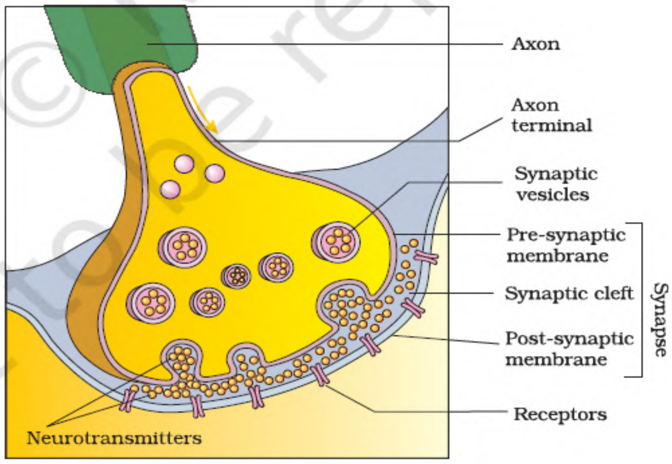


Figure 18.3 Diagram showing axon terminal and synapse

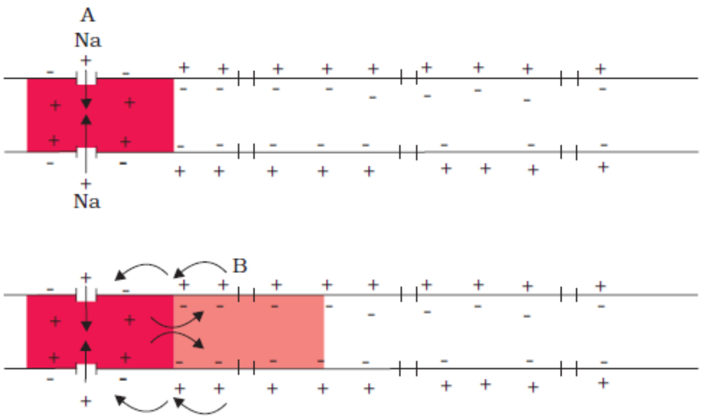
Q28 When you hold a pen, nerve signals are generated in nerve endings in the fingertips and sent to your brain. Once the touch has happened, an action potential (nerve signal) is generated at one end of a neuron.

A. What does it mean to generate an action potential on touch?

B. What causes the nerve signal to move from that point along the length of the neuron to
the other end? Write in 7 steps.

C. Why can't a nerve signal go backwards?

Ans:-



A. The nerve fibre is in the resting phase when it is not stimulated by any impulse and it possesses the potential difference along the membrane, which is known as the resting potential (-70mv). When this potential difference changes due to a signal, it is called generation of action potential.

B.

1. In response to a signal (touch), the membrane becomes permeable to sodium ions rather than potassium ions.
2. A rapid inflow of sodium ions happens.

3. The membrane of the nerve end depolarises as it becomes a positive charge inside and a negative charge outside the nerve fibre.
4. At the peak action potential, permeability to sodium ions decreases and that to potassium ions increases.
5. A rapid outflow of potassium ions happens.
6. The first part of the membrane repolarises
7. The depolarization spreads down the axon as opened Na+ gates stimulate neighbouring Na+ gates to open.

C. When a segment of nerve fibre is depolarised, the previous segment is always in a repolarised state and cannot be depolarised immediately. This is why a nerve signal cannot travel backwards.

Q29.Read the following and answer any four questions from 29 (i) to 29 (iv) given below :

Ajinomoto, the most popular ingredients commonly used in Chinese dishes as a taste enhancer is otherwise known as mono sodium glutamate (MGS). Excessive consumption of Ajinomoto can cause various harmful effects such as hypertension, effect on Brain and nerves, nausea, headache, sleeping disorders and cancer. As glutamate can serve as a neurotransmitter, high intake of MSG can adversely affect the brain and nerves. In our body neurotransmitters are involved in carrying nerve impulses across a chemical synapse.

Common neurotransmitters are epinephrine, adrenaline, acetylcholine, dopamine and GABA. When an impulse arrives at the axon terminal, it stimulates the movement of synaptic vesicles towards the presynaptic membrane, where they fuse and release their neurotransmitters in the synaptic cleft. Now these neurotransmitters bind to their specific receptors present on the postsynaptic membrane, which opens ion channels.
Thus signal is transmitted across the synapse. In electrical synapse signal can flow directly from one neuron to another.

(i) Identify the harmful effects of excessive consumption of ajinomoto :

(a) Hypertension (b) Headache (c) Effects nerves (d) All of them

(ii) Ajinomoto serves as a _________ neurotransmitter:

(a) Glutamate (b) GABA (c) Dopamine (d) Acetyl choline

(iii) Interaction between neurons occurs commonly across junctions called:

(a) Action potential (b) Synapse (c) Axon terminal (d) Juxtaposition

(iv) Receptor site for neurotransmitters are present on :

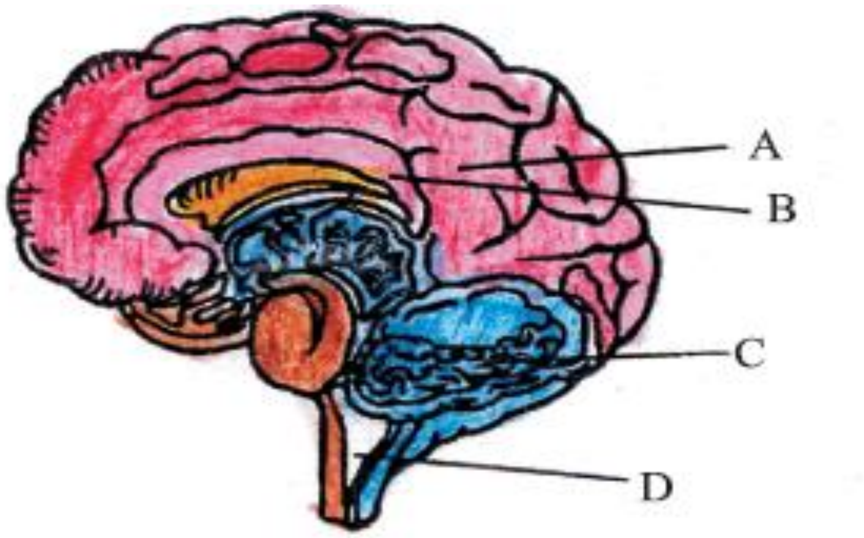
(a) Presynaptic membrane (b) Tips of axons

(c) Postsynaptic membrane (d) Membrances of synaptic vesicles

Ans- (i) (d) All of them (ii) (a) Glutamate

(iii) (b) synapse (iv) (c) post synaptic membrane

Q30.Observe the diagram given below and answer the following questions :



(i) Label the parts A, B, C & D.

(ii) Give the function of C and D.

(iii) Name the layers which wrap this organ.

Ans:-(i) A : Cerebrum C : Cerebellum

B : Corpus callosum D : Medulla oblongata

(ii) C : Balancing of body and maintain posture

D : Vomiting , coughing, breathing, salivation or any other correct answer

(iii) Pia mater, arachnoid and dura mater.

LA-I (5marks)

Q31. Explain the process of the transport and release of a neurotransmitter with the help of a labelled diagram.
Ans:-

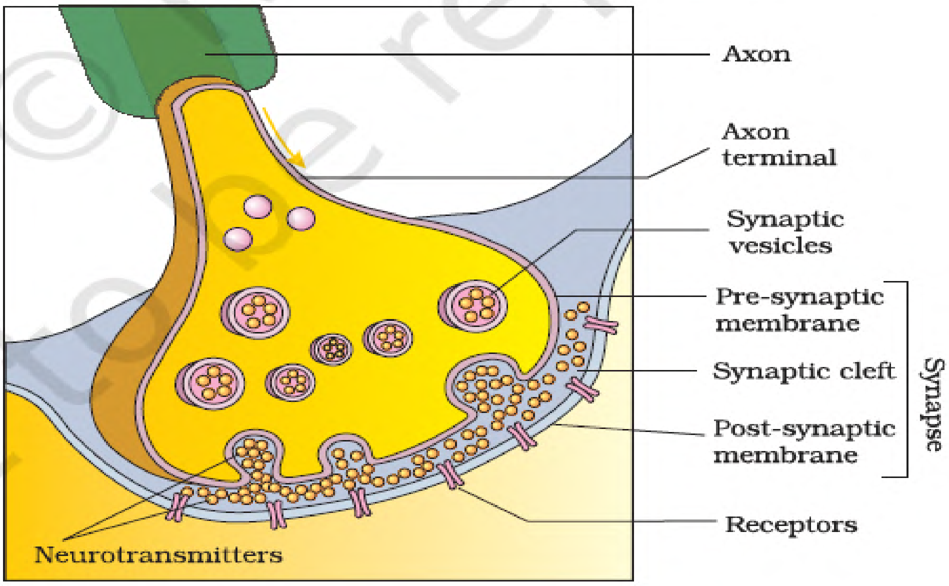
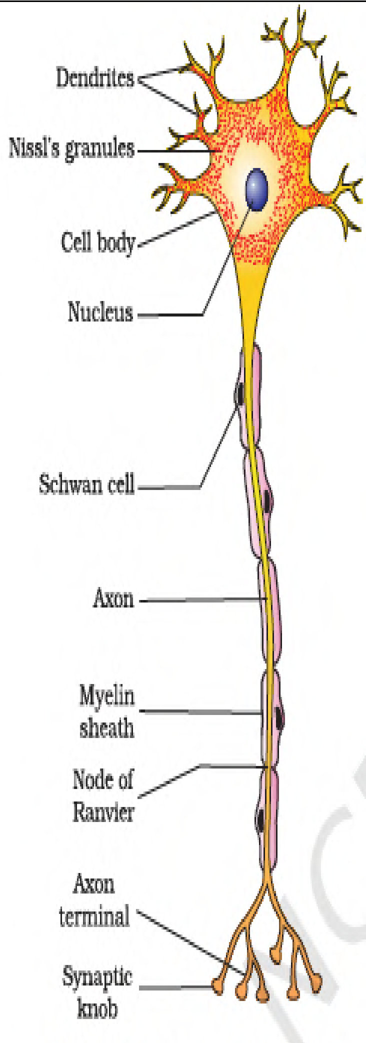


Figure 18.3 Diagram showing axon terminal and synapse

A nerve impulse is transmitted from one neuron to another through junctions called synapses. A synapse is formed by the membranes of a pre-synaptic neuron and a post-synaptic neuron, which may or may not be separated by a gap called synaptic cleft. There are two types of synapses, namely, electrical synapses and chemical synapses. At a chemical synapse, the membranes of the pre- and post-synaptic neurons are separated by a fluid-filled space called synaptic cleft. Chemicals called neurotransmitters are involved in the transmission of impulses at these synapses. The axon terminals contain vesicles filled with these neurotransmitters. When an impulse (action potential) arrives at the axon terminal, it stimulates the movement of the synaptic vesicles towards the membrane where they fuse with the plasma membrane and release their neurotransmitters in the synaptic cleft. The released neurotransmitters bind to their specific receptors, present on the post-synaptic membrane. This binding opens ion channels allowing the entry of ions which can generate a new potential in the post-synaptic neuron. The new potential developed may be either excitatory or inhibitory.

Q32. Draw and describe structure of a neuron cells.

 **Figure 18.1** Structure of a neuron	A neuron is a microscopic structure composed of three major parts, namely- **(i) Cell body:** The cell body contains cytoplasmwith typical cell organelles and certain granular bodies called Nissl's granules. **(ii) Dendrites:**Short fibres which branch repeatedly and project out of the cell are called dendrites. These fibres receives and transmit impulses towards the cell body. **(iii) Axon:** The axon is a long fibre, the distal end of which is branched. Each branch terminates as a bulb-like structure called synaptic knob which possess synaptic vesicles containing chemicals called neurotransmitters. The axons transmit nerve impulses away from the cell body to a synapse or to a neuro-muscular junction. There are two types of axons / nerve: **(i)Myelinatednerve** fibres are enveloped with Schwann cells, which form a myelin sheath around the axon. The gaps between two adjacent myelin sheaths are called nodes of Ranvier. Myelinated nerve fibres are found in spinal and cranial nerves. (ii) **Un-myelinated nerve** fibre is enclosed by a Schwann cell that does not form a myelin sheath around the axon, and is commonly found in autonomous and the somatic neural systems.

Q33. Name the parts of human forebrain indicating their respective functions.

Ans.

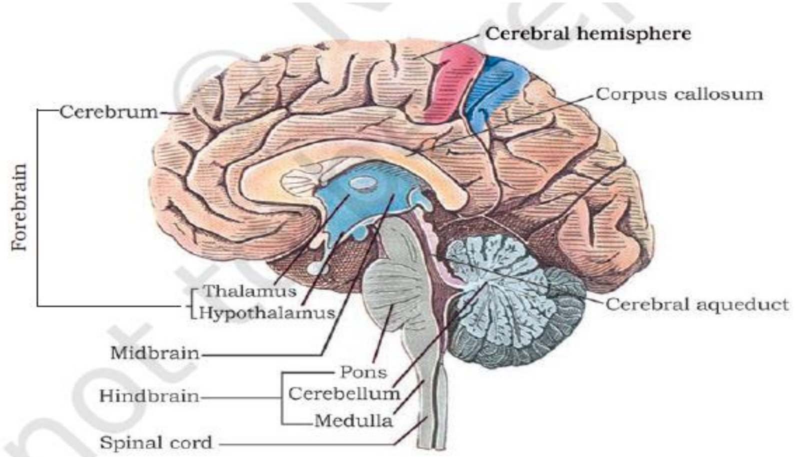


Figure 18.4 Diagram showing sagital section of the human brain

The forebrain consists of three parts:

(i) Cerebrum: It forms major part (approx. 80%) of brain. A deep cleft divides the cerebrum longitudinally into two halves, which are termed as the left and right cerebral hemispheres. The hemispheres areconnected by a tract of nerve fibres called **corpus callosum**. The layer ofcells which covers the cerebral hemisphere is called **cerebral cortex.** The cerebral cortex is referred to as the **grey matter** due to its greyish appearance. The neuron cell bodies are concentrated here giving the colour. The cerebral cortex contains motor areas, sensory areas and large regions that are neither clearly sensory nor motor in function. These regions called as the association areas are responsible for complex functions like intersensory associations, memoryand communication. Fibres of the tracts are covered with the myelin sheath, which constitute the inner part of cerebral hemisphere.

They give an opaque white appearance to the layer and, hence, is called the white matter.

(ii) Thalamus: The cerebrum wraps around a structure called thalamus, which is a major
coordinating centre for sensory and motor signalling.

(iii) Hypothalamus: It is very important part of the brain. It lies at the base of the thalamus. It contains a number of centres which control body temperature, urge for eating and drinking. It also contains several groups of neurosecretory cells, which secrete hormones called **hypothalamic hormones / neurohormones**. The inner parts of cerebral hemispheres and a group of associated deep structures like amygdala, hippocampus, etc., form a complex structure called the **limbic lobe or limbic system**. Along with the hypothalamus regulates sexual behaviour, expression of emotional reactions (e.g., excitement, pleasure, rage and fear), and motivation.

CHAPTER-22 Chemical Coordination & Integration

Coordination - Integration of function between different organs of body.

Introduction:

- Chemical coordination is through hormones.
- Hormones act on target tissue.
- Hormones & neural system together control & coordinate the body physiology.

Endocrine Glands & hormone:

- Ductless glands.
- Secretions having hormones are directly poured into blood.
- Hormones are non- nutrient chemicals acting as inter-cellular messenger& are produced in trace amounts.

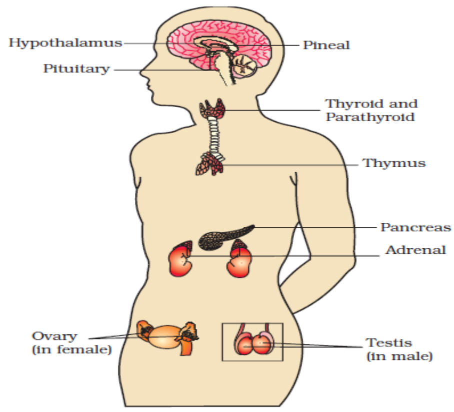


Figure 22.1 Location of endocrine glands

Human Endocrine System:

- Consist of-Endocrine Glands & diffused tissues or cells.
- Main glands are-Pituitary, Pineal, Thyroid, Adrenal, Pancreas, Parathyroid, Thymus & Gonad others are organs: Hypothalamus, Gastro-intestinal tract, Liver, Kidney, and Heart.

The Hypothalamus:

- Basal part of fore brain.
- Cell groups- called nuclei release hormones of two types-

1-Releasing Hormones- stimulate secretion of pituitary hormones e.g.GnRH.

2-Inhibiting Hormones- inhibit the release of Pituitary hormones. e.g. Somatostatin.

- These hormones act on anterior pituitary.

<u>Location of endocrine glands</u>

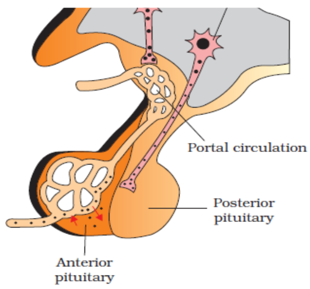


Figure 22.2 Diagrammatic representation of pituitary and its relationship with hypothalamus

<u>Pituitary (with Hypothythalamus)</u>

The Pituitary Gland:

- Placed in Sella Tursica

Two parts- (1) Adenohypophysis having two regions –pars distalis & pars intermedia (2) Neurohypophysis

- Hormones of Pars distalis-

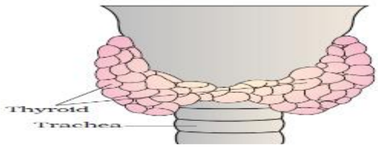
Hormones	**Function**
Growth Hormone (GH)	Controls body growth. Low secretion – dwarfism High secretion –Gigantism.
Prolactin (PR)	Controls growth of mammary gland & milk formation
Thyroid Stimulating Hormone(TSH)	Synthesis & secretion of thyroid hormone
Adrenocorticotropic Hormone(ACTH)	Stimulates synthesis & secretion of glucocorticoids of Adrenal cortex
Luteinising Hormone(LH)	In males synthesis & secretion of androgens. In females induces ovulation.
Follicle Stimulating Hormone(FSH)	Growth & development of ovarian follicles

- Pars-intermedia- produces only one hormone- Melanocyte Stimulating Hormone (MSH).
- MSH regulates Melanin pigmentation of skin.
- Hormones of Neurohypophysis-

Hormones	Function
Oxytocin(birth hormone)	Acts on smooth muscles, uterus wall contraction during child birth, milk ejection.
Vasopressin(Antidiuretic Hormone ADH)	Stimulates resorption of water & electrolytes by kidney.

Thyroid Gland:

- Two lobes in gland joined with isthmus.
- Present on either side of trachea.



Thyroid Gland

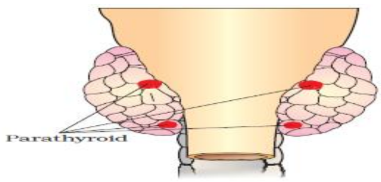
The Pineal Gland: On dorsal side of brain.

Hormone	Function
Melatonin	Regulates 24-hour rhythm of body & influences temperature, metabolism, pigmentation, menstrual cycle, body defence.

Hormone	Function
Tetraiodothyronine or Thyroxin(T_4) & Triiodothyronine(T_3)	Regulate basic metabolic rate, support RBC formation
Thyrocalcitonin	Regulate blood calcium level.

Parathyroid Gland:

- Present on back side of Thyroid gland two in each lobe.
- Secrete one hormone - Parathyroid hormone which increases blood Ca^{++} level.



Thymus gland:

Parathyroid Gland

- Present on dorsal side of Heart & aorta.
- Secrete Thymosins hormone.
- Thymosins regulate T- Lymphocyte differentiation (Cell mediated immunity) & promote antibody formation (Humoral immunity).
- Thymus degenerates in old people.

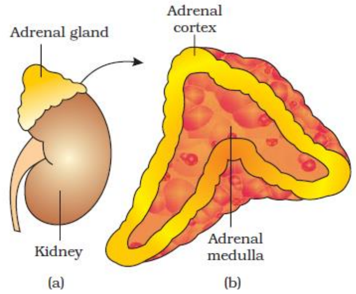


Figure 22.4 Diagrammatic representation of : (a) Adrenal gland on kidney (b) Section showing two parts of adrenal gland

Adrenal Gland:

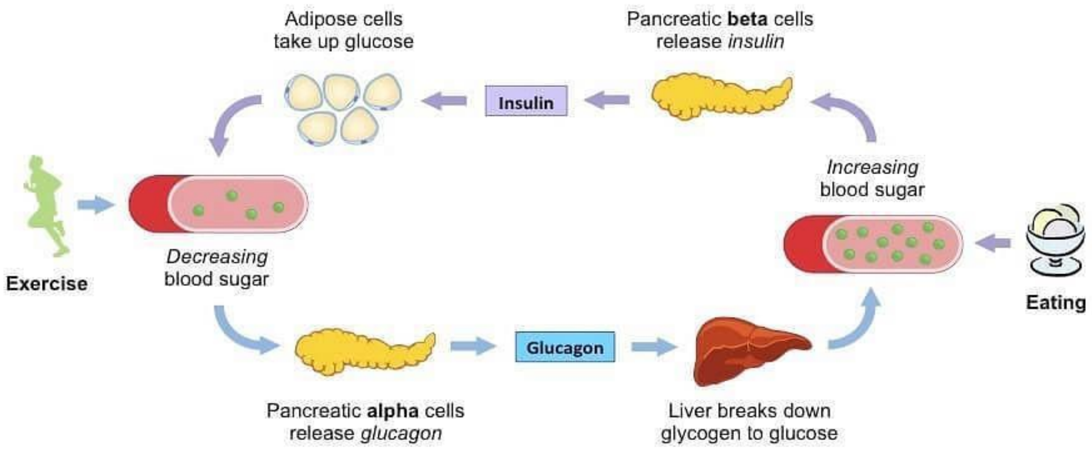
- Present at anterior part of each kidney.
- Has two parts- outer cortex & central- medulla.

Hormone	Function
Adrenaline or epinephrine & Noradrenalin or Nor-epinephrine (Emergency Hormone)	Increase alertness, pupillary dilation, piloerection sweating etc, increase heartbeat, rate of respiration, breakdown of glycogen into glucose.
Aldosterone	Balance of water & Electrolytes in body ,blood pressure,
Cortisol	Metabolism of carbohydrates, anti-inflammatory reactions & suppress immune response.
Androgenic steroids	Growth of axial, pubic & facial hair.

Pancreas:

- Composite or mixed gland.
- Islet of Langerhans part is endocrine.
- Lack of insulin leads in to Diabetes Mellitus.

Hormone	Function
Glucagon (from α cells)	Glycolysis, increase blood glucose level
Insulin	Glycogenesis, Cellular uptake & utilisation of glucose



Testis:

- Present in scrotal sac.
- Leydig cells of testis produce androgens mainly Testosterone.

- Androgens regulate maturation & functioning of male sex organs, muscular growth, growth of facial & axial hair, aggressiveness, low pitch voice, spermatogenesis & libido.

Ovary:

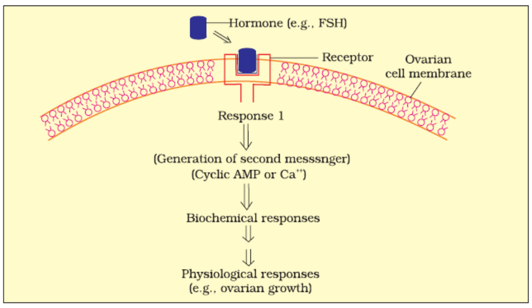
- Produce two groups of hormones-Estrogen & Progesterone.
- Estrogen regulate many actions *viz.* growth & function of female secondary sex organs, growth of ovarian follicles, high pitch voice, growth of mammary glands & sexual behaviour in females.
- Progesterone supports pregnancy & stimulates milk secretion.

Hormones of Heart, Kidney & Gastrointestinal Tract:

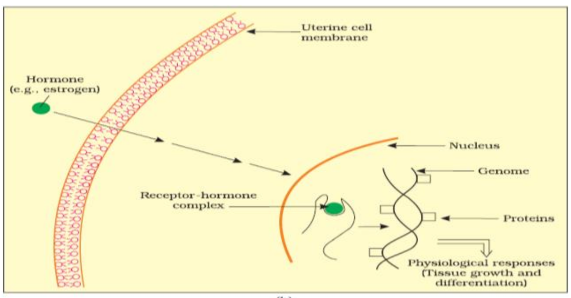
Organ	Hormone	Function
Heart	Atrial Natriuretic Factor	Reduces blood pressure.
Kidney	Erythropoietin	Formation of RBC.
Gastrointestinal Tract	Gastrin	Stimulates secretion of HCl & Pepsinogen in stomach.
,,	Secretin	Secretion of water & bicarbonate ions from pancreas.
,,	Cholecystokinin(CCK)	Secretion of pancreatic juice & bile juice.
,,	Gastric Inhibitory Peptide(GIP)	Inhibits gastric secretion & motility.
Several other non endocrine tissues	Growth Factor	Growth, repair& regeneration

Mechanism of Hormone Action:

- Hormones bind to hormone receptors of target tissue cells.
- Protein hormones bind to membrane bound receptors & steroid & thyroid hormones bind to intracellular receptors & make hormone-receptor complex.
- Former generates second messengers *viz.* cAMP, IP_3, Ca^{++} & later interact with genome.
- Above messengers or genome affects the cellular physiology giving required result.



(a)



(b)

Figure 22.5 Diagramatic representation of the mechanism of hormone action : (a) Protein hormone (b) Steroid hormone

MULTIPLE CHOICE QUESTIONS

Q1. The small part of the brain that is present below the thalamus and serves as the main link between the nervous and endocrine system is

a) pons b) hypothalamus c) brain stem d) medulla oblongata

Q2. Consider the following events:

(A) Production of regulatory hormones from neurosecretory cells. (B) Hormones are secreted into the portal system. (C) Hormones move down the axons to axon endings. Arrange them in sequential order and select the correct option.

a) A, B, C b) A, C, B c) B, C, A d) C, A, B

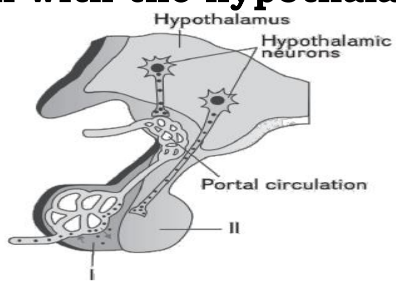
Q3. The pituitary gland is a pea-shaped gland that lies in the hypophyseal fossa of

a) sella turcica of the glenoid bone b) sella turcica of the sphenoid bone
c) sella turcica of the parietal bone d) sella turcica of the frontal bone

Q4. The pituitary gland is connected to the hypothalamus by

a) infundibulum b) bony cavity c) hyaline cartilage d) elastic cartilage

Q5. Following is the diagrammatic representation of the pituitary gland and its connection with the hypothalamus.



Select the correct option regarding the same.

a) I: Anterior pituitary that is composed of neural tissues.
b) I: Anterior pituitary that is composed of epithelial tissues.
c) II: Posterior pituitary that is composed of epithelial tissues.
d) II: Posterior pituitary that is composed of connective tissues.

Q6. Hypersecretion of prolactin hormone in females causes inappropriate lactation and absence of menstrual cycle. Based on the given information, select the pair of correct statements.

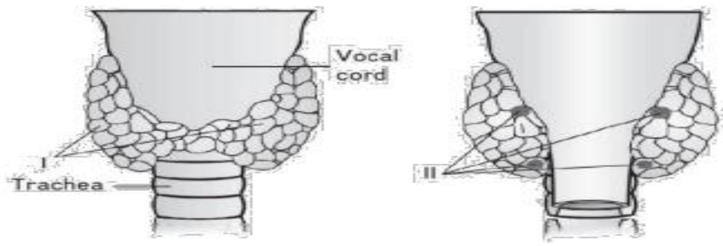
(A) Prolactin is required for milk ejection from mammary glands. (B) The blood level of prolactin is increased just before menstruation. (C) During pregnancy, prolactin inhibiting hormone suppresses the release of prolactin. (D) Sucking action of newborn inhibits the release of PIH.

a) A and B b) B and C c) A and C d) B and D

Q7. Which of the following set of functions is not regulated by the hormone of the pineal gland?

a) Diurnal rhythm and body temperature b) Metabolism and pigmentation
c) Growth of bones and defense capability d) Diurnal rhythm and defense capability.

Q8. Following is the diagrammatic view of the position of endocrine glands. Select the option that correctly labels the glands and their respective hormones.



a) I - Thyroid gland - Thyroxine and TSH b) II - Parathyroid gland - PTH
c) II - Thyroid gland - Thyroxine and calcitonin d) I - Parathyroid gland - PTH and calcitonin

Q9. Which of the following hormones can play a significant role in osteoporosis?

a) Aldosterone and Prolactin b) Progesterone and Aldosterone
c) Estrogen and Parathyroid hormone d) Parathyroid hormone and Prolactin

Q10. Which of the following pairs of hormones have antagonistic effects?

a) T3 and T4 b) ACTH and glucocorticoids
c) PTH and TCT (thyrocalcitonin) d) T3 and TSH

Q11. The endocrine gland present at the top of kidneys and involved in the fluid-electrolyte balance of the body is

a) adrenal gland b) pineal gland c) parathyroid gland d) pancreas

Q12.. Which of the following categories of hormones is correctly matched with its examples?

a) Catecholamines: adrenaline and noradrenaline b) Emergency hormones: adrenaline and insulin.
c) Glucocorticoids: aldosterone d) Mineralocorticoids: cortisol

Q13. Glucocorticoids are involved in

a) fluid electrolyte balance b) carbohydrate metabolism
c) water reabsorption from kidneys d) regulation of blood glucose levels

Q14. Which of the following sets of physiological functions correctly describes the role of cortisol in the human body?

a) Anti-inflammatory response and suppression of the immune response b) Breakdown of RBCs in spleen c) Upregulation of uptake of amino acids d) Reabsorption of Na+ from kidneys

Q15. Match the following hormones with the respective disease.

	Column I		Column II
A	Insulin	1	Addison's disease
B	Thyroxin	2	Diabetes Insipidus
C	Corticoid	3	Acromegaly
D	Growth Hormone	4	Goitre
		5	Diabetes mellitus

Select the correct option.

	A	B	C	D
a	5	1	2	3
b	2	4	3	1
c	5	4	1	3
d	2	3	1	3

Q16. The function of testosterone in human males is/are

a) development of male secondary sexual characters b) male sexual behaviour
c) stimulation of protein breakdown d) both (A) and (B)

Q17. Which of the following hormones of the gastrointestinal tract is wrongly matched with its function?

	Column I		Column II
A	Gastrin	1	Inhibition of gastric secretions
B	Gastric inhibitory peptide (GIP)	2	Stimulates secretion of pancreatic juice and bile juice
C	Secretin	3	Secretion of gastric juice
D	Cholecystokinin	4	Stimulates secretion of pancreatic juice

Select the correct option.

	A	B	C	D
a	3	1	4	2
b	2	1	4	3
c	3	4	2	1
d	2	3	4	1

Q18. Assertion: In human males, LH is required for sperm production.

Reason: FSH and testosterone stimulate interstitial cells to secrete androgen binding protein.

a) Both Assertion and Reason are true and Reason is correct explanation of Assertion.
b) Both Assertion and Reason are true, but Reason is not the correct explanation of Assertion.
c) Assertion is true, but Reason is false.
d) Assertion is false, but Reason is true.

Q19. Assertion: TSH stimulates the thyroid gland to secrete thyroid hormones.

Reason: The hormones of anterior pituitary that regulate the secretions of other endocrine glands are called tropic hormones.

a) Both Assertion and Reason are true and Reason is correct explanation of Assertion.
b) Both Assertion and Reason are true, but Reason is not the correct explanation of Assertion.
c) Assertion is true, but Reason is false.
d) Assertion is false, but Reason is true.

Q20. Assertion: Hyposecretion of growth hormone causes stunted growth in infants.

Reason: Epiphyseal plates are closed after the childbirth.

a) Both Assertion and Reason are true and Reason is correct explanation of Assertion.
b) Both Assertion and Reason are true, but Reason is not the correct explanation of Assertion.
c) Assertion is true, but Reason is false.
d) Assertion is false, but Reason is true.

.ANSWER KEY
MULTIPLE CHOICE QUESTION BANK

No. of Chapter -22 Name of Chapter- Chemical Coordination & Integration

Q.1	**Q.2**	**Q.3**	**Q.4**	**Q.5**	**Q.6**	**Q.7**	**Q.8**	**Q.9**	**Q.10**
b	b	b	a	a	d	c	b	c	c
Q.11	**Q.12**	**Q.13**	**Q.14**	**Q.15**	**Q.16**	**Q.17**	**Q.18**	**Q.19**	**Q.20**
a	a	b	a	c	d	a	c	a	c

SA-I (2marks)

Q21. List the endocrine gland that is absent in males and the one absent in the female.

Ans:-1. A pair of testes are present in the scrotal sac in males that performs functions of the endocrine gland as well as acts as a sex organ. This gland is absent in females as they possess a pair of ovaries situated in the abdomen. It produces progesterone and estrogen and is absent in males.

Q22. Define erythropoiesis. Name the hormone that triggers it.

Ans: The process of formation of RBC is known as erythropoiesis. The peptide hormone erythropoietin produced from the juxtaglomerular cells of the kidney triggers the erythropoiesis.

Q23. Which is the endocrine gland that secretes calcitonin? What role does this hormone play?

Ans: It is produced by the parafollicular cells of the thyroid gland. It restricts excess Ca2+ and phosphate in the plasma by lowering mobilization from bones. Its deficiency causes osteoporosis or loss of bone density.

Q24. Which hormone aids in cell-mediated immunity?

Ans:- Thymosins play a significant role in the differentiation and development of T-lymphocytes that provide cell-mediated immunity.

Q25.Which hormone is responsible for normal sleep cycle?

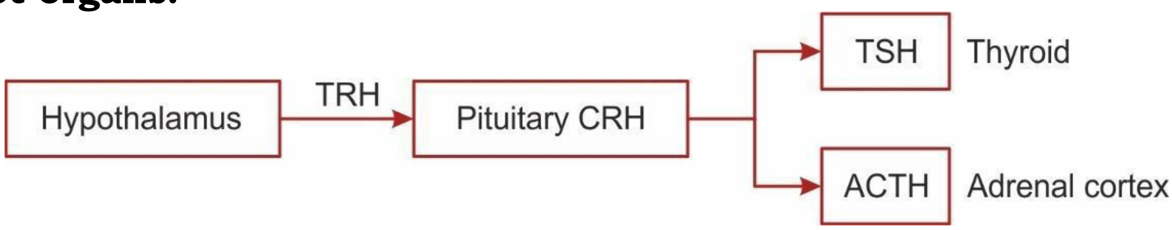
Ans: There are a variety of hormones, which are responsible for sleep-wake cycles. This hormone includes– cortisol, melatonin, prolactin and thyroid-stimulating hormone- TSH.

SA-II (3 marks)

Q26. State the significance of luteinizing hormones in males and females.

Ans: The luteinizing hormone in males triggers the production and secretion of hormones known as androgens from testes. Along with Follicle Stimulating Hormone (FSH), androgens control the spermatogenesis. The LH in females causes ovulation of the Graafian follicles and maintains the corpus luteum, developed from the traces of the Graafian follicles after ovulation that produces progesterone.

Q27. Look at the flow chart showing some hormones and their target organs.



A. Name one hormone secreted by the thyroid and adrenal cortex and their function.

B. An inhibitor has been introduced into the body that inhibits the hypothalamus from secreting any hormone. How will this affect the hormonal action of the thyroid and adrenal cortex?

C. Growth hormone is secreted by the anterior pituitary gland. A dwarfism disease called Laron dwarfism does not respond to growth hormone treatments (growth hormone injected into the body externally).

Ans:-

A. The thyroid gland secretes thyroxine. It plays an important role in the regulation of the basal metabolic rate. The adrenal cortex secretes cortisol, which is involved in carbohydrate metabolism.

B. If the secretion of hormones by the hypothalamus is inhibited, then the thyroid and adrenal cortex would not be able to secrete any hormones as well due to a lack of stimulation from the pituitary gland. This, in turn, would lead to a decreased body metabolic rate and reduced carbohydrate metabolism.

C. There can be a deficiency in growth hormone receptors. So, even when the growth hormone is supplied externally, no action can be observed.

Q28. Name the disease/disorder caused by :

(a) Excessive secretion of Thyroid hormone in adults.

(b) Insufficient amount of insulin secreted by pancreas.

(c) Damage of adrenal cortex.

Ans:. (a) Exophthalmic goitre (b) Diabetes
(c) Addison's disease

Case study based Questions (4marks)

Q29.Read the following and answer any four questions from 29 (i) to 29 (iv) given below :

Xenoestrogens are found in a variety of everyday items. Its sources are plastic, pesticides, insecticides, beauty products etc. Many of us don't think twice about the make up we wear, container we use to pack a lunch. Unfortunately this may be altering the way our body works naturally because they all contain endocrine disruptors called Xenoestrogens. Xenoestrogens are a subcategory of endocrine disruptor that specifically has estrogen like effects. Estrogen is a natural hormone synthesized by the growing ovarian follicles in females. It helps in the growth of female secondary sex organs and female secondary sex characters. It is also important for bone growth and reproduction in men and women. When xenoestrogen enter the body they increase the total amount of estrogen in the body resulting in a phenomenon called estrogen dominance. As they are not biodegradable they are stored in our fat cells. This leads to breast cancer, prostate cancer, obesity, infertility, miscarriages and diabetes.

(i) Xenoestrogen mimics the action of _______ and its excess causes______.

(a) Progesterone, bone and prostate cancer (b) Estrogen, breast and prostate cancer

(c) Cortisol, brain and blood cancer (d) Thyrocalcitonin, bone and lung cancer

(ii) Estrogen is secreted mainly by :

(a) GI tract (b) Pancreas (c) Growing ovarian follicles (d) Thymus

(iii) Select the function/functions performed by estrogen in females:

(a) Growth of female secondary sex organs (b) Bone growth

(c) Female secondary sex-characters (d) All of these

(iv) What measures, as an individual you would take to reduce your exposure to these harmful xenoestrogen?

(a) Eat local and organic food (b) Use beauty products made from natural ingredients

(c) Do not use plastic lunch box and water bottles (d) All of these

Ans:- (i) (b) Estrogen, breast and prostate cancer

(ii) (c) Growing ovarian follicles

(iii) (d) All of these

(iv) (d) All of these

Q30. The thyroid gland is composed of two lobes which are located on either side of the trachea. Both the lobes are interconnected with a thin flap of connective tissue called isthmus. The thyroid gland is composed of follicles and stromal tissues. Each thyroid follicle is composed of follicular cells, enclosing a cavity. These follicular cells synthesise two hormones, tetraiodothyronine or thyroxine (T4) and triiodothyronine (T3). Iodine is essential for the normal rate of hormone synthesis in the thyroid. Deficiency of iodine in our diet results in hypothyroidism and enlargement of the thyroid gland, commonly called goitre.

Hypothyroidism during pregnancy causes defective development and maturation of the growing baby leading to stunted growth (cretinism), mental retardation, low intelligence quotient, abnormal skin, deaf-mutism, etc. In adult women, hypothyroidism may cause menstrual cycle to become irregular.

Due to cancer of the thyroid gland or due to development of nodules of the thyroid glands, the rate of synthesis and secretion of the thyroid hormones is increased to abnormal high levels leading to a condition called hyperthyroidism which adversely affects the body physiology.

Exophthalmic goitre is a form of hyperthyroidism, characterised by enlargement of the thyroid gland, protrusion of the eyeballs, increased basal metabolic rate, and weight loss, also called Graves' disease.

Thyroid hormones play an important role in the regulation of the basal metabolic rate. These hormones also support the process of red blood cell formation. Thyroid hormones control the metabolism of carbohydrates, proteins and fats. Maintenance of water and electrolyte balance is also influenced by thyroid hormones. Thyroid gland also secretes a protein hormone called thyrocalcitonin (TCT) which regulates the blood calcium levels.

(i) _______________ Protein hormone secreted by thyroid gland regulates the blood calcium levels along with PTH.

a) thyromelatonin b) thyrocalcitonin c) thyrocalcitonin d) thyrocarbotonin

(ii) Cretinism is referred as,

a) Stunted growth due to deficiency of iodine
b) Stunted growth due to deficiency of thyroid hormones
c) Mental retardation due to deficiency of iodine
d) Deaf-mutism due to deficiency of iodine

(iii) Explain how the both lobes of thyroid gland are interconnected?

(iv) Give the composition of thyroid follicle and their function?

Answer:-

(i) b (ii) a

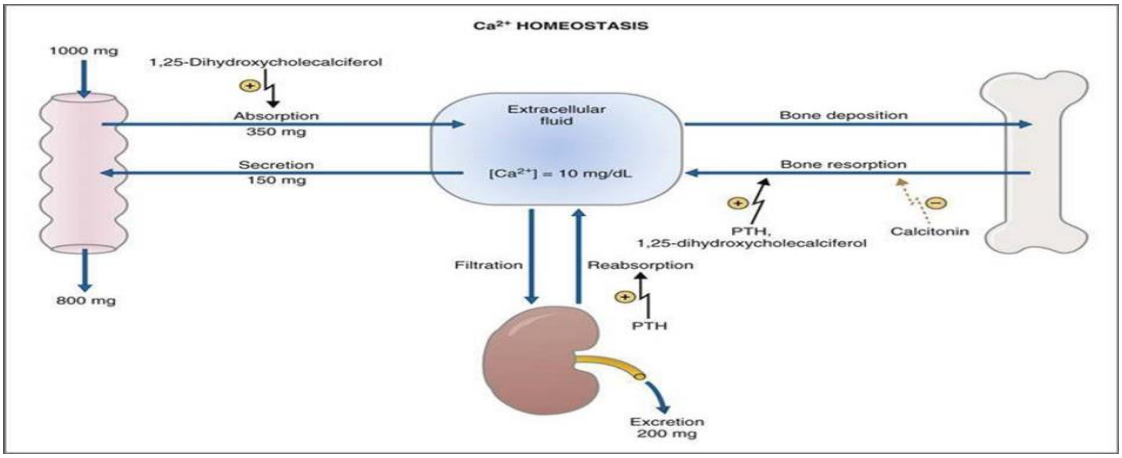
(iii) Thyroid gland is composed of two lobes these lobes are interconnected with a thin flap of connective tissue called isthmus.

(iv) Thyroid follicle is made up of follicular cells.

LA-I (5 marks)

Q.31. Describe the importance of hormones and endocrine glands responsible for regulating the Calcium Homeostasis.

Ans:



The hormones and endocrine glands that regulate calcium homeostasis are thyroid and parathyroid glands and their related hormones which are Parathyroid hormone (PTH) and calcitonin. The endoderm of the embryo develops the parathyroid glands and has two types of cells – oxyphil cells and chief cells. The chief cells secrete the parathyroid hormone (PTH) which is involved in controlling phosphate and calcium stability between other tissues and blood. From bones, it causes the secretion of calcium into the blood. PTH causes an increase in the reabsorption of calcium by the organs of the body such as kidneys and intestine. The thyroid gland is the largest endocrine gland that is situated prefrontal to the thyroid cartilage of the larynx in the neck. It regulates the calcium homeostasis and releases thyrocalcitonin hormone which is produced by the 'C' cells. The hormone is secreted when the calcium concentration in blood is high. They lower the calcium level by suppressing the release of calcium ions from the bones. Hence calcitonin has a contrary effect on calcium in comparison to the parathyroid hormone.

Q32. Explain the mechanism of hormone action.

Ans: MECHANISM OF HORMONE ACTION

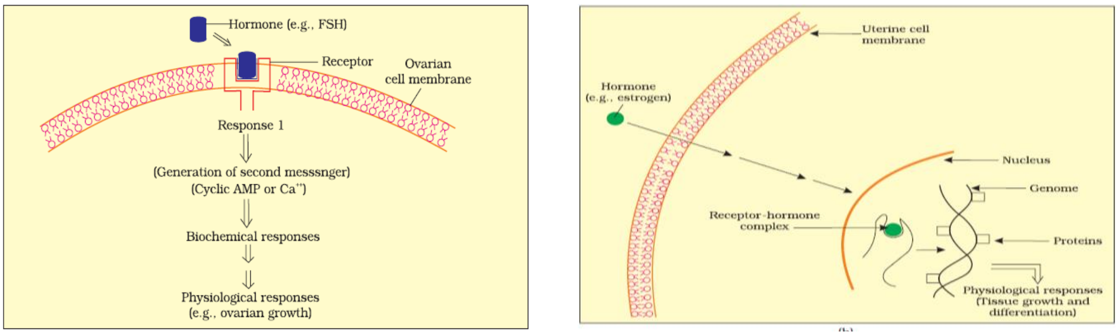


Figure 22.5 Diagramatic representation of the mechanism of hormone action : (a) Protein hormone (b) Steroid hormone

● Hormones produce their effects by binding to the specific proteins (hormone receptors) located in target tissues.

● A hormone binds to its specific receptor to form hormone- receptor complex.

● It leads to biochemical changes in target tissue and thereby regulates metabolism and physiological functions.

Hormone receptors are 2 type.

● Membrane- bound receptors: Some hormones (e.g. protein hormone, FSH) interact with membrane - bound receptors (do not enter the target cell).It generates second messengers(e.g. cyclic AMP ,IP3

● It in turn regulates cellular metabolism and causes physiological effects.

● Intercellular receptors (mostly nuclear receptors.): Some hormones (e.g, steroid hormones, iodothyronines) interact with intercellular receptors. They mostly regulate gene expression ,or chromosome function by the interaction of hormone-receptor complex with the genome.

● Cumulative biochemical actions result in physiological and developmental effects,

Q33. Name the hormone that regulates each of the following and mention the source of it :

(i) Urinary elimination of water. (ii) Storage of glucose as glycogen.

(iii) Na+ and K+ ions metabolism. (iv) Basal metabolic rate. (v) Descent of testes into scrotum.

Ans: (i) ADH (ii) Insulin (iii) Aldosterone (iv) Thyroxine

(v) Follicular Stimulating Hormone and testosterone

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COURTESY: THE SOURCE OF SUBJECT CONTENT AND DIAGRAMS FROM NCERT TEXT BOOK FOR EDUCATION PURPOSE OF CLASS 11 STUDENTS OF KVS. NOT FOR ANY COMMERCIAL PURPOSE / PRIVATE CIRCULATION.

KENDRIYA VIDYALAYA SANGATHAN, ZIET, MUMBAI

SAMPLE PAPER - 1 BLUE PRINT

SUBJECT: BIOLOGY **CLASS: XI**

TIME: 3 Hours **M. M: 70**

UNIT	CHAPTER	1 MARK MCQ A&R		2 MARKS VSA	3 MARKS SA	4 MARKS CASE BASED	5 MARKS LA	TOTAL
I	DIVERSITY OF LIVING ORGANISMS	5	1	1	1	1		15
II	STRUCTURAL ORGANIZATION IN PLANTS AND ANIMALS	4	1	1	1			10
III	CELL: STRUCTURE AND FUNCTION	1	1	1	2		1	15
IV	PLANT PHYSIOLOGY –	1	1	1	1		1	12
V	ANIMAL PHYSIOLOGY	1		1	2	1	1	18
	TOTAL	12 X 1 =12	4X1 =4	5 X2=10	7X3=21	2X4=8	3X5=15	70

KENDRIYA VIDYALAYA SANGATHAN,

SAMPLE QUESTION PAPER - 1

SUBJECT: BIOLOGY **CLASS: XI**

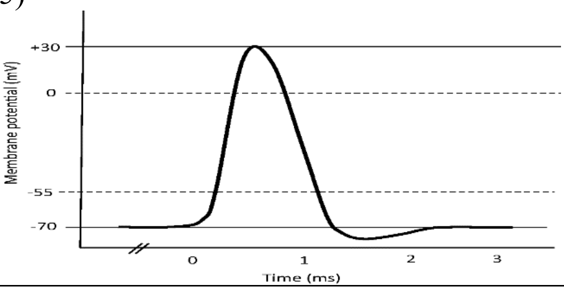
TIME: 3 Hours **M. M: 70**

General Instructions:
(i) All questions are compulsory.
(ii) The question paper has five sections and 33 questions. All questions are compulsory.
(iii) Section–A has 16 questions of 1 mark each; Section–B has 5 questions of 2 marks each; Section– C has 7 questions of 3 marks each; Section– D has 2 case-based questions of 4 marks each; and Section–E has 3 questions of 5 marks each.
(iv) There is no overall choice. However, internal choices have been provided in some questions. A student must attempt only one of the alternatives in such questions.
(v) Wherever necessary, neat, and properly labelled diagrams should be drawn.

Section–A		
Q.NO	QUESTION	MARKS
1.	During cell division the centromere of each chromosome split. Identify the stages of mitosis and meiosis respectively when it happens? (a) Mataphase, Metaphase II (b) Prophase, diplotene of prophase I (c) Telophase, Anaphase I (d) Anaphase, Anaphase II	1
2.	Given below a list of unique characteristics in column I and list of organisms in column II , Match column -I with column-II. Column-I — Column-II (A) Contractile vacuole — (I) Asterias (B) Water vascular system — (II) Amoeba (C) Canal system — (III) Pila (D) Radula — (IV) Spongilla Choose the correct answer from the options given below: (a) (A)-(IV), (B)-(II), (C)-(I), (D)-(III) (b) (A)-(I), (B)-(III), (C)-(II), (D)-(IV) (c) (A)-(III), (B)-(II), (C)-(I), (D)-(IV) (d) (A)-(II), (B)-(I), (C)-(IV), (D)-(III)	1
3.	In phylum arthropoda, excretion takes place through (a) nephridia (b) flame cells (c) malphigian tubules (d) gills	1
4.	Select the correct statements: (A) Platyhelminthes are triploblastic pseudocoelomate and bilaterally symmetricalorganisms. (B) Ctenophores reproduce only sexually and fertilization is external. (C) In tapeworm, fertilization is internal but sexes are not separate. (D) Ctenophores are exclusively marine, diploblastic and bioluminescent organisms. (E) In sponges, fertilization is external and development is direct. Choose the correct answer from the options given below: (a) (A), (C) and (D) only (b) (B), (C) and (D) only (c) (A) and (E) only (d) (B) and (D) only	1
5.	The transverse section of a plant part showed polyarch, radial vascular bundle with endodermis and pericycle. The plant part is identified as: (a) Monocot root	1

	(b) Dicot root (c) Dicot stem (d) Monocot stem	
6.	Which out of the following statements is incorrect? (a) Grana lamellae have both PS I and PS II (b) Cyclic photophosphorylation involves both PS I and PS II (c) Both ATP and NADPH + H+ are synthesised during non-cyclic photophosphorylation. (d) Stroma lamellae lack PS II and NADP reductase	1
7.	Aestivation found in the members of family Solanaceae is: (a) Valvate (b) Vexillary (c) Imbricate (d) Twisted	1
8.	The correct order for unidirectional flow of e- in non-cyclic photophosphorylation is- (a) PS II ---— e- —> PS I —-- e- —> NADP —- e- —> water (b) Water — e- —> PSII —-- e- —> PS I —---- e- —> NADP (c) PS I ----— e- —> NADP — e-—> water —- e-—> PS II (d) Water — e- —> PS I —--- e- —> PS II —--- e- —> NADP	1
9.	In which of the plant group,gametophytic phase is dominant and independentwhile the sporophytic phase is dependent. (a) Angiosperms (b) Gymnosperms (c) Bryophytes (d) Pteridophytes	1
10.	An organism without cell wall and can survive without oxygen, they are the smallest living cell known. (a) *Gonyaulax* (b) *Ustilago* (c) *Mycoplasma* (d) *Saccharomyces*	1
11.	Identify in order the plants showing alternate , opposite and whorled phyllotaxy. (a) China rose,*Alstonia*, *Calotropis*. (b) *Alstonia*.*Calotropis,* china rose. (c) *Calotropis*, Chinarose, *Alstonia.* (d) China rose, *Calotropis, Alstonia*.	1
12.	Systematics refers to the study of (a) Nomenclature and identification of plants and animals (b) Different kinds of organisms and their classification (c) Diversity of kinds of organisms and their relationships (d) Identification and classification of plants and animals	1
Question No. 13 to 16 consist of two statements – Assertion (A) and Reason (R). Answer these questions selecting the appropriate option given below: a) Both A and R are true and R is the correct explanation of A. b) Both A and R are true and R is not the correct explanation of A. c) A is true but R is false. d) A is false but R is true.		
13.	Assertion: Cell walls of diatoms are indestructible Reason:Cell wall of diatoms possess silica.	1
14.	Assertion: Bulliform cells are useful in the unrolling of leaf. Reason: Bulliform cells store water and remain turgid.	1
15.	Assertion:Mitochondria are known as the “Power house” of the cell.	1

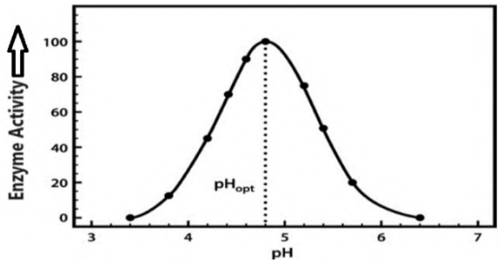
	Reason:They produce biologically useful energy for the cell activities.	
16.	Assertion: Photosynthetically C4 plants are less efficient than C3 plants. Reason: The operation of C4 pathway reduces the loss caused by photorespiration.	1
	Section–B	
17.	What do the terms Bioluminescence and red tide signify?	2
18.	In modern medicine certain infectious neurological diseases were found to be transmitted by an agent consisting of abnormally folded protein. What are they called? Name one disease caused by the agent.	2
19.	Plant growth regulators (PGRs) have innumerable practical applications. Name the PGR you should use to (i) Increase yield of sugarcane. (ii) Promote lateral shoot growth. (iii) Bolting in rosette plants. Inhibit seed germination.	2
20.	Suppose there were plants that had a high concentration of Chlorophyll b, butlacked chlorophyll a, would it carry out photosynthesis? Justify your answer.	2
21.	Differentiate between Prothallus and Protonema, OR What do the terms phycobiont and mycobiont signify? How they are related to each other?	2
	Section–C	
22.	Differentiate between green algae, red algae and brown algae on the basis of--- a) Major pigments in them b) Stored food.	3
23.	Give an outline of classification of plastids based on pigment and stored nutrients.	3
24.	"All *enzymes are protein still some enzymes require a non-proteinaceous part for its activity*"- give a brief review on it..	3
25.	Give a comparison between Cyclic and non-cyclic photo-phosphorylation .	3
26.	A) Given hereunder a graphical representation of different phases of nerve impulse conduction. Identify the following in the graph- i) resting potential, ii) depolarization, iii) repolarization. (1.5) b) How does a resting nerve fibre maintain a potential difference? Name one Neurotransmitter. (1.5)	3

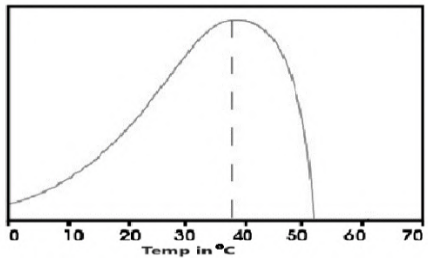


27.	What are the three major steps of urine formation? Explain in brief.	3
28.	i) Why S-A Node is called the pace maker of heart? ii) What are heart sounds? How and when they are produced? OR With respect to various lung volumes explain i) Vital capacity ii) residual volume iii) tidal volume.	3
	Section–D	
Q. No. 29 and 30 are case-based questions. Each question has 3 subparts with internal choice in one subpart.		
29.	In a research expedition to the Sanjay Gandhi National Park , a team of biologists discovered a unique species of Bird. This Bird had distinct characteristics not seen in any other known bird species. The team collected data on	4

	its anatomy, behavior, and genetics to classify it within the systematics framework. I. Which branch of biology is concerned with the classification and categorization of living organisms based on their evolutionary relationships and characteristics? A) Genetics B) Ecology C) Systematics D) Physiology II. Based on the case study, what is the primary focus of the team of biologists in their attempt to classify the newly discovered bird species? A) Its habitat and ecology B) Its potential use in medicine C) Its unique characteristics and evolutionary relationships D) Its population density. III. Which of the following is a taxonomic rank that represents the broadest category in biological classification? A) Genus B) Family C) Domain D) Kingdom IV. To classify the new bird species accurately, which of the following factors would be the most crucial for the biologists to consider? A) Its size and coloration B) Its diet and feeding habits C) Its evolutionary history and genetic data D) Its geographical distribution OR In taxonomic classification, if the cellular characters are considered to classify, such as chromosome number, structure, behaviour, it is called. a) Numerical Taxonomy b) Chemotaxonomy c) Cytotaxonomy d) Cladistic.	
30.	While performing research experiments in biochemistry laboratory, Researchers observed some interesting properties of an enzyme called "Enzym-M." Enzym-M is responsible for joining of two specific substrates into a product. The researchers are also studying the classification and inhibition of Enzym-M. I) At 72^0C the enzyme-M stops functioning, its activity does not recovers even after lowering the temperature to 30^0C. A) The substrate-binding site B) The cofactor attachment site C) The enzyme's three-dimensional shape D) The enzyme's classification II)Which of the following correctly describes competitive enzyme inhibition? A) The inhibitor binds to the active site of the enzyme. B) The inhibitor binds to a different site on the enzyme. C) The inhibitor increases the rate of the reaction. D) The inhibitor does not resemble the substrate. III) The enzyme M can be classified under? A) Hydrolase B) Isomerase C) Ligase D) Transferase IV)They also did experiment on the activity of the "Enzyme-M" in various	4

temperature and pH range and obtained the following graph





Find out the optimum Temperature & pH of enzyme-M from the graph.

OR

How the activity of Ligase different from Lyase.

Section–E

31. Represent schematically the Calvin cycle & explain the process. — 5

OR

Describe Z – scheme of light reaction along with figure. Why it is called non-cyclic photophosphorylation also?

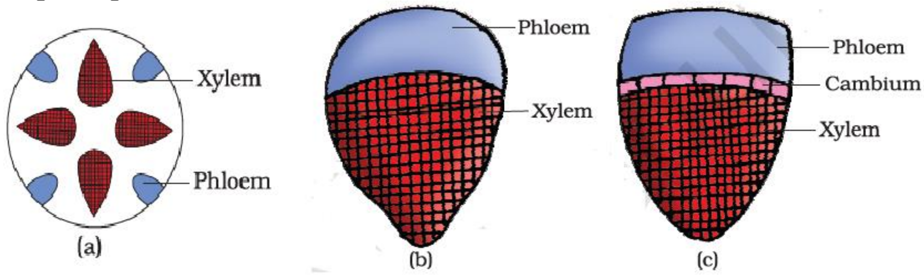
32. During contraction of striated muscles different proteins present in the thin and thick filaments play pivotal role, three such proteins marked A, B and C are mentioned hereunder in the diagram. Identify A, B and C. Name the oxygen storing pigment present in striated muscles. — 5

Explain sliding filament theory of muscle contraction.

OR

i) Write the correct function against each protein given below:
(a)Collagen --
(b)Trypsin ---
(c)Insulin ---
(d)Antibody ---
(e)Receptor ---
(f) GLUT 4 ---
ii)What are co-factors? Mention its types.

33. Plant anatomy reveals that Vascular bundles can be of various types, observe the diagram given below and answer. — 5



a) Identify them and state where they are found?
b) What is Casparian strip? Mention its composition and location located?

OR

Refer to the floral formula

Floral Formula: $\oplus$ ⚥ $K_{(5)}\ \overset{\frown}{C_{(5)}\ A_5}\ \underline{G}_{(2)}$

a) Write semi-technical description of the flower based on the given floral formula.
b) State two information about the flower that we do not get from floral formula?

SAMPLE PAPER - 1 MARKING SCHEME

SUBJECT: BIOLOGY **CLASS: XI**

TIME: 3 Hours **M. M: 70**

<table>
<tr><th>Q. No</th><th>Value Points</th><th>Marks</th></tr>
<tr><td>1.</td><td>d. Anaphase, Anaphase II</td><td>1</td></tr>
<tr><td>2.</td><td>d. (A)-(II), (B)-(I), (C)-(IV), (D)-(III)</td><td>1</td></tr>
<tr><td>3.</td><td>c. malphigian tubules</td><td>1</td></tr>
<tr><td>4.</td><td>b.) (B), (C) and (D) only</td><td>1</td></tr>
<tr><td>5.</td><td>a. Monocot root</td><td>1</td></tr>
<tr><td>6.</td><td>b. Cyclic photophosphorylation involves both PS I and PS II</td><td>1</td></tr>
<tr><td>7.</td><td>a. Valvate</td><td>1</td></tr>
<tr><td>8.</td><td>b. Water — e- —> PSII —-- e- —> PS I ——-- e- —> NADP</td><td>1</td></tr>
<tr><td>9.</td><td>c. Bryophytes</td><td>1</td></tr>
<tr><td>10.</td><td>c. Mycoplasma</td><td>1</td></tr>
<tr><td>11.</td><td>d. China rose, Calotropis, Alstonia.</td><td>1</td></tr>
<tr><td>12.</td><td>c. Diversity of kinds of organisms and their relationships</td><td>1</td></tr>
<tr><td>13.</td><td>a. Both A and R are true and R is the correct explanation of A.</td><td>1</td></tr>
<tr><td>14.</td><td>c.) A is true but R is false.</td><td>1</td></tr>
<tr><td>15.</td><td>a. Both A and R are true and R is the correct explanation of A.</td><td>1</td></tr>
<tr><td>16.</td><td>d.) A is false but R is true .</td><td>1</td></tr>
<tr><td>17.</td><td>Bioluminescence is the ability of production and emission of light by living organisms.
Red Tide- Rapid multiplication of red dinoflagelates (Gonyaulax)</td><td>1+1</td></tr>
<tr><td>18.</td><td>Prions-
bovine spongiform encephalopathy (BSE)in cattle / Cr–Jacob disease (CJD) in humans (any one)</td><td>1+
1</td></tr>
<tr><td>19.</td><td>Proper definition-1
2 examples (0.5 + 0.5)</td><td>1+ 0.5 +
0.5</td></tr>
<tr><td>20.</td><td>NO.
Chlorophyll-a is an essential chlorophyll pigment as it forms the reaction centre</td><td>1+1</td></tr>
<tr><td>21.</td><td><table>
<tr><td>Protonema</td><td>Prothallus</td></tr>
<tr><td>a thread like structure develops at the initiation of the moss development after the spore germination</td><td>is the gametophyte stage appears in the life cycles of ferns and other pteridophytes. It is a heart-shaped structure which developed through the germination of a spore</td></tr>
<tr><td colspan="2">OR</td></tr>
<tr><td>Mycobiont</td><td>phycobiont</td></tr>
<tr><td>refers to the fungal component that is present in lichen</td><td>refers to the algal component of lichen</td></tr>
</table></td><td></td></tr>
</table>

<table>
<tr><td></td><td><table><tr><td>It provides shelter and peforms water and mineral absorption for algae</td><td>prepares food by the process of photosynthesis. it provides food to fungi.</td></tr></table></td><td></td></tr>
<tr><td>22.</td><td><table>
<tr><th>Common Name</th><th>Major Pigments</th><th>Stored Food</th></tr>
<tr><td>Green algae</td><td>Chlorophyll a, b</td><td>Starch</td></tr>
<tr><td>Brown algae</td><td>Chlorophyll a, c, fucoxanthin</td><td>Mannitol, laminarin</td></tr>
<tr><td>Red algae</td><td>Chlorophyll a, d, phycoerythrin</td><td>Floridean starch</td></tr>
</table></td><td>(0.5+0.5) X3</td></tr>
<tr><td>23.</td><td>Proper classification – Chloroplast, chromoplast, leucoplast,-amyloplast, elaioplast, aleuroplast. (each correct term ½ marks)</td><td>½ X6=3</td></tr>
<tr><td>24.</td><td>Proper Justification-</td><td></td></tr>
<tr><td>25.</td><td>Inferior ovary/Epigynous $\overline{G}$
Superior ovary/ Hypogynous $\underline{G}$,
Perigynous -G</td><td>1+1+1</td></tr>
<tr><td>26.</td><td>Correct Identification
-70mV
Acatylcholine/ noradrenalin</td><td>1+2</td></tr>
<tr><td>27.</td><td>1.Glomerulus filtration
2. Tubular reabsorbtion
3.tubular secretion</td><td>1+2</td></tr>
<tr><td>28.</td><td>Ihe impulse of heartbeat originates in S.A.node.
Sharp closure of Sv Valves & semilunar valves causes Heart sound.
Lubb – 1st heart sound , due to closure of Tricuspid & mitral valve.
Dubb-2nd heart sound , due to sharp clodure of semi lunar valves.</td><td>05+05=1

(.5X4)=2</td></tr>
<tr><td>29.</td><td>I C
II C
III C
IV C
Or
C</td><td>4</td></tr>
<tr><td>30.</td><td>I C
II A
III D
IV Temp 38 Degree Centigrade, pH 4.8 (approx.) (.5+.5)
Or
One basic point of difference (.5+.5)</td><td>4</td></tr>
<tr><td>31.</td><td>Correct representation 2 marks
Correct explanation 3marks
OR
Z-scheme diagram+ description 4
Proper Reason - 1 marks</td><td>2+3

4+1</td></tr>
<tr><td>32.</td><td>Singer & Nicolson (1 Mark)
Diagram 2 marks,
explanation 2 marks
OR</td><td>1+2+2</td></tr>
</table>

<table>
<tr>
<td></td>
<td>
<table>
<tr><th>Protein</th><th>Functions</th></tr>
<tr><td>Collagen</td><td>Intercellular ground substance</td></tr>
<tr><td>Trypsin</td><td>Enzyme</td></tr>
<tr><td>Insulin</td><td>Hormone</td></tr>
<tr><td>Antibody</td><td>Fights infectious agents</td></tr>
<tr><td>Receptor</td><td>Sensory reception (smell, taste, hormone, etc.)</td></tr>
<tr><td>GLUT-4</td><td>Enables glucose transport into cells</td></tr>
</table>
0.5X6= 3
Proper definition of Co-factors -1
Types at least 2 (X.5) =1
</td>
<td>3+1+1</td>
</tr>
<tr>
<td>33.</td>
<td>A (a) Radial – in roots of both dicot & monocot
(b) conjoint closed
(c)conjoint open
B proper definition/ explanation
OR
A. Semi technical description, (4)
Actinomorphic, bisexual, calyx 5, fused , Gamosepalous, corolla 5, gamopetalous, androecium 5, epipetalous, ovary superior carpels 2 (bicarpellary) syncarpous.
B. Aestivation, placentation. (1)</td>
<td>3+2

4+1</td>
</tr>
</table>

KENDRIYA VIDYALAYA SANGATHAN,

SAMPLE PAPER - 2 BLUE PRINT

SUBJECT: BIOLOGY **CLASS: XI**

TIME: 3 Hours **M. M: 70**

S No.	Unit	VSA - I 1 mark	Assertion – reasoning 1 mark	Case study 1*4=4 marks	SA - I 2 marks	SA - II 3 marks	Long Answer 5 marks	Marks allotted
1	Diversity in the living world	2	1	1	1	2	-	15
2	Structural organization in plants and animals	2	1	-	2	1	-	10
3	Cell: -Structure and functions	2	-	-	1	2	1	15
4	Plant physiology	3	1	-	-	1	1	12
5	Animal physiology	3	1	1	1	1	1	18
	Total (Questions- 33)	**12(12)**	**4(4)**	**2(8)**	**5(10)**	**7(21)**	**3(15)**	**70**

KENDRIYA VIDYALAYA SANGATHAN,

SAMPLE QUESTION PAPER - 2

SUBJECT: BIOLOGY **CLASS: XI**

TIME: 3 Hours **M. M: 70**

General Instructions:
(i) All questions are compulsory.
(ii) The question paper has five sections and 33 questions. All questions are compulsory.
(iii) Section–A has 16 questions of 1 mark each; Section–B has 5 questions of 2 marks each; Section– C has 7 questions of 3 marks each; Section– D has 2 case-based questions of 4 marks each; and Section–E has 3 questions of 5 marks each.
(iv) There is no overall choice. However, internal choices have been provided in some questions. A student must attempt only one of the alternatives in such questions.
(v) Wherever necessary, neat, and properly labelled diagrams should be drawn.

SECTION: A		
Q NO.	**QUESTIONS**	**MARKS**
1	Both Pteridophytes and Gymnosperms possesses? (a) Independent gametophyte. (b) seed (c) ovules (d) Archegonia	**1**
2	Which of the following is a fresh water sponge? (a) Spongilla (b)Pleurobrachia (c) Euspongia (d) Sycon	**1**
3	The form of thalamus in which ovary is at top and stamens, petals and sepals are borne below is called- (a) Perigynous (b) Epigynous (c) Hypogynous (d) semi-epigynous	**1**
4	Frogs show which type of excretion? (a) Ureotelic (b) Ammonotelic in water and ureotelic on land (c)Ammonotelic (d) Urecotelic	**1**
5	Which among the five-kingdom system of classification do not possess nuclear membrane? (a)Monera (b) Protista (c) Fungi (d) Plantae	**1**
6	Axoneme having 9 + 2 doublet microtubule arrangement is found in (a) cilia (b) flagella (c) cilia and flagella (d) Centriole	**1**
7	Thylakoids occurs inside (a) mitochondria (b) Chloroplast (c) endoplasmic reticulum (d) Endoplasmic reticulum	**1**
8	Oxidative phosphorylation occurs in the- (a) Outer membrane of mitochondria	**1**

	(b) Inner membrane of mitochondria (c) Stroma of chloroplast (d) Grana of chloroplast	
9	Auxin was isolated from tips of coleoptiles of oat seedlings by- (a) F. W. Went (b) Skoog (c) E. Kurosawa (d) Miller	**1**
10	One of the examples of the action of the autonomous nervous system is (a) swallowing of food (b) pupillary reflex (c) peristalsis of the intestines (d) knee-jerk response	**1**
11	The part of brain located between the thalamus, hypothalamus of fore brain and pons is known as- (a) Mid-brain (b) Hind-brain (c) Limbic system (d) All of these	**1**
12	The potential difference across resting membrane is negatively charged. This is due to differential distribution of the following ions- (a) Na+ and K+ ions (b) CO3 ++ and Cl- ions (c) Ca++ and Mg++ ions (d) Ca++ and Cl- ions	**1**
	Read the assertion and reason carefully to mark the correct option out of the options given below: **(a) If both the assertion and the reason are true and the reason is a correct explanation of the assertion.** **(b) If both the assertion and reason are true but the reason is not a correct explanation of the assertion.** **(c) If the assertion is true but the reason is false.** **(d) If both the assertion and reason are false**	
13	Assertion: Slime moulds are saprophytic protists. Reason: Slime moulds derive their nutrition mainly from decaying organic matter.	**1**
14	Assertion: Actinomorphic flowers show radial symmetry. Reason: Zygomorphic flowers have bilateral symmetry.	**1**
15	Assertion: The flower is modified shoot meant for sexual reproduction. Reason: Flowers are arranged in different types of inflorescences.	**1**
16	Assertion: The skeleton of sponges is made up of spicules. Reason: Composition of spicules help in classification of sponges.	**1**
	SECTION - B	
17	What is micturition?	**2**
18	The mode of arrangements of sepals or petals in floral bud is known as aestivation. Draw the various aestivation possible for a typical pentamerous flower. Or How are open vascular bundles different from closed vascular bundles.	**2**
19	What is diatomaceous earth? Write its two uses.	**2**
20	How do ureters in male frog differ from that of female frog?	**2**
21	Give an account of significance of mitosis.	**2**
	SECTION - C	
22	Describe the role of red blood cells in the transport of oxygen and carbon dioxide by blood.	**3**

	Or How do Testosterone, progesterone and estrogen differ from each other?	
23	Why is ABA known as 'stress hormone'? Mention any two functions of this hormone. How are they antagonistic to gibberellins?	**3**
24	Enlist four steps involved in catalytic action of an enzyme.	**3**
25	What do you understand by the secondary, tertiary structure of a protein? Explain with diagram.	**3**
26	Draw illustrations to bring out the anatomical difference between Monocot stem and Dicot stem.	**3**
27	Describe briefly the four major groups of Protozoa.	**3**
28	Explain the gametophytic and sporophytic stages in *Funaria* with labelled diagram only.	**3**
	SECTION - D	
29	**Read the following to answer four questions from (i) to (iv) given below**: The androecium is composed of stamens. The anther of stamen is usually bilobed and each lobe has two chambers called pollen sacs. Stamens may be united with each other or with the petal or tepals. A flower is a modified shoot where the shoot apical meristem changes to floral meristem. Internodes do not elongate and the axis gets condensed. (i) The pollen grains are produced in pollen-sacs. What is a sterile stamen called? (ii) The term given to stamens attached with tepals is--------------. (iii) Give example of a flower in which stamens are united in more than two bundles. (iv) The variation in the length of filament within the flower is seen in- China rose and citrus b) rose and pea c) mustard and salvia d) rose and mirabilis	**4**
30	**Read the following and answer four questions from (i) to (iv) given below:** We have two lungs which are covered by a double layered pleura, with pleural fluid between them. It reduces friction on the lung-surface. The outer pleural membrane is in close contact with the thoracic lining whereas the inner pleural membrane is in contact with the lung surface. The part starting with the external nostrils up to the terminal bronchioles constitute the conducting part whereas the alveoli and their ducts form the respiratory or exchange part of the respiratory system. The conducting part transports the atmospheric air to the alveoli, clears it from foreign particles, humidifies and also brings the air to body temperature. Exchange part is the site of actual diffusion of O2 and CO2 between blood and atmospheric air. (i) Demonstrate your understanding of respiratory physiology. Define the term "residual volume" in the context of breathing (ii) Explain the biomechanical changes in the ribs and diaphragm during exhalation. How do these structural alterations contribute to the process of exhalation? (iii)Utilize your knowledge to identify the specific term used for the volume of air inspired or expired during normal respiration. (iv)Arrange the following in the order of increasing volume 1. Tidal volume 2. Residual volume 3. Expiratory reserve volume 4. Inspiratory reserve volume (a) $1 < 2 < 3 < 4$ (b) $1 < 4 < 3 < 2$ (c) $1 < 3 < 2 < 4$ (d) $1 < 4 < 2 < 3$	**4**
	SECTION - E	
31	Explain sliding filament theory of muscle contraction with neat sketches. OR Draw a standard ECG and explain the different segments in it.	5
32	(i) What do you understand by oxidative phosphorylation? Where does it occur inside the cell? Name the enzyme responsible for this reaction. 3 (ii) List two ways by which molecules of ATP are produced in glycolysis during aerobic respiration in a cell.	5
33	Growth is a special feature of the living organism this growth of the organisms is due	5

	cell division. Write the stages of such division with diagrams. OR Is there a species- or region-specific type of plastids? How does one distinguish one from the other?	

KENDRIYA VIDYALAYA SANGATHAN,

SAMPLE PAPER – 3 BLUE PRINT

SUBJECT: BIOLOGY **CLASS: XI**

TIME: 3 Hours **M. M: 70**

S. no	Unit/chapter	Knowledge & understanding /marks	Application of knowledge/concept(30%)									Analyse, evaluate & create					
		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	Total
1	1. The Living World.	1(1)															
2	2. Biological classification.												1(2)				15
3	3. Plant Kingdom.						1(1)								1(4)		
4	4. Animal Kingdom.	1(1)		1(3)					1(3)								
5	5.Morphology of Flowering Plants					1(5)	1(1)										10
6	6.Anatomy of Flowering Plants			1(3)													
7	7. Structural Organisation in Animals	1(1)															
8	8. Cell: The Unit of Life		1(2)											1(3)			15
9	9. Biomolecules	1(1)	1(2)					1(2)									
10	10. Cell Cycle and Cell Division.										1(5)						
11	13.Photosynthesis in higher plants.						1(1)		1(3)								12
12	14.Respiration in plants	1(1)		1(3)													
13	15:.Plant growth and development.						1(1)							1(3)			
14	17. Breathing and exchange of gases.					1(5)	1(1)										
15	18. Body fluids and circulation.	1(1)										1(1)					
16	19. Excretory	1(1)															18

	products and elimination.															
17	20. Locomotion and movement.						1(1)									
18	21. Neural control and coordination.	1(1)						1(2)				1(1)				
19	22. Chemical coordination and integration				1(4)											
	Total		21									14				
	Percentage		30%									20%				

Note : 1. Number of Questions is indicated outside the bracket and Total Marks is indicated within the bracket.

2. Internal choices wherever applicable is followed as per the norms of CBSE.

KENDRIYA VIDYALAYA SANGATHAN,

SAMPLE QUESTION PAPER -3

SUBJECT: BIOLOGY **CLASS: XI**

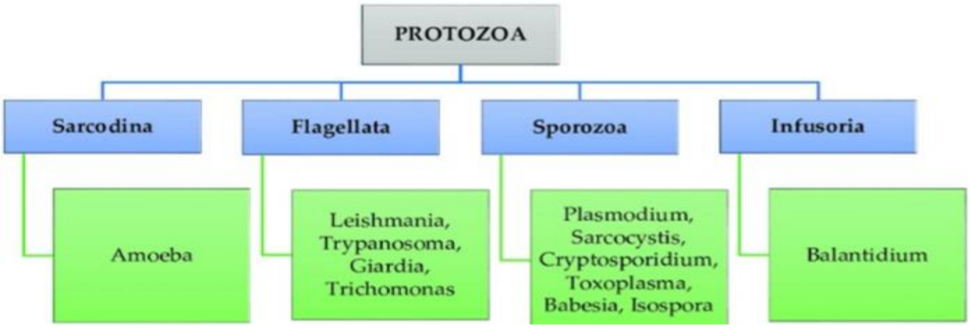
TIME: 3 Hours **M. M: 70**

General Instructions:
(i) All questions are compulsory.
(ii) The question paper has five sections and 33 questions. All questions are compulsory.
(iii) Section–A has 16 questions of 1 mark each; Section–B has 5 questions of 2 marks each; Section– C has 7 questions of 3 marks each; Section– D has 2 case-based questions of 4 marks each; and Section–E has 3 questions of 5 marks each.
(iv) There is no overall choice. However, internal choices have been provided in some questions. A student must attempt only one of the alternatives in such questions.
(v) Wherever necessary, neat, and properly labelled diagrams should be drawn.

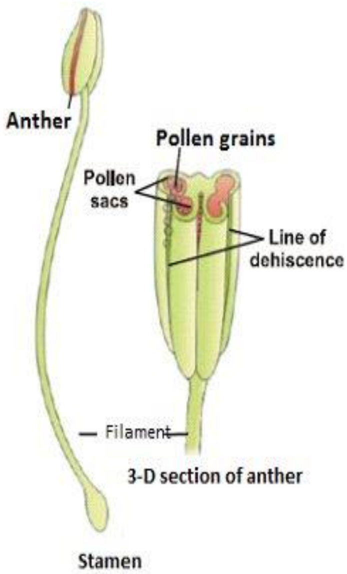
	Section A	
1	The taxanomic unit phylum in the animal classification is equal to which hierarchial level in plant classification. a. Order b. Class c. Division d. Family	1
2	Organisms living in rumen of cattle are called. a. Methanogens b. Halophyles c. Heliophytes d. Thermoacidophyles.	1
3	Which of the following called reptilians of plant kingdom a. Pteridophytes b. Gymnosperms c. Monocots d. Bryophytes	1
4	Mainly mineral absorption takes place by a. roor hair zone b. Meristematic zone c. Elongation zone d. Zone of maturation	1
5	In monocot seed aleurone layer consists of a. carbohydrates b. Lipids c. Proteins d. Nucleic acid	1
6	Find out from the following, which is under the direct neural regulation of hypothalamus a. pineal b. Thymus c. Posterior pituitary d. Adrenal medulla	1
7	Which among following is the smallest, pathogenic on (without cell wall) both plant and	1

	animals. a. bacillus b. Pseudomonas c. Nostoc d. Mycoplasma	
8	An amino acid under certain conditions has both -ve and +ve charges simultaneously in the same molecule a. Acidic form b. Basic form c. Aromatic form d. Zwitterionic form	1
9	Non-disjunction occurs during a. metaphase II b. Anaphase I c. Telophase II d. Metaphase II	1
10	Pyruvic dehydrogense requires for its activity is a. Sodium b. Sulphur c. Cobalt d. Magnesium	1
11	Calcitonin hormone decreases the blood--------levels a. Glucose b. Iodine c. Calcium ions d. Serum proteins	1
12	Carbon Dioxide dissociates from carbaminohaemoglobin when a. pCO2 is high & pO2 is low b. High pO2 & low pCO2 c. Both pCO2 & pO2 are equal d. None of the above	1
	Question No. 13 to 16 consist of two statements- a statement of assertion (A) is followed by a statement of reason (R). Mark the correct choice as: (a) Both A and R are true and R is the correct explanation of A (b) Both A and R are true and R is not the correct explanation of A (c) A is true but R is false. (d) Both A and R is false	
13	Assertion : Plant having unisexual flowers is called incomplete dioecious flowers Reason : Papaya plant produces unisexaul flowers.	1
14	Assertion :The sum of growth and differentiation is development. Reason : Development in plants is under the control of extrinsic factors only.	1
15	Assertion : Adrenaline & nor-adrenaline are rapidly secreted in response to stress of any kind and during emergency situations. Reason : Due to this reason they are called emergency hormones or hormones of fight and flight	1
16	Assertion : Hormone calcitonin has antagonistic effect to that of Parath hormone. Reason : Calcitonin decreases blood Calcium levels while parath hormone inceases blood Calcium levels.	1
	Section-B	
17	Expand ICZN and define Taxon.	2
18	Name the eukaryotic kingdom with uncellular organisms in the five kingdom classification proposed by Whittaker	2
19	Write cell theory in brief. OR State any two important characteristics of prokaryotic cells	2
20	A cell is having 24 (2n) chromsosomes undergoes meiosis division. At the end of meiosis I. What will be the ploidy of daughter cells.	2
21	Write the respiratory organs of following a. flatworms b. Frog c. Birds d. Cockroach.	2
	Section –C	
	Give one example each of following (i) Acoelomate animals (ii) Bilateral symmetrical animal (iii) Diploblastic animals	3
23	Explain different types of plastids, with their location and function.	3
24	List any three differences between cyclic and non-cyclic photophosphorylation.	3
25	Draw neatly labelled diagram of frog digestive system.	3
26	Respiratory pathway is amphibolic. Explain. OR Explain Kreb"s cycle with a neat flow chart.	3

<table>
<tr><td>27</td><td>Which hormones are secreted by neurohypophysis? Mention their functions.</td><td>3</td></tr>
<tr><td>28</td><td>Explain the three different modes of movements observed in human body.</td><td>3</td></tr>
<tr><td></td><td>Section—D</td><td></td></tr>
<tr><td>29</td><td>Read the text carefully and answer the questions:
Sarcodines are unicellular/jelly-like protozoa found in fresh or sea water and in moist soil. Their body lacks a periplast. Therefore, they may be naked or covered by a calcareous shell. They usually lack flagella and have temporary protoplasmic



outgrowths called pseudopodia. These pseudopodia or false feet help in movement and capturing prey. They include free-living forms such as Amoeba or parasitic forms such as Entamoeba. Zoo flagellates ciliates and I sporozoans are other groups of protozoan protists. They are all unicellular and heterotrophic. They may be holozoic, saprobic or parasitic.
(I) Write two lines about flagellated protozoans and also mention some flagellated protozoans.
. (II) Which protozoan group has two nuclei, macronucleus, and micronucleus? Mention characteristics of it.
(III) Observe the given protozoan classification and mention what is the basis of protozoan classification.
(IV) Mention some locomotory organs of protozoa.</td><td>4</td></tr>
<tr><td>30</td><td>Read the text carefully and answer the questions:
The androecium is composed of stamens. Each stamen that represents the male reproductive organ consists of a stalk or a filament and an anther. Each anther is usually bilobed and each lobe has two chambers, the pollen-sacs. Stamens of flowers may be united with other members such as petals or among themselves. The stamens may be epipetalous or epiphyllous. A flower is a modified shoot wherein the shoot apical meristem changes to floral meristem. Internodes do not elongate and the axis gets condensed. The apex produces different kinds of floral appendages laterally at successive nodes instead of leaves. The arrangement of flowers on the floral axis is termed an inflorescence.



(i)Observe the figure and mention what is androecium composed of.

(ii)The pollen grains are produced in pollen-sacs. What is a sterile stamen is called?

(iii)Is salvia and mustard show variation in the length of filaments within a flower?

(iv) Mention statement justifies that the given figure is</td><td>4</td></tr>
</table>

	racemose inflorescence.	
	Section—E	
31	Describe the following: (i) synapsis (ii) bivalent (iii) chiasmata Draw a diagram to illustrate your anwer. OR With the help of suitable diagrams describe mitosis.	5
32	Enumerate the assumptions that we undertake in making the respiratory balance sheet. Are these assumptions valid for a living system? Compare fermentation and aerobic respiration in this context. OR Where is the electron transport system operative in mitochondria? Explain the system highlighting the role of oxygen.	5
33	(i) Describe different types of flowers on the basis of arrangement of ovary with reference to position of remaining floral parts. (3) (ii) List any two differences between racemose and cymose inflorescences. (2) OR (i) Draw the neatly labelled diagram of monocotyledonous seed (3) (ii) Explain any two types of placentation with suitable examples (2)	5

KENDRIYA VIDYALAYA SANGATHAN,

SAMPLE PAPER - 4 BLUE PRINT

SUBJECT: BIOLOGY **CLASS: XI**

TIME: 3 Hours **M. M: 70**

		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	Total
1	1. The Living World.	1(1)															15
2	2. Biological classification.												1(2)				
3	3. Plant Kingdom.						1(1)								1(4)		
4	4. Animal Kingdom.	1(1)		1(3)					1(3)								
5	5.Morphology of Flowering Plants					1(5)	1(1)										10
6	6.Anatomy of Flowering Plants			1(3)													
7	7. Structural Organisation in Animals	1(1)															
8	8. Cell: The Unit of Life		1(2)											1(3)			15
9	9. Biomolecules	1(1)	1(2)					1(2)									
10	10. Cell Cycle and Cell Division.										1(5)						
11	13. Photosynthesis in higher plants.						1(1)		1(3)								12
12	14.Respiration in plants	1(1)		1(3)													

13	15:.Plant growth and development.						1(1)							1(3)			
14	17. Breathing and exchange of gases.					1(5)	1(1)										18
15	18. Body fluids and circulation.	1(1)										1(1)					
16	19. Excretory products and elimination.	1(1)															
17	20. Locomotion and movement.						1(1)										
18	21. Neural control and coordination.	1(1)						1(2)				1(1)					
19	22. Chemical coordination and integration				1(4)												
	Total	35					21					14					70
	Percentage	50%					30%					20%					100 %

Note : 1. Number of Questions is indicated outside the bracket and Total Marks is indicated within the bracket.

2. Internal choices wherever applicable is followed as per the norms of CBSE.

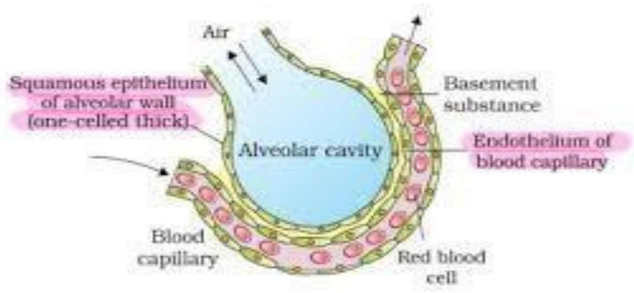
KENDRIYA VIDYALAYA SANGATHAN,

SAMPLE QUESTION PAPER - 4

SUBJECT: BIOLOGY **CLASS: XI**

General Instructions:
(i) All questions are compulsory.
(ii) The question paper has five sections and 33 questions. All questions are compulsory.
(iii) Section–A has 16 questions of 1 mark each; Section–B has 5 questions of 2 marks each; Section– C has 7 questions of 3 marks each; Section– D has 2 case-based questions of 4 marks each; and Section–E has 3 questions of 5 marks each.
(iv) There is no overall choice. However, internal choices have been provided in some questions. A student must attempt only one of the alternatives in such questions.
(v) Wherever necessary, neat, and properly labelled diagrams should be drawn.

Q.No.		**Marks**
	SECTION-A	
1	The scientific name of House fly is a)*Tribolium confusum* b)*Tribolium castaneum* c)*Musca domestica* d)*Blatta orientalis*	**1**
2	The forelimbs and hindlimbs of frogs are a) Four digits b) Five digits c)Four and five digits respectively **d)** Six digits	**1**
3	If husband is Rh^+ and wife is Rh^- then	**1**

	a) No problem with first child b) Second child would have anemia (erythroblastosis foetalis) c)Second child would be normal d)both (a) and (b)	
4	The following statements are drawn as conclusions for the image shown: -  I. Exchange of gases occurs at the alveolar surface. II.Partial pressure of gases is the main factor responsible of exchange of O2 and CO2. III.For alveolar air, pO_2=40 mmHg, & pCO_2=104. IV.The total thickness of membranes across which exchange occurs in lungs is three millimeters. Choose the options which are CORRECT a)I and IV b)III and IV c)II and III d)I and II	**1**
5	We can produce a concentrated/diluted urine. This is facilitated by a special Mechanism . Identify the mechanism. a) Re absorption from PCT b) Reabsorption from collecting duct c)Reabsorption/Secretion in DCT d)Counter current mechanism in Henle's loop/Vasa recta.	**1**
6	Hold fast,stipe and frond constitutes the plant body in case of a)Rhodophyceae b)Chorophyceae c)Phaeophyceae d)All of these	**1**
7	The mature seeds of plants such as gram and pea possess no endosperm because a)These plants are not angiosperms	**1**

	b) There is no double fertilization in them c) Endosperm is not formed in them d)Endosperm gets used up by the developing embryo during seed development.	
8	The primary acceptor of CO_2 in Hatch and Slack cycle is a)Phosphoenol pyruvate b)Phosphoglyceric acid c)Ribulose bisphosphate d)Oxaloacetic acid.	**1**
9	To promote flowering in pineapple, it is sprayed with which of the following plant growth regulator a)IAA b) cytokinin c) Gibberellin d) Ethylene	**1**
10	Which one of the following is showing the correct sequential order of vertebrae in the vertebral column of human beings. a) Cervical –lumbar-thoracic-sacral-coccygeal b) Cervical-thoracic-sacral-lumbar-coccygeal c) .Cervical-sacral-thoracic-lumbar-coccygeal d)d)cervical-thoracic-lumbar-sacral-coccygeal	**1**
11	Match the following columns I Component of circulatory system with column II related to the functions.	**1**

Column I	Column II
A.Lymphatic system	1.Carries oxygenated blood
B.Pulmonary vein	2.Immune response
C. Blood platelets	3.To drain back the tissue fluid to the circulatory system
D.Lymphocytes	4.Coagulation of blood

Codes A B C D

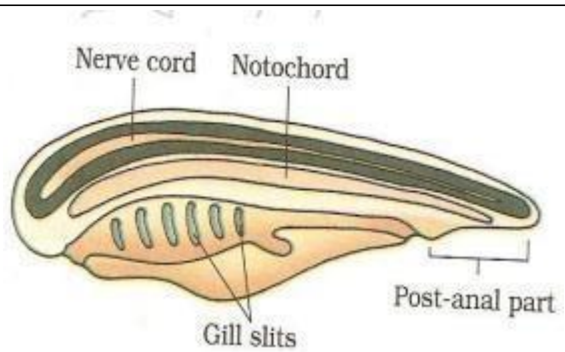
a) 2 1 3 4

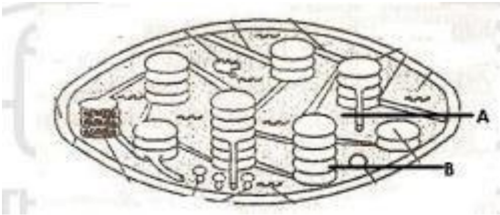
b) 3 1 4 2

c) 3 1 3 4

d) 2 1 3 4

12	The cerebral hemispheres are connected with tract of nerve fibres called a)White matter b) Corpus venosus c)Grey matter d)Corpus Callosum	**1**
	Question no 13 to 16 consist of two statements –Assertion (A) and Reason(R) .Answer these questions selecting the appropriate option given below. A. Both A and R are true and R is the correct explanation of A. B. Both A and R are true and R is not the correct explanation of A C. A is true but R is false D. A is false but R is true	

13	Assertion (A): Air sacs are connected to lungs in class –Aves Reason (R) :They supplement respiration in birds	**1**
14	Assertion (A):starch is a polymer of glucose Reason (R): It is made of several glucose units	**1**
15	Assertion (A): Carbohydrates are used first by most cells in respiration Reason (R): Lipids are never used in respiration	**1**
16	Assertion (A): Neurons are excitable cells Reason(R): Membranes of the neurons are in a polarized state which is responsible for the excitability .	**1**
	SECTION –B	
17	(i)Name two surface extensions that are not concerned with motility in bacterial cells. (ii) Give the name of the structure that helps in motility in bacterial cells.	**2**
18	Starch, cellulose, glycogen, chitin are polysaccharides found among the following. Choose the one appropriate and write against each. 1. cotton fibre_______ 2. Exoskeleton of cockroach_______ 3. liver____________ 4. Peeled potato___________	
19	How are prosthetic groups different from cofactors?	**2**
20	Distinguish between afferent neurons and efferent neurons. OR Differentiate between myelinated and non-myelinated axons.	**2**
21	A virus is considered as a living organism and an obligate parasite when inside a host cell. But virus is not classified along with bacteria or fungi. What are the characters of virus that are similar to non-living objects?	**2**
	SECTION- C	
22	 a) Classify the above organism according to the labelling given. **b)** Name the organism. C) Why are they called protochordates?	**3**
23	Give an example for each of the following. a) An organism possessing water-vascular system b)A fish possessing a poison sting c)A fish possessing an electric organ d)An organ, which regulate buoyancy e)An animal, which exhibits alternation of generation.	**3**

	F) Name one flightless birds.	
24	Observe the given diagram and answer the questions that follow  a) Identify the picture shown above. b) Label A and B c) Give the function of each	**3**
25	Cut a transverse section of young stem of a plant from your school garden and observe it under the microscope. How would you ascertain whether it is a monocot stem or a dicot stem? Give reason.	**3**
26	Represent schematically the pathway of TCA cycle?	**3**
27	In what kind of plants do you come across Kranz anatomy? To which conditions are those plants better adapted? How are these plants better adapted than the plants, which lack this anatomy?	**3**
28	Name a hormone which a) is gaseous in nature b)induces femaleness in flower of cucumber c)is used for killing weeds(dicots) **OR** How are gibberellins useful in agriculture to improve productivity. Give	**3**
	SECTION –D	
29	Read the given passage and answer the questions that follows. each question has subparts with internal choice in one. In pteridophytes, the main plant body is a sporophyte which is differentiated into tree, root and leaves. These organs possess well differentiated vascular tissues. 1) What is sporophylls? 2)Name any two species of pteridophytes which show heterosporous. 3)Name the male and female sex organs of pteridophytes. **OR** What are the two events that are considered as precursors of seed habit?	**4**
30	Pancreas is a composite gland which acts as both exocrine and endocrine gland. The endocrine pancreas consists of Islets of Langerhans. The two main types of cells in the Islet of Langerhans are called α cells and β cells. The α cells secrete a hormone called glucagon while β cells secrete insulin. 1.Which endocrine gland and its part is involved in the secretion of insulin? 2.What is the role of insulin in controlling level of glucose in blood? 3.What is hypo glycaemia? **OR**	**4**

	Justify glucagon is a hyperglycemic hormone?	
	SECTION –E	
31	Describe with neat diagram internal structure of a dorsiventral leaf. **OR** The diagram represents a kind of Aestivation.  A. Define aestivation. B. Identify this type of aestivation. C. Name an example for a plant exhibiting this. Differentiate actinomorphic and Zygomorphic.	**5**
32	What are the various stages of meiotic prophase I? Enumerate the chromosomal events during each stage? **OR** a) Comment on the statement –Telophase is reverse of prophase? b) Why is mitosis called equational division?	**5**
33	Describe the role of red blood cells in the transport of oxygen and carbon dioxide by blood. **OR** a) Inspiratory muscles and expiratory muscles play very important role in respiratory process. Explain. 3M b) Cigarette smoking causes emphysema. Give reason 2M	**5**

तत् त्वं पूषन् अपावृणु

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