BIOLOGY WORK BOOK

CLASS - XI

State Council of Educational Research and Training
Govt. of Tripura

BIOLOGY WORK BOOK

Class - XI

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রতন লাল নাথ
মন্ত্রী
শিক্ষা দপ্তর
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বার্তা

শিক্ষার প্রকৃত বিকাশের জন্য, শিক্ষাকে যুগোপযোগী করে তোলার জন্য প্রয়োজন শিক্ষাসংক্রান্ত নিরন্তর গবেষণা। প্রয়োজন শিক্ষা সংশ্লিষ্ট সকলকে সময়ের সঙ্গে সঙ্গে প্রশিক্ষিত করা এবং প্রয়োজনীয় শিখন সামগ্রী, পাঠ্যক্রম ও পাঠ্যপুস্তকের বিকাশ সাধন করা। এস সি ই আর টি ত্রিপুরা রাজ্যের শিক্ষার বিকাশে এসব কাজ সুনামের সঙ্গে করে আসছে। শিক্ষার্থীর মানসিক, বৌদ্ধিক ও সামাজিক বিকাশের জন্য এস সি ই আর টি পাঠ্যক্রমকে আরো বিজ্ঞানসম্মত, নান্দনিক এবং কার্যকর করবার কাজ করে চলেছে। করা হচ্ছে সুনির্দিষ্ট পরিকল্পনার অধীনে।

এই পরিকল্পনার আওতায় পাঠ্যক্রম ও পাঠ্যপুস্তকের পাশাপাশি শিশুদের শিখন সক্ষমতা বৃদ্ধির জন্য তৈরি করা হয়েছে ওয়ার্ক বুক বা অনুশীলন পুস্তক। প্রসঙ্গত উল্লেখ্য, ছাত্র-ছাত্রীদের সমস্যার সমাধানকে সহজতর করার লক্ষ্যে এবং তাদের শিখনকে আরো সহজ ও সাবলীল করার জন্য রাজ্য সরকার একটি উদ্যোগ গ্রহণ করেছে, যার নাম 'প্রয়াস'। এই প্রকল্পের অধীনে এস সি ই আর টি এবং জেলা শিক্ষা আধিকারিকরা বিশিষ্ট শিক্ষকদের সহায়তা গ্রহণের মাধ্যমে প্রথম থেকে দ্বাদশ শ্রেণির ছাত্র-ছাত্রীদের জন্য ওয়ার্ক বুকগুলো সুচারুভাবে তৈরি করেছেন। ষষ্ঠ থেকে অষ্টম শ্রেণি পর্যন্ত বিজ্ঞান, গণিত, ইংরেজি, বাংলা ও সমাজবিদ্যার ওয়ার্ক বুক তৈরি হয়েছে। নবম দশম শ্রেণির জন্য হয়েছে গণিত, বিজ্ঞান, সমাজবিদ্যা, ইংরেজি ও বাংলা। একাদশ দ্বাদশ শ্রেণির ছাত্র-ছাত্রীদের জন্য ইংরেজি, বাংলা, হিসাবশাস্ত্র, পদার্থবিদ্যা, রসায়নবিদ্যা, অর্থনীতি এবং গণিত ইত্যাদি বিষয়ের জন্য তৈরি হয়েছে ওয়ার্ক বুক। এইসব ওয়ার্ক বুকের সাহায্যে ছাত্র-ছাত্রীরা জ্ঞানমূলক বিভিন্ন কার্য সম্পাদন করতে পারবে এবং তাদের চিন্তা প্রক্রিয়ার যে স্বাভাবিক ছন্দ রয়েছে, তাকে ব্যবহার করে বিভিন্ন সমস্যার সমাধান করতে পারবে। বাংলা ও ইংরেজি উভয় ভাষায় লিখিত এইসব অনুশীলন পুস্তক ছাত্র-ছাত্রীদের মধ্যে বিনামূল্যে বিতরণ করা হবে।

এই উদ্যোগে সকল শিক্ষার্থী অতিশয় উপকৃত হবে। আমার বিশ্বাস, আমাদের সকলের সক্রিয় এবং নিরলস অংশগ্রহণের মাধ্যমে ত্রিপুরার শিক্ষাজগতে একটি নতুন দিগন্তের উন্মেষ ঘটবে। ব্যক্তিগত ভাবে আমি চাই যথাযথ জ্ঞানের সঙ্গে সঙ্গে শিক্ষার্থীর সামগ্রিক বিকাশ ঘটুক এবং তার আলো রাজ্যের প্রতিটি কোণে ছড়িয়ে পড়ুক।

(রতন লাল নাথ)

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CONTENT

Unit - I

Chapter - 1	:	The Living World	07
Chapter - 2	:	Biological Classification	14
Chapter - 3	:	Plant Kingdom	23
Chapter - 4	:	Animal Kingdom	32

Unit - II

Chapter - 5	:	Morphology of Flowering Plants	42
Chapter - 6	:	Anatomy of Flowering Plants	52
Chapter - 7	:	Structural Organisation in Animals	63

Unit - III

Chapter - 8	:	Cell : The Unit of Life	72
Chapter - 9	:	Biomolecules	80
Chapter - 10	:	Cell Cycle and Cell Division	91

Unit - IV

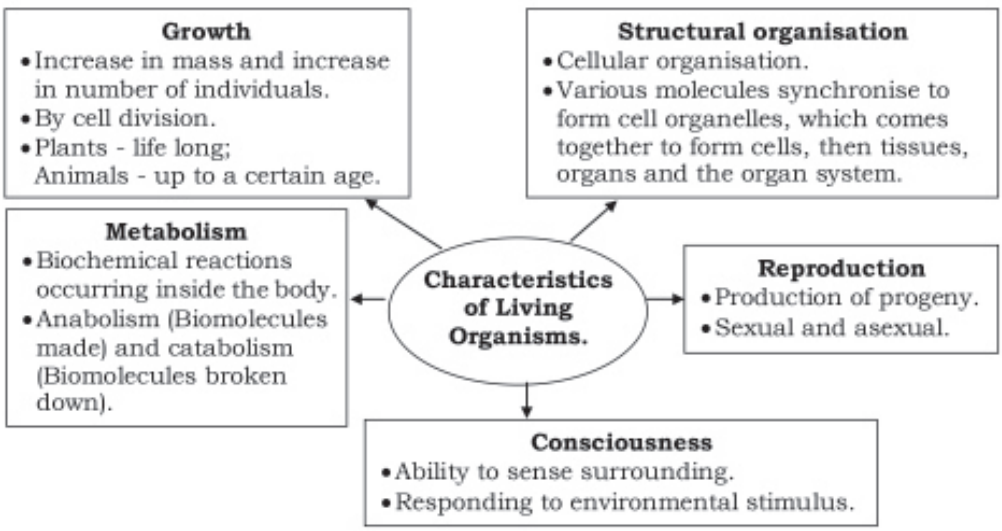
Chapter - 11	:	Transport in Plants	100
Chapter - 12	:	Mineral Nutrition	108
Chapter - 13	:	Photosynthesis in Higher Plants	115
Chapter - 14	:	Respiration in Plants	126
Chapter - 15	:	Plant Growth and Development	136

Unit - V

Chapter - 16	:	Digestion and Absorption	143
Chapter - 17	:	Breathing and Exchange of Gases	153
Chapter - 18	:	Body Fluids and Circulation	162
Chapter - 19	:	Excretory Products and Their Elimination	172
Chapter - 20	:	Locomotion and Movement	183
Chapter - 21	:	Neural Control and Coordination	194
Chapter - 22	:	Chemical Coordination and Integration	205

UNIT - I
CHAPTER - 1
THE LIVING WORLD

IMPORTANT CONCEPTS



- **Biodiversity** refers to the number and types of organism present on earth.
- Millions of plants and animals distributed all over the world are known by different local names in different areas. So, a standardised system of naming of all the living organism is needed. This process is called **nomenclature.**
- Correct description of organism is needed prior to nomenclature. This is called **identification.**
- Nomenclature is done on the basis of the principles and criteria which have been accepted by a number of scientists. For nomenclature of plants, these principle and criteria are given in **International Code for Botanical Nomenclature (ICBN)** and for that of animal, these are given in **International Code of Zoological Nomenclature (ICZN).**
- Biologists follow universally accepted principles to provide scientific names to known organisms. Each name has **two components** - the first one is **Generic name** and the second one is **specific epithet.** This system of providing a name with two components is called **Binomial nomenclature.** This naming system has been given by **Carolus Linnaeus.**
- **Universal roles of nomenclature are:-**

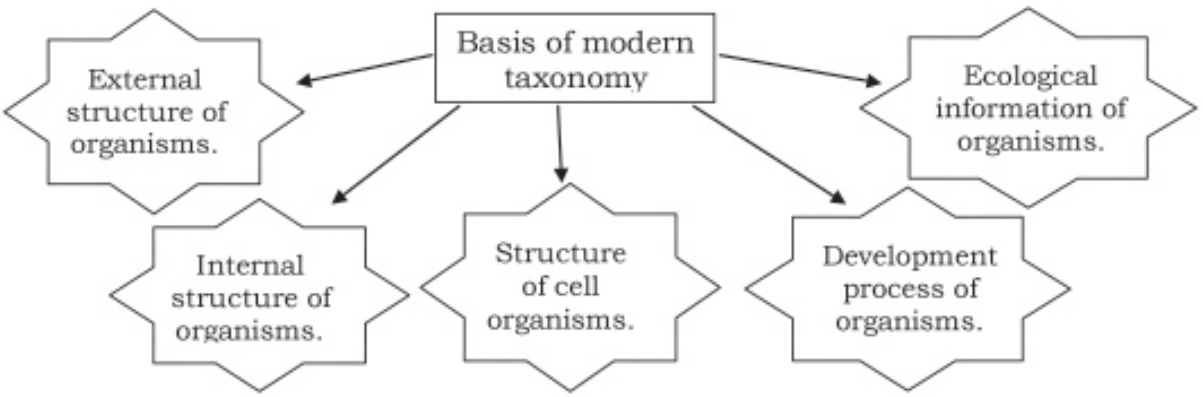
1) Biological names are generally in Latin and written in Italics.
2) The first word in a biological name represents the genus while the second component denotes the specific epithet.

3) Both words in a biological name, when handwritten, are separately underlined or printed in Italics to indicate their Latin origin.

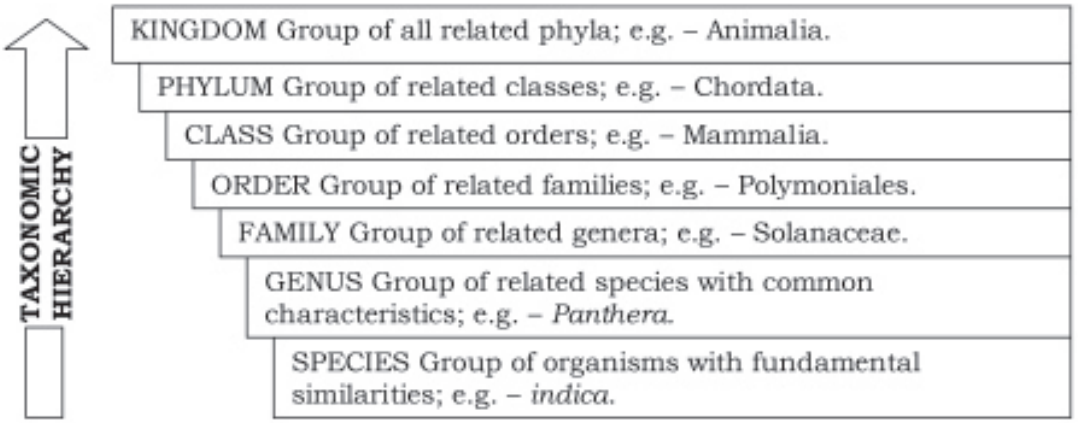
4) The first word denoting the genus starts with a capital letter while the specific epithet starts with a small letter.

   Name of the author (the scientist who has given scientific name to the organism for the first time) appears after the specific epithet, i.e., at the end of the biological name and is written in an abbreviated form for e.g., Mangifera indica Linn. is the scientific name of mango. Here, Mangifera is the genus, indica is the species and Linn. denotes Linnaeus (scientist who has given scientific name to Mango).

- It is necessary to classify the organisms into groups, since it is nearly impossible to study all the organisms separately. The process of grouping anything into convenient categories based on some easily observable characteristics is called **classification.** These categories or groups are called as **taxa** (Unit of classification).
- All living organisms can be classified into different taxa on the basis of their characteristics. This process of classification is called **taxonomy.**



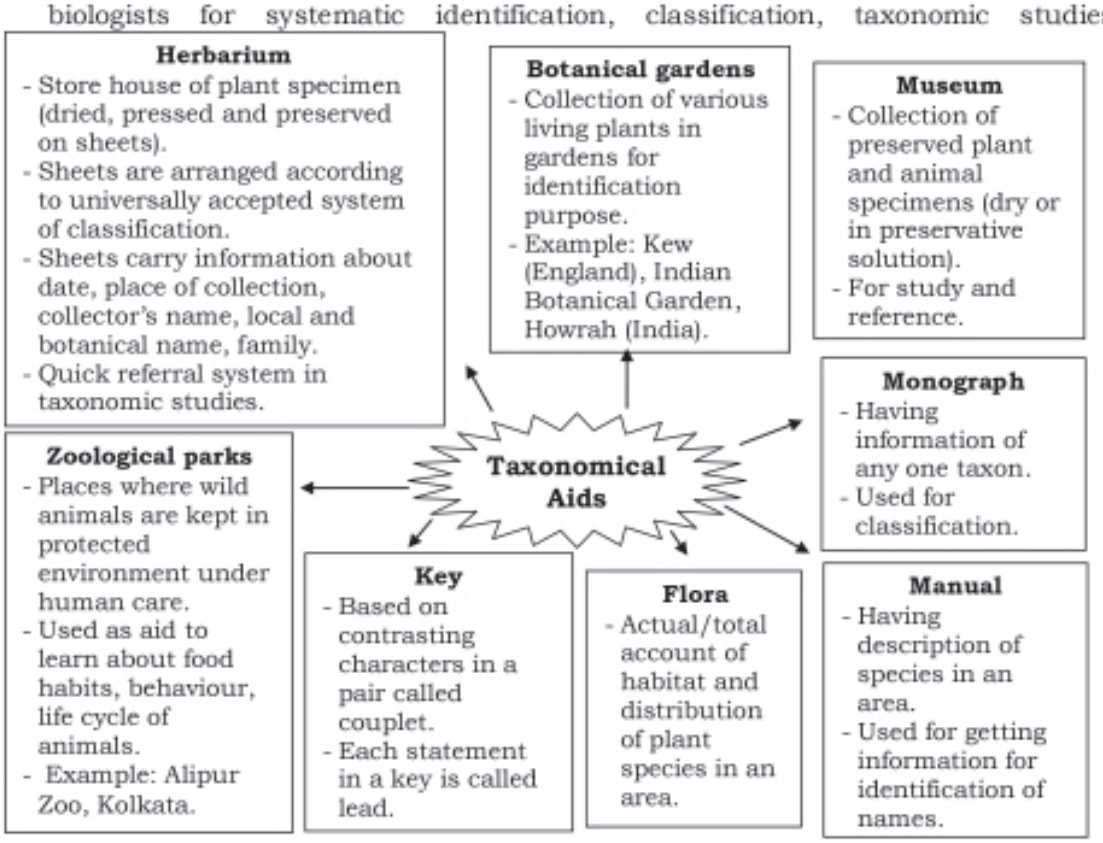
- Systematics is the branch of biology which deals with taxonomy along with evolutionary relationship between organisms. The word systematics have been derived from the Latin word **'systema'** which means systematic arrangement of organisms. Linnaeus used **Systema Naturae** as the title of his publication.
- Each taxon refers to a category, which is part of overall taxonomic arrangement, called as **taxonomic category.** Classification involves a hierarchy of steps in which each step represents a rank or category. All taxonomic category together constitutes the **taxonomic hierarchy.**
- Taxonomical studies of all known organisms have led to the development of common categories such as **kingdom, phylum or division** (for plants), **class, order, family, genus** and **species.** Species is the lowest category and kingdom is the highest category in the taxonomic hierarchy.



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	Dicotyledomae	Angiospermae
Wheat	*Triticum aestivum*	*Triticum*	Poaceae	Poales	Monocotyledonae	Angiospermae

Figure: 1.1 Organisms with their taxonomic categories.

- Taxonomic aids are the techniques, procedures and stored information used by biologists for systematic identification, classification, taxonomic studies of



QUESTION AND ANSWER

A) Objective Questions. [1 mark]

I) Choose the most appropriate option from the following:

1. Pick the odd one out

   (a) Herbarium (b) Nomenclature (c) Zoological parks (d) Botanical gardens

   Ans. (b) Nomenclature

2. The taxonomic unit 'Phylum' in the classification of animals is equivalent to which hierarchical level in classification of plants

   (a) Class (b) Order (c) Family (d) Division

   Ans. (d) Division

3. The principles and criteria for nomenclature of animals are given in _____

   a) Key b) ICZN c) ICBN d) None of the above

   Ans. (b) ICZN

4. As we go from kingdom to species, in a taxonomic hierarchy, the number of common characteristics _____

   a) Decreases b) Remains same c) Increases d) May increase or decrease

   Ans. (c) Increases

5. In classification of plants, the taxonomic category 'family' is indicated by _____

   a) Aceae b) Ales c) Ae d) Onaceae

   Ans. (a) Aceae

II) Fill in the blanks :

1. _____ is considered as the Father of Taxonomy.

   Ans. Linnaeus.

2. The preservative solution used to preserve specimens is _____

   Ans. 40% Formalin.

3. _____ is the unit of classification.

   Ans. Taxon.

4. Contrasting characters in a pair is called _____ in taxonomic key.

   Ans. Couplet.

5. _____ has the largest herbarium in India.

   Ans. Acharya Jagadish Chandra Bose Indian Botanical Garden.

III) State whether the following statements are true or false:

1) In binomial nomenclature system, only the generic name is written in italics.

Ans. False.

2) Metabolism involves both anabolism and catabolism.

Ans. True.

3) 'Ales' is the suffix used for the taxonomic category 'Order'.

Ans. True.

4) Reproduction is not a defining character of living organisms.

Ans. True.

5) Genus represents a group of closely related species of plants or animals.

Ans. True.

IV) Match the columns A with column B:

	Column - A	**Column - B**
	(a) Common name	(i) Arthrpoda
	(b) Genus	(ii) House fly
	(c) Family	(iii) Insecta
	(d) Class	(iv) Musca
	(e) Phylum	(v) Muscidae
	Ans. a - ii; b - iv; c - v; d - iii; e - i.	

B) Very short answer type questions.

1. What is biodiversity?

Ans. The number and types of organisms present on earth is called biodiversity.

2. What is identification?

Ans. Correct description of an organism prior to its nomenclature, is called identification.

3. What is taxonomy?

Ans. The process of classification of living organisms into different taxa on the basis of their characteristics, is called taxonomy.

4. What is systematics?

Ans. Systematic is the branch of biology dealing with taxonomy along with evolutionary relationship between organisms.

5. Who wrote the book systema nature?

Ans. Carolus Linnaeus.

C) Short Answer Type Questions. [2 marks]

1) An organism may have different names in different regions of the world. How can this problem be solved?

Ans. In order to solve this problem, biologists follow universally accepted principles to provide unique scientific names to known organisms, which is called as binomial nomenclature. A scientific name is usually composed of two terms, i.e., a genus name and a species name.

D) Short answer type questions. [3 marks]

1) A mountain increase in terms of mass, volume and size. Is this comparable to growth as seen in living organisms? Why?

Ans. No, the increase of mountain in terms of mass, volume and size cannot be compared to growth seen in living organisms.

Because, in the case of mountains, the growth occurs by accumulation of matter from outside. But, in case of growth of living organisms, growth happens because of accumulation of materials inside the cells of the organisms when cell division occurs.

DO IT YOURSELF

A) Short Answer Type Questions. [2 marks]

1. Expend the terms ICBN and ICZN. (1+1)
2. Name biologists other than Linnaeus who are known for their contribution to the field of plant taxonomy. (1)
3. Define taxon. Give a flow diagram from the lowest to highest category showing the taxonomic hierarchy. (1+1)
4. What is an endemic species? Give one example of an endemic species? (1+1)
5. Define the term species. Why does brinjal and potato to two different species although they belong to same genus? (1+1)

B) Short Answer Type Questions. [3 marks]

1. What is meant by living? Briefly describe any two common characteristic features of living organisms. (1+2)
2. What is taxonomy? Write any two basis of modern taxonomy. (1+2)
3. Who coined the term 'species'? Write the scientific name of the following:

   i) Potato ii) Lion iii) Paddy iv) Wheat (1+½+½+½+½)

4. Brassica campestris Linn.

a) What is the common name of this plant? (1)

b) Why is Linn written at the end of the species name? (1)

c) What does the first and second part of this scientific name denote? (1)

5. Define the following terms along with an example for each:

   a) Kingdom b) Class c) Family (1+1+1)

C) Long Answer Type Questions. [5 marks]

1. What is binomial nomenclature? Write the rules of binomial nomenclature. (1+4)
2. What is herbarium? How do you prepare your own herbarium sheets? What informations should be provided in a preserved plant material on the herbarium sheet for taxonomical studies? (1+3+1)
3. Write all the taxonomic categories of the following organisms:

   a) Mango b) Human being (2½+2½)

Teacher's Note

In "Do it yourself" section -

- Answer for Q.A.2 is G.Bentham and Joseph Dalton Hooker.
- While answering Q.A.3, mention the lowest and the highest category. See page no. -10 of text book (Fig: 1.1).
- Refer paragraph 1.2 of page no. - 6 to 7 of text book for answering Q.C.1.
- Refer paragraph 1.4.1 of page no. - 11 of text book for answering Q.C.2.
- Refer Table 1.1 of page no. - 11 of text book for answering Q.C.3.

UNIT - I

CHAPTER - 2

BIOLOGICAL CLASSIFICATION

IMPORTANT CONCEPTS

- Classification of organisms have been attempted by the human on the basis of different criteria.
- Earliest classification was done by **Aristotle** on the basis of morphological characteristics. He has divided plants into trees, shrubs and herbs, and animals into two groups -those which had red blood and those that did not.
- **Linnaeus** proposed the **two kingdom system of classification - Animal Kingdom** and **Plant kingdom.** But this system did not distinguish between the eukaryotes and prokaryotes, unicellular and multicellular organisms and photosynthetic (green algae) and non photosynthetic (fungi) organisms. And a large number of organisms did not fall into either category.
- In order to attain a proper classification system, classification systems for living organisms have undergone several changes over time. Different scientists have proposed different system of classification.
- **R. H. Whittaker** had proposed the **five kingdom system of classification** on the basis of certain criteria like **cell structure, body organisation, mode of nutrition, reproduction and phylogenetic relationships.**

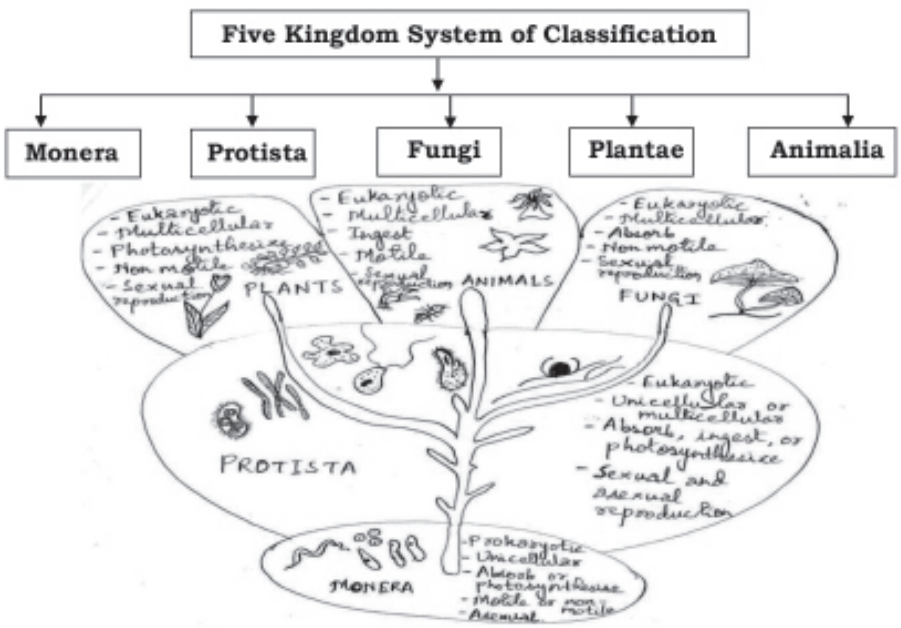


Figure: 2.1 Five kingdom classification and their characteristics.

♦ **Kingdom Monera.**

1) Bacteria are the most important members.
2) Prokaryotic organisms.
3) Can be present in extreme habitats like hot springs, deserts, snow and deep oceans.
4) Do not have true nucleus (Nucleus is not surrounded by nuclear membrane).
5) They can be autotrophs (photosynthetic or chemosynthetic) or heterotrophs.
6) They do have cell wall.
7) Respiration can be aerobic as well as anaerobic.
8) Movement occurs through flagella.
9) Exchange of nutrients or gases occurs by diffusion.

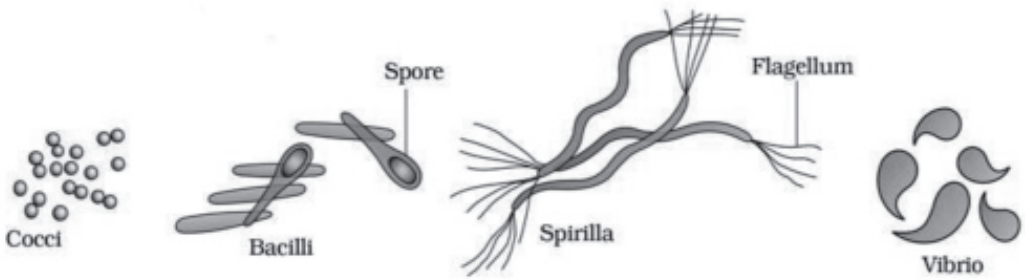


Figure: 2.2 Different shapes of bacteria.

MONERA

Archaebacteria
- Live in extremely salty areas (**Halophiles**), hot springs (**Thermophiles**).
- Different cell wall structure helps to live in extreme conditions.
- **Methanogens,** living in the gut of some ruminants, help in production of biogas from the animal's dung.

Eubacteria
- Referred as "**True bacteria**".
- Having rigid cell wall and flagellum (if motile).
- Includes **cyanobacteria** (blue-green algae). These have chlorophyll – a, hence can photosynthesize; these are filamentous and form colonies; are unicellular; some have specialised structure called **heterocyst** which fixes Nitrogen, e.g. - *Nostoc*.
- Reproduce asexually by fission or by spores.
- **Mycoplasma** do not have cell wall, are smallest living organisms known, and can survive in anaerobic condition.

♦ **Kingdom Protista**

1) Single called eukaryotes; mostly unicellular.
2) Mostly aquatic in nature (for e.g.- Algae server as primary producers in aquatic ecosystem).
3) Have true nucleus bounded by nuclear membrane.
4) Can move by cilia as well as flagella.
5) Respiration can be both aerobic and anaerobic.
6) Reproduction can be sexual as well as asexual.

PROTISTA

Chrysophytes	**Dinoflagellates**	**Euglenoids**	**Slime moulds**	**Protozoans**
- Diatoms and golden algae. - Lives in fresh water as well as marine water. - Mostly photosynthetic. - Cell wall is impregnated with **silica.** - Major producers in ocean. - Mostly unicellular. flagellates, but some are amoeboid. Example - *Prymnesium*	- Marine and photosynthetic organisms. - Can be of different colours like yellow, brown, red, blue, because of different pigments. - Cell wall is made up of **cellulose.** - Biflagellate. Example - *Gonyaulax catenella.*	- Freshwater organisms. - Surrounded by a protein rich layer called **pellicle.** - Have one short and one long flagella. - Can behave as both autotrophic organism. Example - *Euglena.*	- Saprophytic. - Form an aggregation called **plasmodium** under suitable conditions. - During unfavourable conditions, plasmodium breaks to form spores. - Possess true cell walls. - Extremely resistant to adverse conditions. Example - *Diachea*	- Heterotrophs. - Live as predators or parasites. - Four major types: Flagellated, Ciliated, Amoeboid, Sporozoans. Example - *Paramecium*

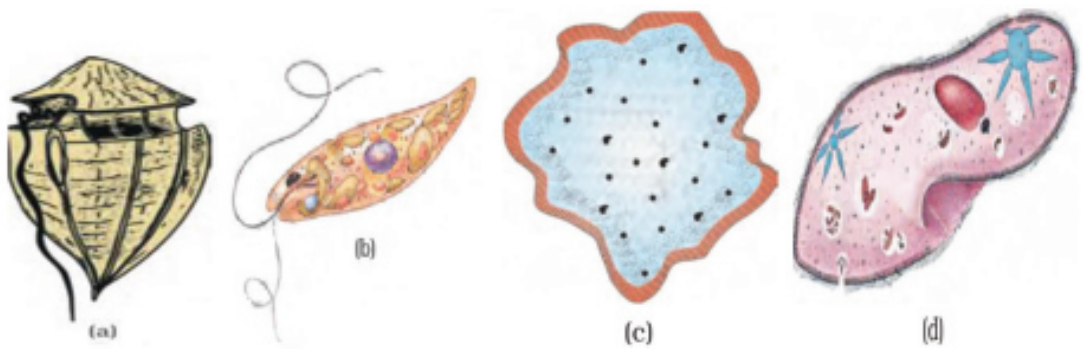


Figure: 2.3 Different types of protists.

♦ **Kingdom Fungi**

1) Most fungi are heterotrophic - **saprophytes** and **parasites.** They also live as **symbionts** in association with algae as lichens, and with roots of higher plants as **mycorrhiza.**

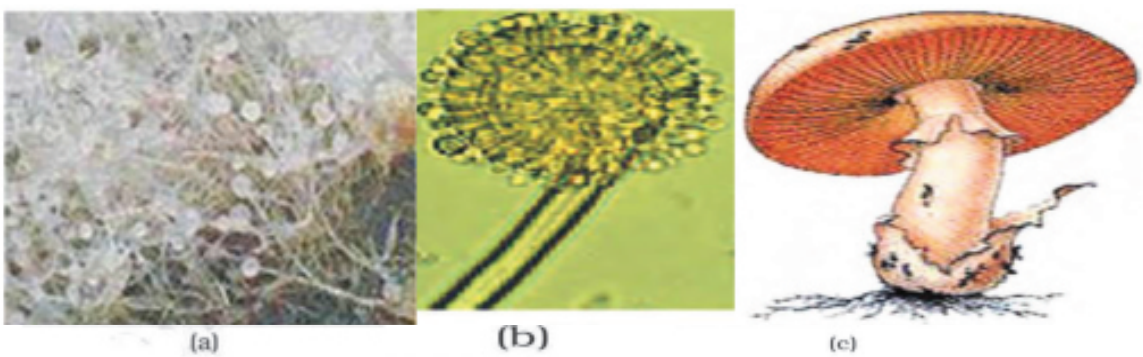
2) Reproduction occurs by vegetative means like **fragmentation, fission** and **budding.** Asexual reproductions occurs by spores called **conidia** or **sporangiospores** or **zoospores.**

3) The sexual cycle involves three steps : **Plasmogamy, karyogamy, meiosis.**

4) During sexual reproduction, two haploid hyphae fuses to form diploid 2n cells.

FUNGI

Phycomycetes	**Ascomycetes**	**Basidiomycetes**	**Deuteromycetes**
- Lower fungi. - Asexual reproduction by **zoospores** (motile) and **aplanospores** (non motile). - Spores produced inside sporangium. - Fusion of gametes to form **zygospore.** - Mycelium is **coenocytic** (multiple nucleus) and multicellular. Example – *Mucor, Albugo*, etc.	- Known as **sac fungi**. - Mostly multicellular. - Saprophytic as well as parasitic. - Asexual reproduction by **conidia**. - Sexual reproduction through **ascospores**. - Branched and septate mycelium. Example – *Penicillium, Aspergillus*	- Known as **club fungi.** - Vegetative reproduction through **fragmentation**. - Sex organs are absent. - **Plasmogamy** between two vegetative cells form **basidium**. - Basidium undergo karyogamy and meiosis to form four basidiospores. Example – *Agaricus, Ustilago*	- Known as imperfect fungi, since they do not have sexual reproduction. - Asexual reproduction by **conidia**. - Mycelium is septate and branched. Example – *Alternaria, Trichoderma.*



(a) (b) (c)

Figure: 2.4 Different types of fungi:
(a) Phycomycetes *(Mucor)* (b) Ascomycetes *(Aspergillus)* (c) Basidiomycetes *(Agaricus)*

♦ **Kingdom Plantae**

1) Includes all eukaryotic chlorophyll - containing organisms (plants).
2) Few members are partially heterotrophic like Pitcher plant (insectivorous), Cuscuta (parasite).
3) Chlorophyll is the main pigment.
4) Synthesis of food occurs by photosynthesis.
5) Reproduction can be sexual as well as asexual.
6) Exhibit a phenomenon called **alternation of generation.**

♦ **Kingdom Animals**

1) Heterotrophic eukaryotic organisms.
2) Are multicellular with variable size, and lack cell wall.
3) Having well developed locomotory organs, and elaborate sensory and neuromotor mechanism.
4) Possess holozoic mode of nutrition.
5) Respiration occurs by gills, skin and lungs.
6) Sexual reproduction takes place by copulation of male and female followed by embryonic development.

♦ **Viruses**

1) Acellular structures.
2) Consists of **nucleic acid (RNA or DNA)** that remains surrounded by a protein coat.
3) Having an inert **crystalline structure outside** the **living cell,** and can **grow and multiply only when inside a living cell.**
4) Causes disease like AIDS, polio, influenza, etc. to the hosts.

♦ **Viroids**

1) Smallest known structure that is capable of causing infection in the hosts.
2) Consists **only nucleic acid without any protein coat.**

♦ **Prions**

1) A type of protein that causes disease in animals by triggering healthy proteins in brain to fold abnormally.

♦ **Lichens**

1) **Symbiotic association of algae and fungi.**
2) The algal partner being autotrophic synthesizes and provides food to the fungi, and the fungal parts provide shelter, minerals and water to the algae to produce food.

** There is no mention of acellular organisms like viruses, prions, viroids, lichens in the five kingdom classification system of Whittaker.

QUESTION AND ANSWER

A) Objective Questions. **[1 mark]**

I) Chose the most appropriate option from the following :

1. The five kingdom classification system of organisms was proposed by -

   (a) R.H. Whittaker (b) Virchow (c) Linnaeus (d) Aristotle

   Ans. (a) R.H. Whittaker

2. A dikaryon is formed when -

a) The cytoplasm does not fuse.

b) Meiosis gets arrested.

c) The two haploid cells do not fuse immediately.

d) Both options (b) and (c) are correct.

   Ans. (c) The two haploid cells do not fuse immediately.

3. All eukaryotic unicellular organisms belong to _____

   a) Fungi b) Protista c) Monera d) Bacteria

   Ans. (b) Protista

4. Choose the correct sequence of events with respect to sexual cycle in fungus ___

a) Meiosis, karyogamy and plasmogamy.

b) Karyogamy, plasmogamy and meiosis.

c) Meiosis, plasmogamy and karyogamy.

d) Plasmogamy, karyogamy and meiosis.

   Ans. (d) Plasmogamy, karyogamy and eiosis.

5. Which of the following statements are true about slime moulds?

i) Possess true cell wall.

ii) Non resistant to adverse conditions.

iii) Form an aggregation called plasmodium.

a) Statements (i) and (ii) are correct.

b) Statements (ii) and (iii) are correct.

c) Statements (i) and (iii) are correct.

d) All three statements (i), (ii) and (iii) are correct.

   Ans. (c) Statements (i) and (iii) are correct.

II) Fill in the blanks :

1. Coccus are _____ shaped bacteria.

   Ans. Spherical.

2. The eubacteria which do not have cell wall is called _____

   Ans. Mycoplasma.

3. Fungi live in association with the roots of higher plants as _____

   Ans. Mycorrhiza.

4. Fusion of gametes in phycomycetes forms _____

   Ans. Zygospore.

5. Earliest classification of organisms was done by _____

   Ans. Aristotle.

III) Match column A with column B:

Column A	Column B
a) Hot springs	i. Chrysophytes
b) Diatoms	ii. Motile
c) Pellicle	iii. Thermophiles
d) Zoospores	iv. Nonmotile
e) Aplanospores	v. Euglenoids

Ans. i- c; ii- a; iii- e; iv- b; v- d.

IV) State whether the following statements are true or false:

1) The fungal component in a lichen is called phycobiont.

   Ans. False.

2) Protein coat is present in virus, but absent in viroid.

   Ans. True.

3) Respiration in members of kingdom Monera can be both aerobic and anaerobic.

   Ans. True.

4) Eubacteria are referred to as "true bacteria".

   Ans. True.

5) Dinoflagellates are found in both marine and fresh water ecosystems.

   Ans. False.

B) Very short answer type questions. [1 mark]

1. What is lichen?

Ans. The association between fungi and algae is known as lichen.

2. Who had proposed *contagium vivum fluidum*?

   Ans. M.W. Beijerinek.

3. Why slime moulds are considered to be belonging to the protista, though they were included in the kingdom fungi?

   Ans. Slime moulds have been considered to be belonging to the kingdom protista, since they are multinucleated and have naked cytoplasm.

4. What are conidia?

   Ans. Conidia are the spores by means of which asexual reproduction occurs in fungi.

5. Why does polluted water usually have abundance of Nostoc and Oscillatoria?

   Ans. Polluted water usually have abundance of Nostoc and Oscillatoria, since they get plenty of nutrients in polluted water.

C) Short Answer Type Questions. [2 marks]

1) What do you mean by halophiles? How can they live in extreme conditions? (1+1)

   Ans. Halophiles are the archaebacteria which can live in extremely salty areas. Their different cell wall structure helps them to live in extreme conditions.

2) Chemosynthetic bacteria are autotrophic. Explain. (2)

   Ans. Chemosynthetic bacteria are autotrophic because of the following reasons -

i) They can synthesize their own food.

ii) They use chemicals as the source of energy during chemosynthesis.

D) Short answer type question. [3 marks]

1) How is five kingdom classification system advantageous over two kingdom system of classification? (3)

   Ans. Five kingdom classification system has been advantageous over two kingdom system of classification because of the following reasons -

i) In two kingdom system, many unrelated organisms were kept under the same kingdom.

ii) The two kingdom system did not distinguish between the eukaryotes and prokaryotes, unicellular and multicellular organisms, photosynthetic and non photosynthetic organisms.

iii) This anomaly has been removed after the introduction of five kingdom classification.

   For example, bacteria were kept under plant kingdom previously. But, now bacteria have been included under a separate kingdom since many bacteria are heterotrophic.

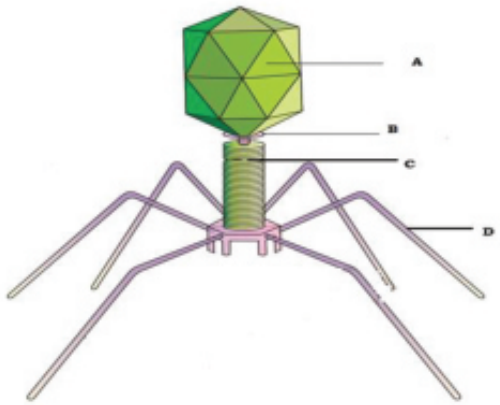
DO IT YOURSELF

A) Short Answer Type Questions. [2 marks]

1. Why are viruses called as obligate parasite? (2)
2. Write two characteristic features of the kingdom Monera. (2)
3. What are methanogens? Write their importance. (1+1)
4. What is heterocyst? Name an organism which bears heterocyst? (1+1)
5. Who are known as imperfect fungi? Comment on the type of mycelium which they bear. (1+1)

B) Short Answer Type Questions. [3 marks]

1. Label A, B, C, D, in the



Name this organism. To which group of organisms does this belong? (½+½+½+½+½+½)

2. What is alternation of generation? Mention two characteristic features of the kingdom showing alternation of generation. (1+2)
3. Differentiate between phycomycetes and ascomycetes. (3)
4. Differentiate between basidiomycetes and deuteromycetes. (3)
5. What is 'diatomaceous earth'? Write its importance. (1+2)

C) Long Answer Type Questions. [5 marks]

1. Unicellular prokaryotes are unique feature of which kingdom? Differentiate between archaebacteria and eubacteria. Why are cyanobacteria included in kingdom monera, but not in protista? (1+3+1)
2. What do you mean by dikaryophase of fungus? Explain the steps of sexual reproduction in fungus. Give an example of basidiomycetes. (1+3+1)

Teacher's Note

In "Do it yourself" section -

- Study the classification of organisms with the help of flow diagrams.
- Compare the features of different kingdom for better understanding.
- Don't forget to give examples, if you are asked to write the characteristic features of any kingdom.

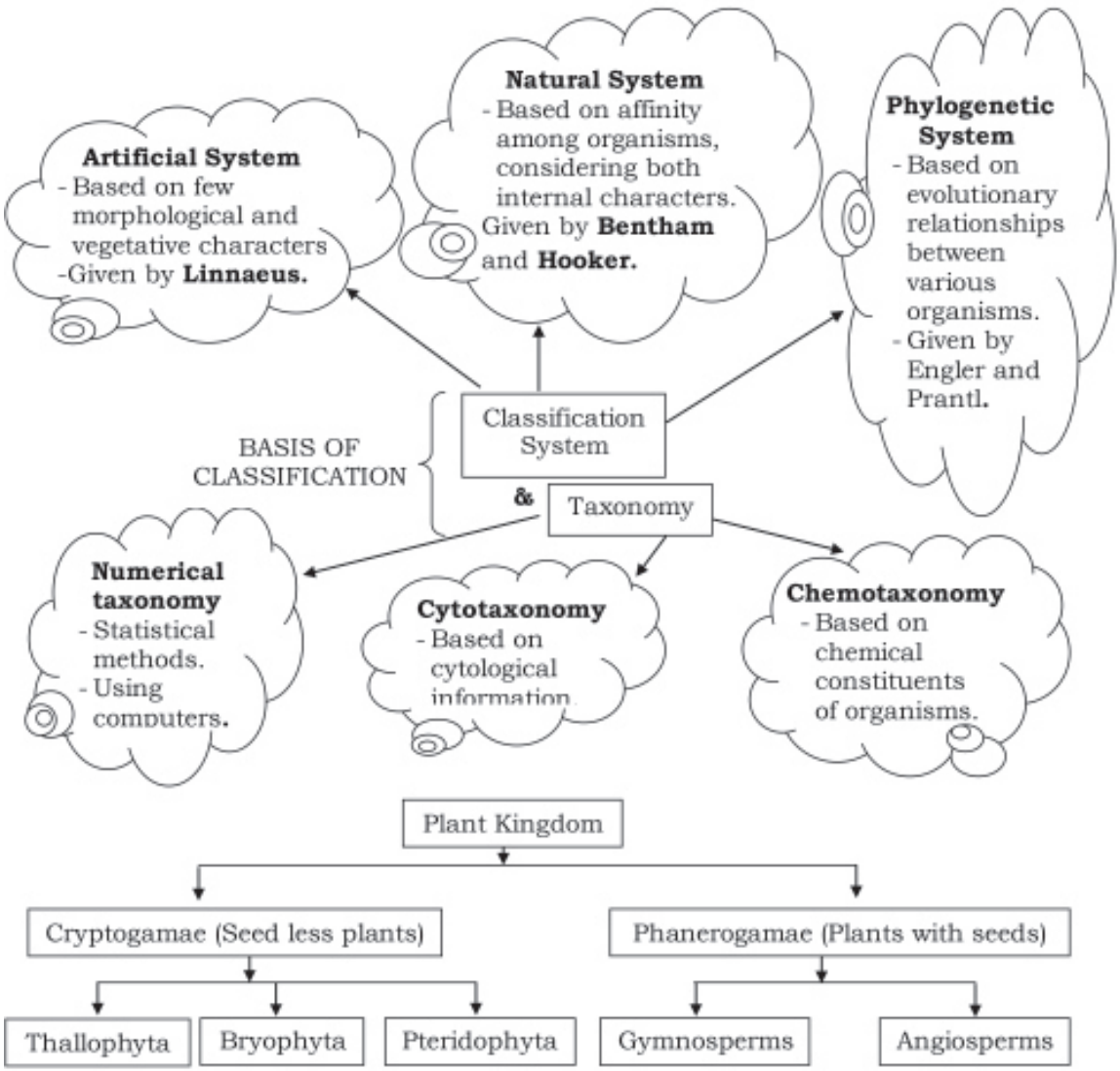
UNIT - I

CHAPTER - 3

PLANT KINGDOM

IMPORTANT CONCEPTS

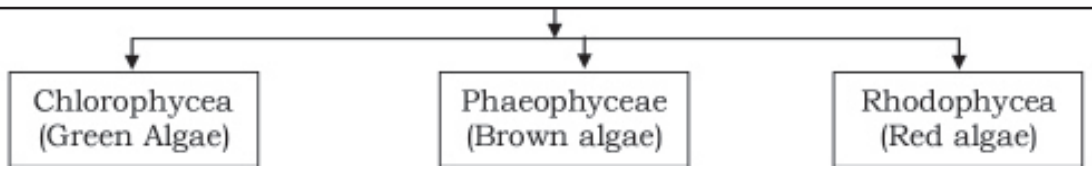
- Plant kingdom has been divided into **Algae, Bryophytes, Pteridophytes, Gymnoperms** and **Angiosperms.**
- Many classification systems like artificial system of classification, natural classification system, phylogenetic system have been used since the time of Aristotle. At present, phylogenetic classification system is acceptable.



♦ **Thallophytes -** Algae are the thallophytes.

Algae

* Chlorophyll bearing; * Simple; Thalloid; * Autotrophic; * Both fresh water and marine; * Occur in variety of habitats; * Colonial (Volvox), filamentous (Ulothrix); *Reproduction is vegetative (fragmentation), asexual reproduction by spores (zoospores), sexual reproduction by fusion of two gametes (Isogamous in Spirogya, anisogamous in Chlamydomonous, Oogamous in Volvox.



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

Table : 3.1 Division of algae and their main characteristics.

** Refer Table : 3.1 of page - 31 of textbook for better understanding of the structure of different algae.

♦ **Economic and ecological importance of algae.**

1) They increase level of dissolved oxygen in their immediate environment.
2) They fix atleast half of the total carbon dioxide on earth.
3) Many algal species like Porphyra, Laminaria, etc are used as food.
4) Chlorella (rich in proteins) is used as food supplements by travellers, even by space travellers.
5) Commercially important hydrocolloids like **algin** and **carrageenan** are produced by brown algae and red algae respectively.
6) **Agar,** obtained from Gelidium and Gracilaria are used commercially to grow microorganisms and in preparation of jelly and ice-creams.

Bryophytes

* Grow in damp and shady habitats, during rainy reasons; * More differentiated than algae, but lack true roots, stems or leaves; * Possess stem-like, leaf-like, root like structures; * Thallus like erect body attached to substratum by **rhizoids**; ***** Can live in soil but depends on water for sexual reproduction; hence called as **amphibians of the plant kingdom**; * Main plant body is **haploid**; *** Gametophyte**; ***** Male sex organ is **antheridium** and female sex organ is **archaegonium**; *Zygote produce **sporophyte**, which remains attached to photosynthetic gametophyte; * Some cells of sporophyte undergo **meiosis** to produce **haploid spores,** which germinate to produce gametophyte.

Liverworts

-Dorsiventral thalloid plant body. Example –*Marchantia.*
-Asexual reproduction by fragmentation or **gemmae** (specialised structure).
-Male and female sex organs produced on same or different thalli.
- Spore is differentiated to foot, setae, capsule.
-Spore (formed by meiosis) germinate to form free-living gametophytes.

Mosses

- Gametophyte (Pre dominant stage of life cycle) consists of **protonema** (first stage) and **leafy stage** (second stage). Example *Funaria.*
-Vegetative reproduction by fragmentation and budding.
- Male sex organ (**Antheridia**) and female sex organ **(Archaegonia).**
-Sporphyte more ellaborate than liverworts.

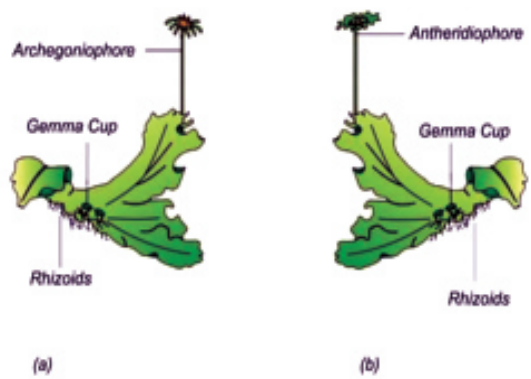


Figure: 3.1 (a) Female thallus of a liverwort-Marchantia (b) Male thallus of a liverwort-Marchantia.

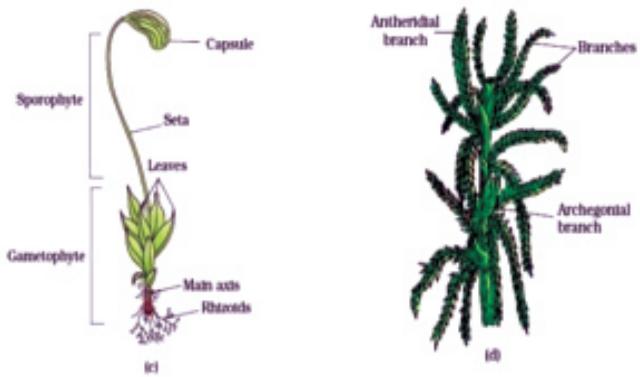


Figure: 3.2 (a) Gametophyte and sporophyte of Funaria (b) Gametophyte of Sphagnum.

- **Pteridophytes.**

- First terrestrial plants to possess vascular tissues (xylem and phloem).
- Mostly found in cool, damp and shady places; some may grow in sandy-soil as well.

- **Main plant body is sporophytic -** differentiated into true root, stem and leaves.
- Sporophytes bear **sporangia,** subtended by **sporophylls.** In some pteridophytes, sporophylls may form **strobili** or **cones** (e.g.- Selaginella, Equisetum).
- Sporangia produces **spores** in **spore mother cells** by meiosis. Spores germinate to produce **prothallus** (multicellular thalloid).
- Most of the pteridophytes produce spores of similar type **(homosporous).** But, in Selaginella and Salvinia, spores are of two types **(heterosporous)- megaspore** (large) producing **female gametophyte** and **microspore** (small) producing male gametophyte.
- The development of zygote into young embryos take place within the female gametophyte. This event is a **precursor to the seed habit.**

Psilopsida (e.g.-*Psilotum*)	**Pteridophyte Classes**	Lycopsida (e.g.-*Selaginella*)
Sphenopsida (e.g.-*Equisetum*)		Pteropsida (e.g.-*Pteris*)

** Refer figure 3.3 of page no.- 37 of textbook to get better understanding of the structure of different pteridophytes.

♦ **Gymnosperms**

- Ovules are not enclosed inside the ovary, hence remain exposed before and after fertilisation **(naked seeds).**
- They are perennial and woody, forming either bushes or trees.
- Stem may be branched or unbranched; taproot system; simple or compound leaves.
- They are **heterosporous,** producing **haploid microspore and megaspore in male and female strobili** respectively.
- Male and female gametophytes do not have independent free - living existence. Pollination occurs through air and zygote develops into embryo and ovule develops into seeds.

  Example - Cycas, Pinus, Ginkgo, etc.

** Refer figure 3.4 of page no. - 39 of textbook to get better understanding of the structure of different pteridophytes.

♦ **Angiosperms**

- Pollen grains and ovules are developed into specialised structure called **flower;** seeds are enclosed inside the **fruits.**
- Size varies from nearly microscopic Wolfia (0.1cm) to tall tree Eucalyptus (more than 100m).
- They are divided into two classes - **dicotyledons** and **monocotyledons.**

- The male sex organ in a flower is the **stamen,** which contains **pollen grain.** Stamen consists of a filament with an another at the tip. Within the anther, **pollen mother cell** divides by **meiosis** to produce **microspores** which matures to form **pollen grains.**
- The female sex organ in a flower is the pistil. Pistil consists of an ovary enclosing one or many ovules. Each ovule has **megaspore mother cell** which divides by **meiosis** to form **four haploid megaspores.** Three of them degenerate and one has a **3-celled egg apparatus - 1 egg cell, 2 synergids, 3 antipodal cells and 2 polar nuclei.** The polar nuclei eventually fuses to form a **diploid secondary nucleus.**
- Each pollen grain produces two male gametes - one gamete fuses with egg cell to form embryo **(Syngamy),** other gametes fuse with two polar nuclei to form endosperms **(triple fusion).** Since fertilisation takes place twice, it is called **double fertilisation.**

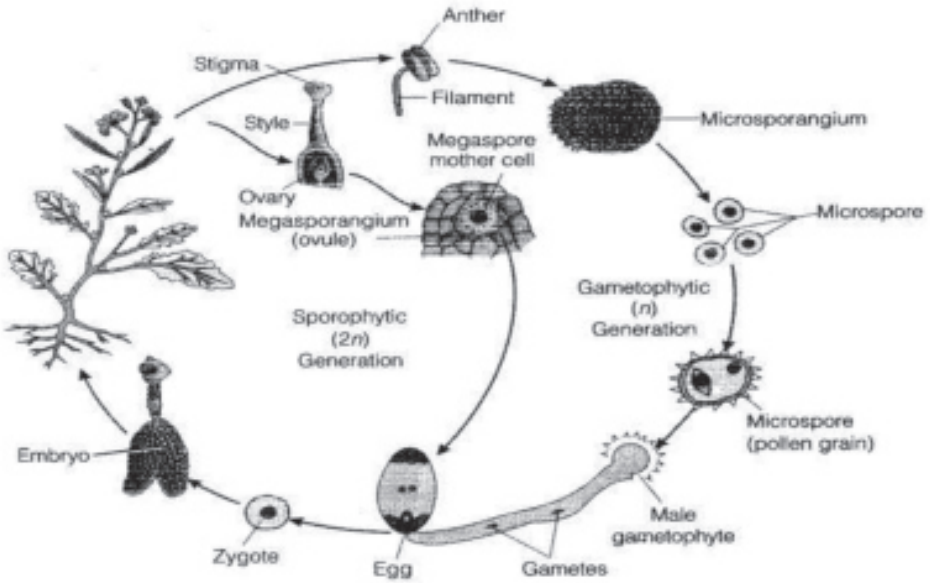


Figure : 3.3 Life cycle of an angiosperm.

** Refer figure 3.5 of page no. - 40 of textbook to get better understanding of different angiosperms.

- During lifecycle of any sexually reproducing plant, there is an **alternation of generations** between gamete producing haploid gametophyte and spore producing diploid sporophyte.
- Different plant groups complete their life cycle in different patterns -

1) **Haplontic - Sporophytic generation** is represented by only **one-celled zygote.** Meiosis in zygote results into haploid spores to divide mitotically and form gametophytes, which is the d**ominant vegetative phase.** Example - Volvox, Spirogyra, etc.
2) **Diplontic - Diploid sporophyte is dominant and independent,** photosynthetic plants. Single to few celled haploid gametophyte represents the gametophytic phase. Example - Fucus.
3) **Haplo-diplontic -** Both phases are multicellular and exhibit an **intermediate condition.** It is found in **bryophytes** and **pteridophytes.** Example - Fern.

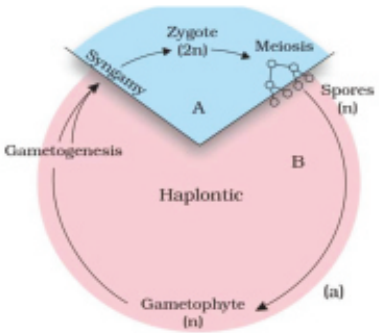


Figure: 3.4 Haplontic life cycle.

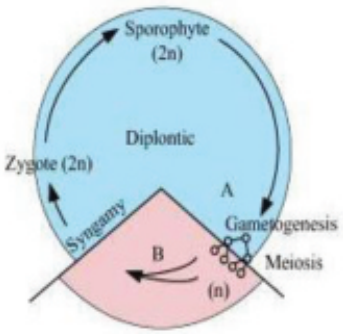


Figure: 3.5 Diplontic life cycle.

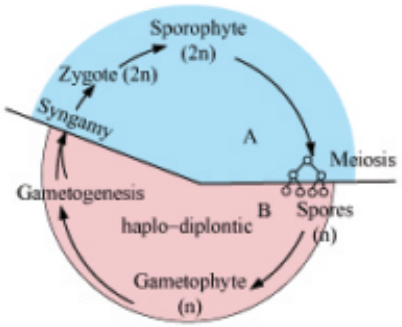


Figure: 3.6 Haplo-diplontic life cycle.

QUESTION AND ANSWER

A) Objective Questions. **[1 mark]**

I) Chose the most appropriate option from the following :

1. Fusion of two gametes which are dissimilar in size is called as -

   (a) Oogamy (b) Anisogamy (c) Zoogamy (d) Isogamy

   Ans. (b) Anisogamy

2. Which statement(s) correctly describes the gymnosperms -

i) Plants are diploid

ii) Plants are well adapted to extreme conditions.

iii) They bear compact structures called cones.

a) All three statements (i), (ii), (iii) are correct

b) Only statement (i) and (ii) are correct

c) Only statement (iii) is correct

d) Only statement (i) is correct.

   Ans. (a) All the three statements (i), (ii), (iii) are correct.

3. The embryo sac of an Angiosperm is made up of -

   a) 7 cells and 7 nuclei b) 8 cells and 7 nuclei

   c) 7 cells and 8 nuclei d) 8 cells and 9 nuclei.

   Ans. (c) 7 cells and 8 nuclei.

4. Holdfast, stipe and front constitutes the plant body in case of -

   a) Chlorophyceae b) Rhodophyceae

   c) Pteridophyceae d) Phaeophyceae.

Ans. (d) Phaeophyceae.

5. The life cycle observed in bryophytes is -

   a) Haplodiplontic b) Diplontic c) Haplontic d) Both (a) and (b) are correct.

   Ans. (a) Haplodiplontic.

II) Fill in the blanks:

1. Protonema is found in _____

   Ans. Mosses.

2. The giant Redwood tree is a/an _____

   Ans. Gymnosperm.

3. The female sex organ in bryophytes is called _____

   Ans. Archegonium.

4. Rhizoids are found in _____

   Ans. Bryophytes.

5. At present _____ system of classification is most acceptable.

   Ans. Phylogenetic.

III) State whether the following statements are true or false:

1) Fusion of two motile gametes which are dissimilar in size is called isogamy.

   Ans. False.

2) Prothallus is a free living gametophyte formed in pteridophytes.

   Ans. True.

3) Diplontic life cycle is found in Fucus.

   Ans. True.

4) Microspores mature to form pollens.

   Ans. True.

5) In gymnosperms, seeds are enclosed within the fruits.

   Ans. False.

IV) Match the given column A with column B:

Column - A	Column - B
a) Chemotaxonomy	I. Computers
b) Artificial system of classification	II. Engler and Prantl
c) Phylogenetic	III. Bentham and Hooker
d) Numerical taxonomy	IV. Linnaeus
e) Natural system of classification	V. Chemical constituents
Ans. a) - V; b) - IV; c) - II; d) - I; e) - III.	

B) Very short answer type questions. **[1 marks]**

1. Who are called as amphibians of plant kingdom?

   Ans. Bryophytes.

2. Name a reserve food material found in Phaeophyceae.

   Ans. Mannitol.

3. What would be the chromosome number in Endosperm, if the diploid number of a flowering plant is 36.

   Ans. 54.

4. Which group of plants have been the first to bear vascular tissues in the course of evolution?

   Ans. Pteridophytes.

5. Which phase is dominant in the life cycle of an angiosperm?

   Ans. Sporophytic phase.

DO IT YOURSELF

A) Short Answer Type Questions. **[2 marks]**

1. Why are bryophytes called amphibians of plant kingdom? (2)
2. Why is Cycas called as 'living fossil'? (2)
3. Differentiate between cryptogamae and phanerogamae. (2)

B) Short Answer Type Questions. **[3 marks]**

1. Write a brief note on economic importance of algae. (3)
2. Draw the labelled diagram of the female thallus of Marchantia. (Drawing-1, Labelling-2)
3. Explain how the heterosporous pteridophytes show certain characteristics which is a precursor of seed habit in gymnosperm. (3)

C) Long Answer Type Questions. **[5 marks]**

1. Comment on the lifecycle of a fern prothallus. What is the nature of fern prothallus? (3+2)
2. Compare the gymnosperms and angiosperms on the basis of their male and female reproductive organs. Draw a labelled diagram of a mature embryo sac. (Diagram-1; Labelling-1)
3. What is double fertilisation? Draw the life cycle of an angiosperm. (2+3)
4. Briefly describe the haplontic and diplontic life cycle patterns in plants. (2½+2½)

Teacher's Note

- Study the characteristics of different plant groups by making short points for each group and comparing them in a tabular form.
- Diagram must be given while answering Q.C.4 in 'Do it Yourself' section see page - 42 of text book - Figure: 3.7 (a & b).
- Don't give any differentiating point other than reproductive organ of gymnosperms and angiosperms while answering Q.C.2. of 'Do it yourself' section.
- Hint for Q.C.1. of 'Do it Yourself' section: Fern shows haplo-diplontic life cycle; Prothallus represents the haploid gametophytic generation.

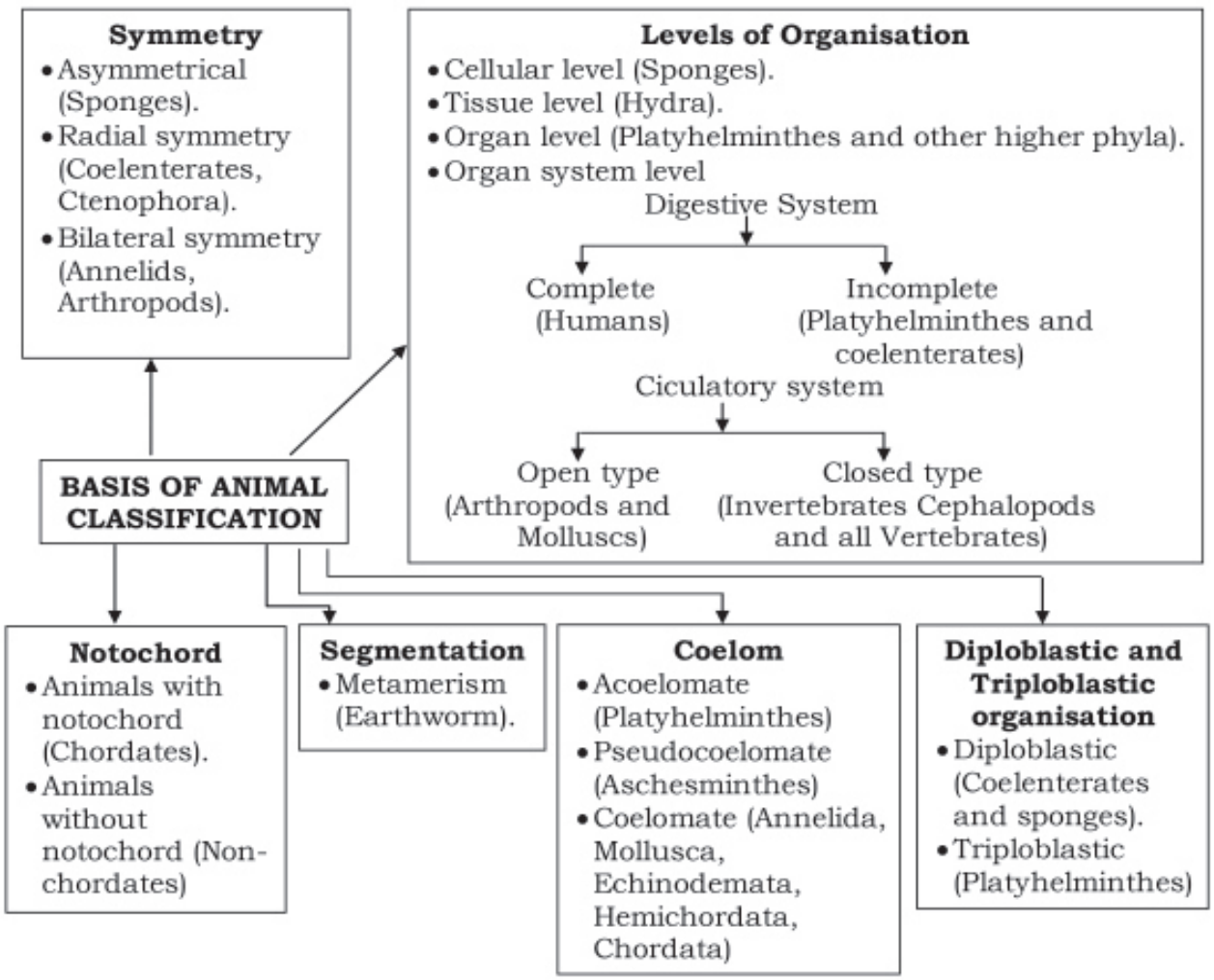
UNIT - I

CHAPTER - 4

ANIMAL KINGDOM

IMPORTANT CONCEPTS

- Fundamental features like arrangement of cells, body symmetry, nature of coelom, patterns of digestive, circulatory or reproductive system are common to various organisms. These features have been used as the basis of animal classification.



- **Incomplete digestive system** has one opening, while **complete digestive system** has two openings - mouth and anus.
- **Open circulatory system -** Blood is pumped out of the heart, and cells and tissues are directly bathed in it.

- **Closed circulatory system -** Blood is circulated through arteries, veins and capillaries.
- The animals in which cells are arranged in two embryonic layer **(external ectoderm** and **internal endoderm)** are called **diploblastic animals.**
- The animals in which developing embryo has a third germinal layer, **mesoderm** along with ectoderm and endoderm, are called as **triploblastic animals.**

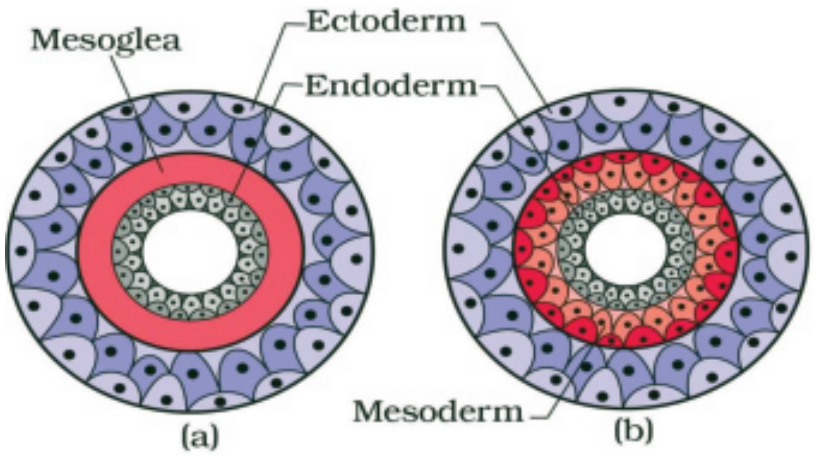


Figure: 4.1 T.S. of different germinal layers: (a) Diploblastic; (b) Triploblastic

- The body cavity which is lined by mesoderm is called **coelom;** the animals having true coelom are called **coelomate.**
- The body cavity is not lined by mesoderm, but scattered as pouches in between ectoderm and endoderm in some animals. They are called **pseudo coelomates.**
- The animals in which body cavity is absent are called as **acoelomate.**

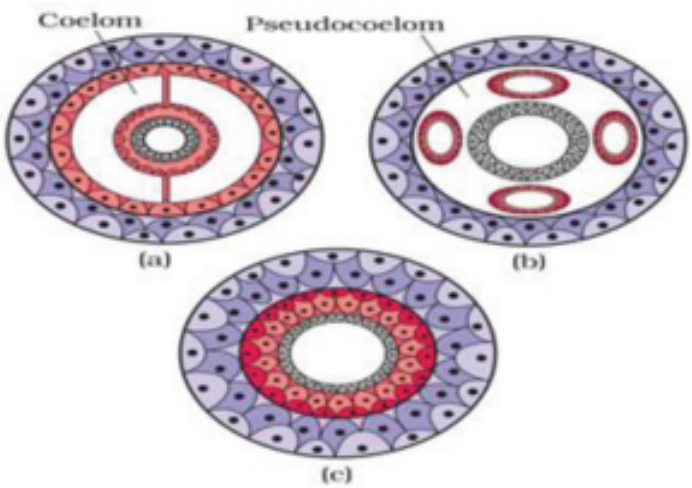


Figure: 4.2 T.S. of (a) Ceolomate; (b) Pseudocoelomate; (c) Acoelomate.

- **Bilateral symmetry -** Only one plane can divide the organism into two indentical left and right halves.

- **Asymmetrical -** The body of the organism cannot be divided into equal halves through median plane.
- **Radial symmetry -** Any plane passing through the central arise can divide the organism into identical halves.

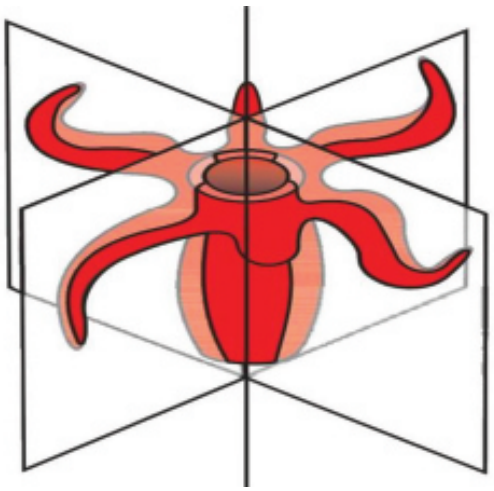


Figure: 4.3 Radial symmetry.

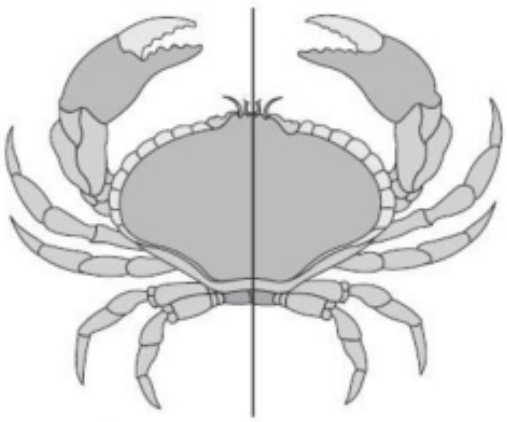


Figure 4.1 (b) Bilateral symmetry

Figure: 4.4 Bilateral symmetry.

- If the body of the organism is externally and internally divided into **segments** (metamers) with serial repetition of atleast some organs, then this phenomenon is called **metamerism** (metameric segmentation shown by body).
- Notochord is a rod- like structure formed during embryonic development on the dorsal side. It is derived from the mesoderm in **chordates.** It is absent in non-chordates.

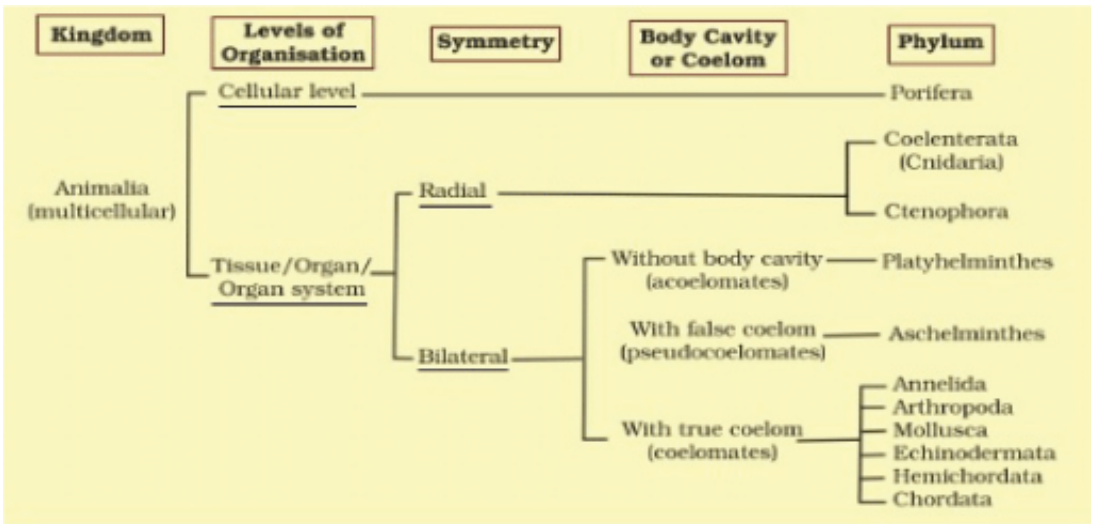


Figure: 4.5 Broad classification of kingdom Animals based on common fundamental basis.

- Based on the common fundamental features, the kingdom Animalia has been broadly classified into **11 phyla.** These are:

1) Porifera	4) Platyhelminthes	7) Arthropoda	10) Hemichordata
2) Coelenterata	5) Aschelminthes	8) Mollusca	11) Chordata
3) Ctenophora	6) Annelida	9) Echinodermata	

- **Phylum Porifera**
  - Members are commonly known as **sponges.**
  - Have water transport or canal system. Water enters through minute pores called **ostia** into central cavity **spongocoel,** form where it goes out through **osculum.**
  - Skeleton is made up of **spicules** or **spongin fibres.**
  - They are **hecmaphrodites.** Fertilisation is internal and development is direct. e.g - Spongilla.
- **Phylum Cnidaria**
  - Tissue level organisation, diploblastic, coelomate with single opening.
  - Show two types of body called **polyp** and **medusa.** e.g. - Hydra.
- **Phylum Ctenophora**
  - Known as **Comb Jellies** or **Sea Walnuts.**
  - **Bioluminescence** is present.
  - Body bears eight **ciliated comb plates** which help in locomotion.
  - Are **hermaphrodites.** Fertilisation is external and development is indirect. e.g. - Ctenoplana.
- **Phylum Platyhelminthes**
  - Common members are **flatworms.**
  - **Hooks and sucker** are present in parasitic forms. **Flame cells** help in osmoregulation.
  - Fertilisation is internal, development is indirect. e.g. - Planaria.
- **Phylum Aschelminthes**
  - **Round worm** are the common members.
  - Alimentary canal is complete with well-developed **pharynx**.
  - Are **dioecious** (Females are longer than male). e.g. - Ascaris.
- **Phylum Annelida**
  - Possesses lateral appendages **parapodia** for swimming. **Nephridia** helps in osmoregulation and excretion.
  - **Dioecious** (Nereis) or **monocious** (earthworm). e.g.- Hirunidaria.
- **Phylum Arthropoda**

- Includes **insects.**
- Body consists of **head, thorax** and **abdomen,** jointed appendages **(jointed feet).**
- Respiratory organs are **gills, book lungs** or **tracheal system** with **open circulatory system.**
- Excretion through **malpighain tubules.**
- Internal fertilisation, mostly **oviparous.** e.g. - Apis.

♦ **Phylum Mollusca**

- Body is divided into **head, foot** and **visceral hump;** unsegmented and covered with **calcareous shell.**
- Feather like gills are present between hump and mantle.
- Mouth contains rasping organ for feeding called **radula.** e.g.-Pila.

♦ **Phylum Echinodermata**

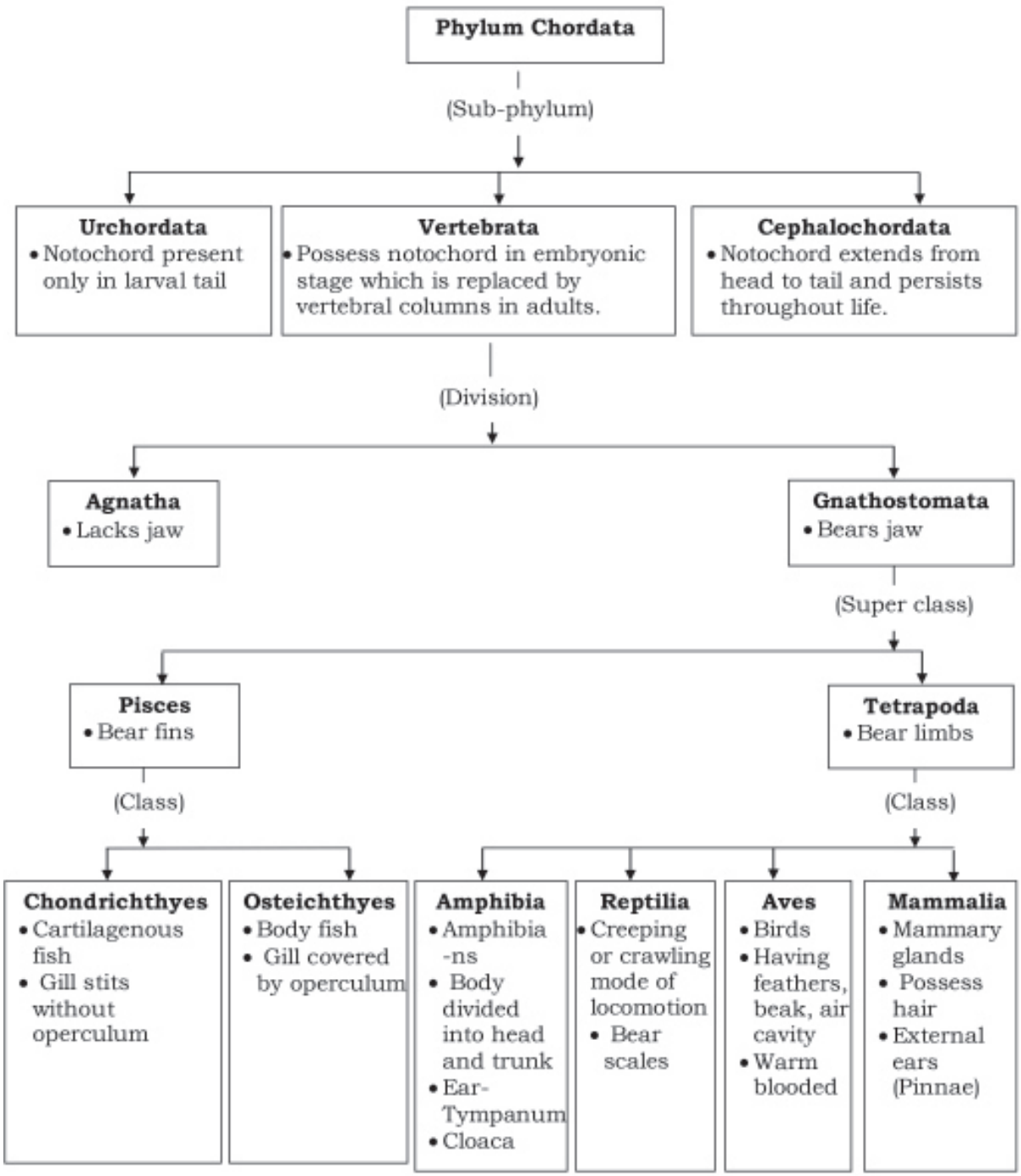
- Endoskeleton is made up of **calcareous ossicles.**
- Presence of **water vascular system** for locomotion, capture of food and respiration.
- Sexes are separate; fertilisation is external and development is indirect. e.g. - Asterias (Star fish).

♦ **Phylum Hemichordata**

- Worm like marine animals.
- Body is cylindrical, composed of anterior **proboscis,** a **collar** and a long **trunk.**
- Open circulatory system; respiration occurs by gills; proboscis gland is excretory organ.
- Separate sexes; external fertilisation and indirect development. e.g. - Balanoglossus.

♦ **Phylum Chordata**

- Presence of **notochord,** having **dorsal hollow nerve chord** and **paired pharyngeal gill slits.**
- **Closed circulatory system, ventral heart and post anal tail** are present. e.g. - Ascidia.


Phylum Chordata
(Sub-phylum)
Urchordata
• Notochord present only in larval tail
Vertebrata
• Possess notochord in embryonic stage which is replaced by vertebral columns in adults.
Cephalochordata
• Notochord extends from head to tail and persists throughout life.
(Division)
Agnatha
• Lacks jaw
Gnathostomata
• Bears jaw
(Super class)
Pisces
• Bear fins
Tetrapoda
• Bear limbs
(Class)
(Class)
Chondrichthyes
• Cartilagenous fish
• Gill stits without operculum
Osteichthyes
• Body fish
• Gill covered by operculum
Amphibia
• Amphibia -ns
• Body divided into head and trunk
• Ear- Tympanum
• Cloaca
Reptilia
• Creeping or crawling mode of locomotion
• Bear scales
Aves
• Birds
• Having feathers, beak, air cavity
• Warm blooded
Mammalia
• Mammary glands
• Possess hair
• External ears (Pinnae)

QUESTION AND ANSWER

A) Objective Questions. [1 mark]

I) Chose the most appropriate option from the following:

1. Which of the following cells can differentiate to perform different functions?
   (a) Nemotocytes (b) Interstitial cells (c) Choanocyes (d) Gastrodermal cells
   Ans. (b) Interstitial cells
2. Which of the following animals have a four chambered heart?
   (a) Mammals (b) Fishes (c) Reptiles (d) None of these
   Ans. (a) Mammals
3. Which one of the following is oviparous?
   a) Whale b) Elephant c) Platypus d) Python
   Ans. (c) Platypus
4. The animals in which body cavity is absent are called as -
   a) Pseudocoelomates b) Coelomates c) Pericoelomates d) Acoelomates
   Ans. (d) Acoelomates
5. Which of the following animals have non-glandular skin?
   a) Chameleon b) Frog c) Human d) Tiger
   Ans. (a) Chameleon

II) Fill in the blanks:

1. In Obelia, _____ is present between ectoderm and endoderm.
   Ans. Mesoglea.
2. Asterias exhibit _____ symmetry.
   Ans. Radial.
3. Animals with notochord are called as _____
   Ans. Chordates.
4. Arthropods posses _____ type circulatory system.
   Ans. Open type.
5. Incomplete digestive system has _____ opening(s).
   Ans. One.

III) State whether the following statements are true or false:

1) Body hair is an unique feature of amphibians.

Ans. False.

2) The body cavity which is lined by mesoderm is called coelom.

Ans. True.

3) Cnideria are known as comb jellies.

Ans. False.

4) Arthropoda is having parapodia.

Ans. False.

5) Porifera has water canal system.

Ans. True.

IV) Match the given columns:

Column - A	Column – B
(a) Echinodermata	(i) Muscular pharynx
(b) Aschelminthes	(ii) Metameres
(c) Annelida	(iii) Water-vascular system
(d) Arthropoda	(iv) Jointed appendages
(e) Ctenophora	(v) Visceral hump
(f) Mollusca	(vi) Comb plates
Ans. (a) - (iii); (b) - (i); (c) - (ii); (d) - (iv); (e) - (vi); (f) - (v).	

B) Very short answer type questions. [1 mark]

1. Which characteristic feature is a common feature between birds and mammals?

   Ans. Warm blooded.

2. Name the excretory organ present in cockroach.

   Ans. Malpighian tubules.

3. Name the phylum in which adults exhibit radial symmetry and larva exhibit bilateral symmetry.

   Ans. Echinodermata.

4. Which group of chordates possess sucking and circular mouth without jaws?

   Ans. Cyclostomata.

5. Give an example of an animal which have calcareous shell and radula.

   Ans. Pila.

C) Short Answer Type Questions. [2 marks]

1) What is the role of radula in molluscs?

   Ans. The radula helps the moluses to -

i) Scraping and scratching the food.

ii) Creating depressions in rock, which are used by these animals as their home.

D) Short answer type questions. **[3 marks]**

Differentiate between chondrichthyes and osteichthyes.

Ans. The following are the differences between chondrichthyes and osrichthyes:

Chondrichthyes	Osteichthyes
i) They have cartilaginous exoskeleton, hence they are called as cartilaginous fishes. ii) Their skin is covered with placoid scales. iii) Air bladder is absent in them. e.g. - *Scoliodon.*	a. They have bony skeleton, hence they are called as body bony fishes. b. Their skin is covered with cycloid scales. c. Air bladder is present in them. e.g. - *Rohu.*

DO IT YOURSELF

A) Short Answer Type Questions. **[2 marks]**

1. Mention two similarities between aves and mammals? (2)
2. Comment upon external features and habitat of amphibians. (2)
3. Mention two modifications in reptiles required for terrestrial mode of life. (2)
4. Write the importances of pneumatic bones and air sacs in aves. (2)
5. What is metamerism? Mention one animal which exhibits metamerism. (1+1)

B) Short Answer Type Questions. [3 marks]

1. Write three important function of feathers in birds. (3)
2. Write the technical terms for each of the following. (1+1+1)

a) Blood filled cavity in arthropods.

b) Stinging organ of jelly fishes.

c) Lateral appendages in annelids.

3. Write one example for the following: **(1+1+1)**

a) Cold blooded animal.

b) Dioecious animal.

c) Animal possessing dry and cornified skin.

4. Name the locomotory organs of each of the following animals:

a) Crocodile b) Octopus c) Ctenoplana (1+1+1)

5. Differentiate between urochordata and cephalochordata. (3)

C) Long Answer Type Questions. [5 marks]

1. What is medusa? Comment upon habital and external features of cnidaria. (1+1+3)
2. Differentiate between chordates and non-chordates. (5)
3. What is the relationship between germinal layers and the formation of body cavity in case of coelomates, psendocoelomates and acoelomates? Mention two important characteristics of phylum hemichordata. (3+2)
4. Mammals are most adapted among the vertebrates. Explain. (5)
5. Explain the levels of organisation used for classification of animals along with examples. (5)

Teacher's Note

- Refer figure - 4.5 to figure 4.24 of textbook for better identification of different phyla, sub-phyla and classes.
- In 'Do it yourself' section,
  - Give diagram while answering Q.C.3.
  - Answer Q.C.5 in points.

UNIT - II

CHAPTER - 5

MORPHOLOGY OF FLOWERING PLANTS

IMPORTANT CONCEPTS

- **Morphology** is the study of external parts of an organism, that deals with the study of form, structure, colour, size and relative position of various parts of organisms.
- All flowering plants have roots, stem, leaves, flower and fruits.
- The underground part of the flowering plants forms the **root system.**

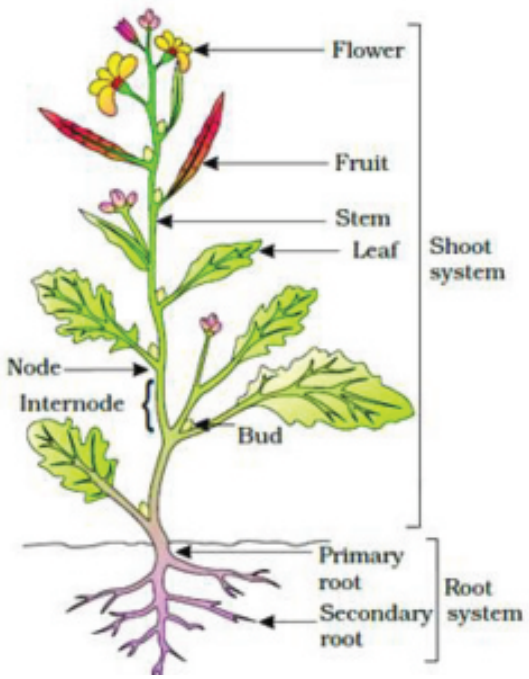
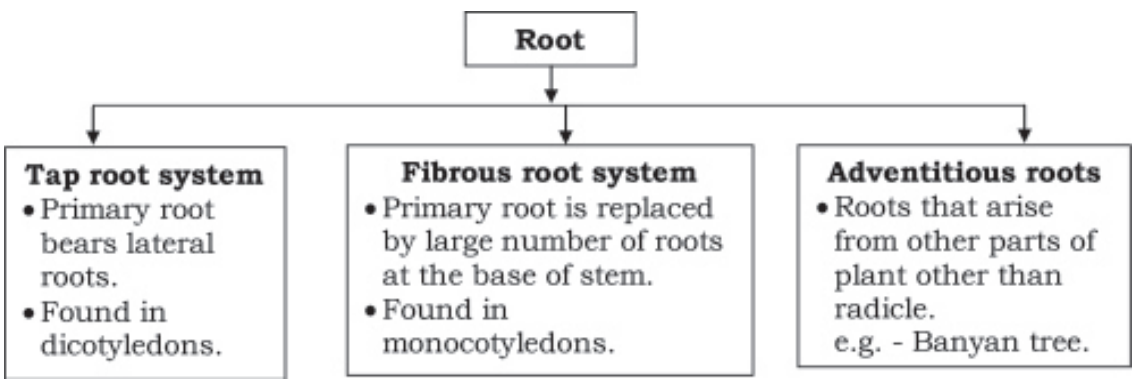


Figure: 5.1 Different parts of a flowering plant.



- The main function of roots are to provide proper anchorage to the plants and absorption of water and minerals from the soil and to store reserve food material.
- The root has different regions like the **root cap, region of meristematic activity, region of elongation, region of maturation.**
- Roots are modified for nitrogen fixation, aeration, support and storage.

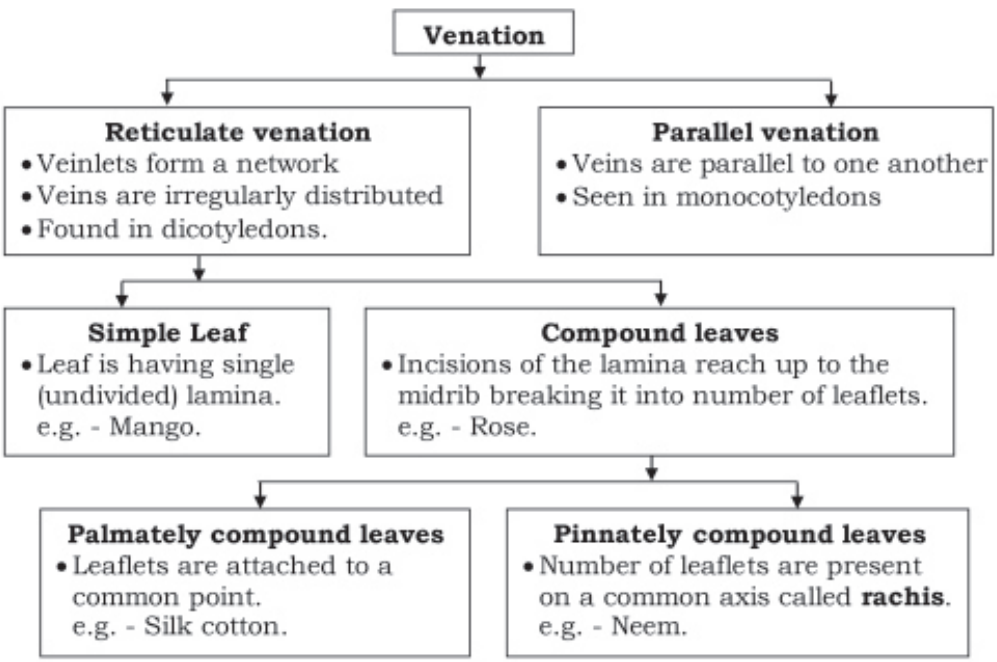
  Example - Tap root of **carrot** and adventitious roots of **sweet potato** gets swollen for storing food; prop roots of banyan tree gives support to the plant.

Refer Figure - 5.2, 5.3, 5.4, 5.5 of text book for better understanding of root and its modifications.

- The **stem** is the ascending part of the axis of the plant bearing leaves, flowers, branches and fruits. It develops from the plumule of the embryo of the germinating seed. It bears **nodes** and **internodes.**
- The stem shows various modifications for various purposes like storage (potato), climbing (tendril of pumpkin), protection (thorns of citrus) and flattens to bear more chlorophyll (Opuntia).

Refer Figure - 5.6 of text book for better understanding of modifications of stem.

- Leaf is a lateral, flattened structure borne on node of the stem and is specialised to perform photo-synthesis.
- A typical leaf consists of three parts - **leaf base, petiole** and **lamina.**
- Veins provide rigidity to the leaves and act as a channel for transport of water and minerals. The arrangement of vein and veinlets on the lamina is called **venation.**



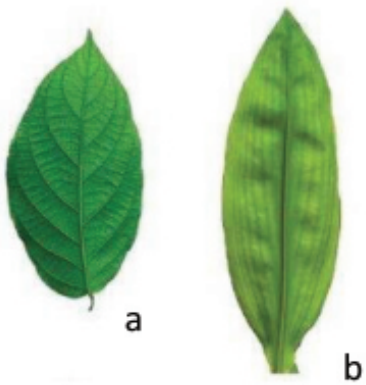


Figure : 5.2 (a) Reticulate venation; (b) Parallel venation.

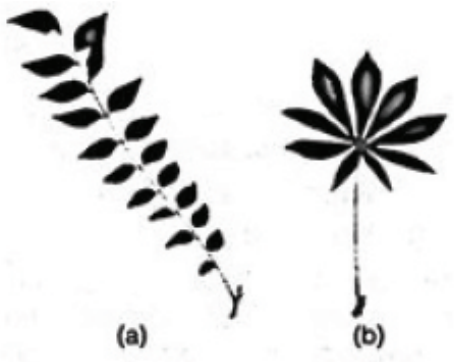


Figure : 5.3 (a) Pinnately compound leaf; (b) Palmately compound leaf.

- The pattern of arrangement of leaves on the stem or branch is called **phyllotaxy.** It is mainly of three types:

i) **Alternate type phyllotaxy** → Single leaf arises from each node. e.g. - Hibiscus.

ii) **Opposite type phyllotaxy** → A pair of leaves arise from each node opposite to each other. e.g. - Guava.

iii) **Whorled type phyllotaxy** → More than two leaves arise from a node to form a whorl. e.g.- Alstonia.

- Leaves are modified to perform various other functions like tendril for climbing (Pea plants) and spines for defense (Cactus).

Refer figure - 5.9 and 5.10 of page - 71 of textbook for better understanding.

- The arrangement of flowers on the floral axis is termed as inflorescence. Two main types of inflorescence are:

i) **Racemose -** Main axis continues to grow; flowers are borne laterally in an acropetal succession. e.g.- Radish.

ii) **Cymose -** Main axis terminates; flowers are borne in a basipetal succession. e.g.- Jasmine.

Figure : 5.4 Racemose inflorescence

Figure : 5.5 Cymose inflorescence

- Flower is the reproductive part of angiospermic plants.
- A typical flower has **four whorls** arranged on **thalamus.** These are calyx, corolla, androecium and gynoecium.
- The flower is called **bisexual** if it has both androecium and gynoecium; the flower is called **unisexual** if it has either androecium or gynoecium.
- The flower is called **actinomorphic** if it can be divided into two equal radial halves in any radius passing through the centre of symmetry of the flower. e.g. - Datura.
- The flower is called **zygomorphic** if it can be divided into two similar parts only in one vertical plane. e.g. - Pea.
- When **floral appendages** are in multiple of 3, 4 or 5, they are called as **trimerous, tetramerous** and **pentamerous** respectively.
- Flowers with bracts are called **bracteates** and without it are called **ebracteate.**

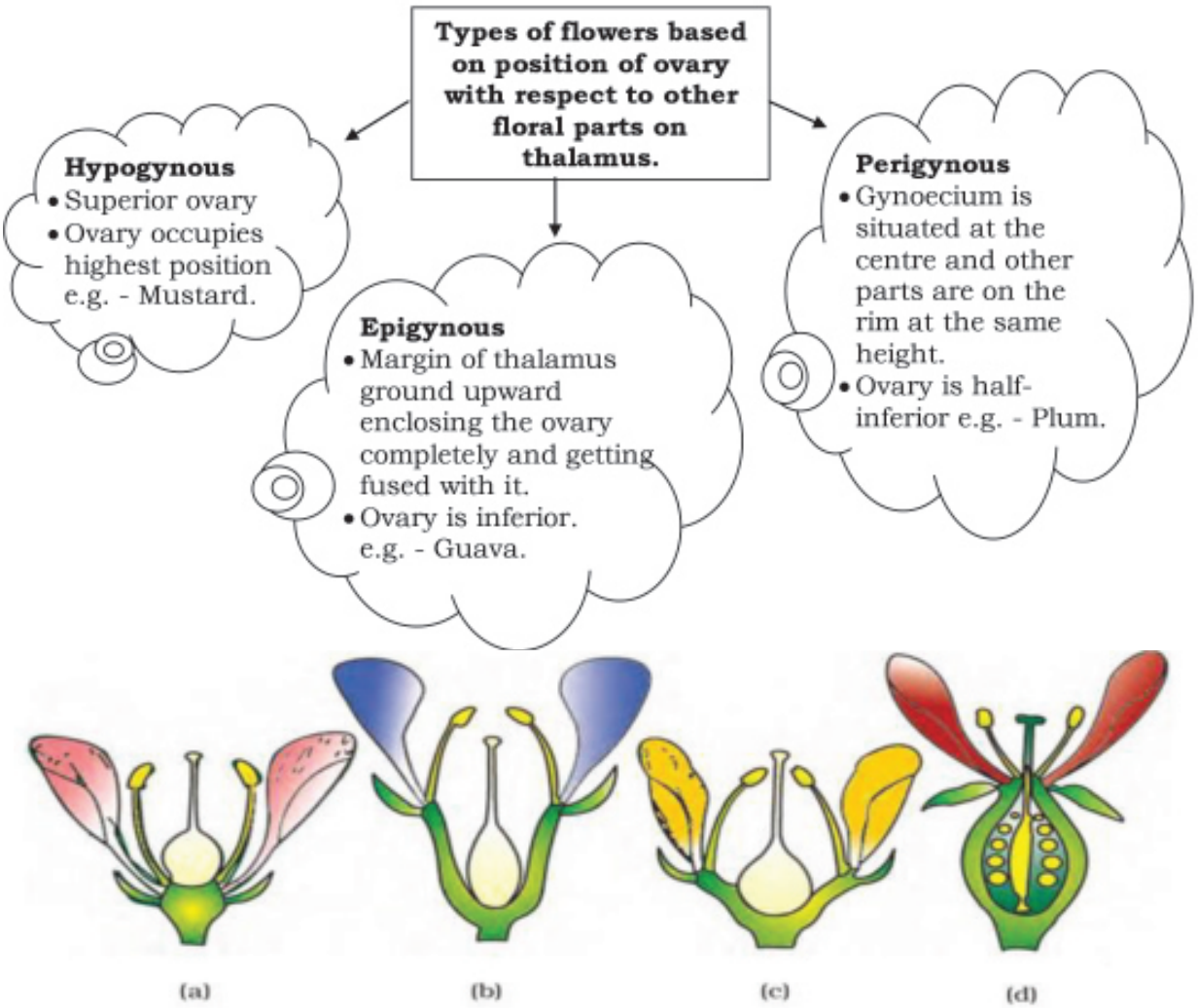


Figure : 5.6 (a) Hypogynous flower; (b) and (c) Perigynous flower; (d) Epigynous flower

- **Calyx** is the outermost whorl of flower. Its members are sepals. The calyx is either **gamosepalous** (sepals united) or **polysepalous** (sepals free).
- Corolla's members are petals. These are brightly coloured to attract insects for pollination. The corolla is either **gamopetalous** (petals united) or **polypetalous** (petals free).
- The mode of arrangement of sepals or petals in floral bud with respect to other members of same whorl is called **aestivation.** It is of four types:

i) **Valvate -** Whorls of sepals or petals touch each. e.g. **- Calotropis.**

ii) **Twisted -** Margin of the appendage overlaps that of the next one. e.g. - China rose.

iii) **Imbricate -** Margins of sepals or petals overlap one another, but not in any particular direction. e.g. - Gulmohar.

iv) **Vexillary -** Largest petal **(standard)** overlaps the two lateral petals **(wings)** which in turn overlap the two smallest anterior petals **(keel);** total petals in such flowers are five. e.g. - Pea.

Figure : 5.7 (a) Valvate aestivatin; (b) Twisted aestivation; (c) Imbricate aestivation; (d) Vexillary aestivation.

- **Androecium** is the male reproductive part of flower. It consists of stamen. **Stamen** consists of **filament** and **anther.** Anther bears the **pollen sacs. Pollen grains** are produced in the pollen sacs. A sterile stamen is called **staminode.**
- The stamen is called **epipetalous** if the stamens remain attached with the petals (Brinjal); the stamen is called **epiphyllous** if the stamens are attached to the perianth (Lily).
- Stamen may be free **(polyandrous)** or may be united in one bundle **(monadelphous),** two bundles **(diadelphous),** more than two bundles **(polyadelphous).**
- Female reproductive part of flower is called **gynoecium.** It consists of one or more carpels. Each carpel is made up of **stigma, style** and **ovary.**
- When more than one carpel is present, they may be free **(apocarpous)** as in lotus or fused together **(syncarpous)** as in tomato.

- Ovary bears one or more ovules, which are attached to the **placenta.** The arrangement of ovules within the ovary is called placentation. The **placentation** are of different types:

  (a) Marginal (Pea); (b) Axial (China rose); (c) Parietal (Mustard); (d) Free central (Dianthus); (e) Basal (Sunflower).

- Mature and ripened ovary develops to form fruit after fertilisation. If a fruit is formed without fertilisation of ovary, it is called **parthenocarpic fruit.**
- Fruit consists of seeds and pericarp. Thick and fleshy pericarp is three layered-**epicarp, mesocarp** and **endocarp.**

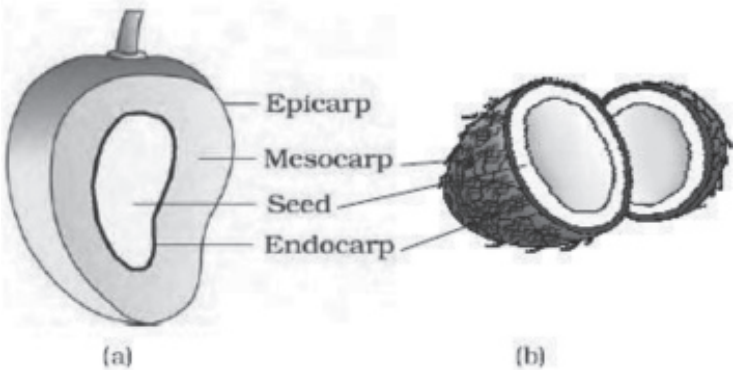


Figure: 5.8 (a) Parts of a mango fruit; (b) Parts of a coconut fruit.

- After fertilisation, the ovules develop into seeds. A seed is made up of a seed coat and an embryo. The embryo is made up of a radicle, an embryonal axis and one or two cotyledons.
- The outermost covering of a dicotyledonous seed is the seed coat, which has two layers - outer testa and inner tegmen. Seeds remain attached to the fruit through hilum. Micropyle is a small pore situated above hilum. In some seeds like in castor seeds, endosperm is formed as a result of double fertilisation.
- In monocotyledonous seed, outer covering of endosperm separates the embryo by a proteinaceous layer called aleurone layer. It has one large cotyledon known as scutellum. A short axis with a plumule and radicle is present, which are enclosed in coleoptiles and coleoohiza respectively.

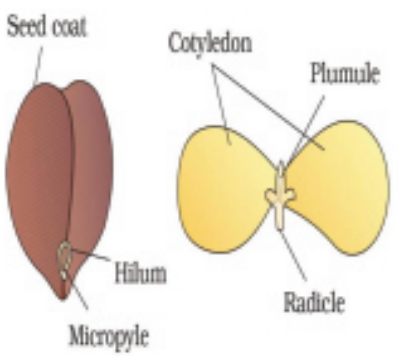


Figure : 5.9 Structure of a dicotyledonous seed.

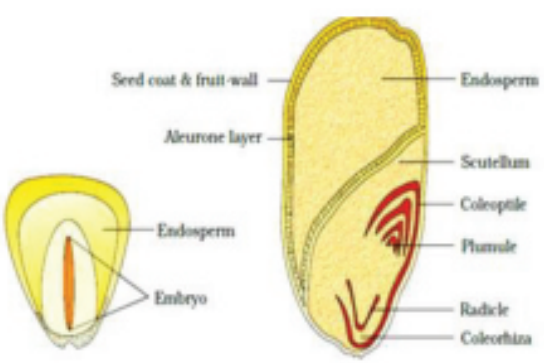


Figure : 5.10 Structure of a monocotyledonous seed.

♦ Description of any plant begins with description of its habitat, vegetative characters (root, stem and leaves) and then floral characters (in florescence and flower parts).

♦ The floral formula is represented by the following symbols:

Br-Bracteate; K-Calyx; C-Corolla; P-Perianth; A-Androecium; G-Gynoecium; G-Superior ovary; G-Inferior ovary; %-Zygo morphic; -Actino morphic; ?-Male; ?-Female; ?-Bisexual; Fusion is indicated by enclosing the figure within bracket and adhesion is drawn by a line above the symbols of the floral parts.

- **Description of some families:**

Fabaceae	Solanaceae	Liliaceae
• Herbs, shrubs or tree; Roots with root nodules; alternate and pinnately compound leaves with reticulate venation. • **Floral formula:** %♀ $K_{(5)}\ C_{1+2+(2)}\ A_{(a)+1}\ \underline{G}_{1}$	• Herbs or shrubs, rarely small tress; Known as Potato family; Alternate and simple or pinnately compound leaves with reticulate venation. • **Floral formula:** ⊕ ♀ $K_{(5)}\ \overline{C_{(5)}\ A_5}\ \underline{G}_{(2)}$	• Monocots; perennial herbs; leaves with parallel venation; Known as Lily family. • **Floral formula:** Br ⊕ ♀ $\overline{P_{(3+3)}\ A_{3+3}}\ G_{(3)}$
		

QUESTION AND ANSWER

A) Objective Questions. [1 mark]

I) Choose the most appropriate option from the following:

1. When flowers are borne laterally in an acropetal succession, the position of the youngest floral bud is -

(a) Proximal (b) Intercalary (c) Distal (d) Anywhere.

Ans. (c) Distal

2. Roots developing from parts of the plant other than radical are called -

(a) Adventitious root (b) Tap root (c) Fibrous root (d) Nodular root

Ans. (a) Adventitious root.

3. Endosperm is found in the seeds of -

   a) Mango b) Coconut c) Orchids d) Both options 'a' and 'b' are correct.

   Ans. (d) Both options 'a' and 'b' are correct

4. Potato belongs to the family -

   a) Fabaceae b) Solanaceae c) Liliaceae d) Poaceae

   Ans. (b) Solanaceae.

5. Which of the following plants is used to extract blue dyes?

   a) Lupin b) Cassia c) Indigofera d) Tridax

   Ans. (c) Indigofera.

II) Fill in the blanks :

1. Arrangement of veins in a leaf is called _____

   Ans. Venation.

2. The placenta is attached to the developing seed through the _____

   Ans. Hilum

3. Sweet potato is a modified _____

   Ans. Root

4. Dicotyledons show _____ venation.

   Ans. Reticulate.

5. The outer covering of endosperm separates the embryo by a proteinaceous layer called _____

   Ans. Aleurone layer.

III) State whether the following statements are true or false :

1) A short axis with a plumule remains enclosed in coleoptile.

   Ans. True.

2) Monocots have parallel venation.

   Ans. True.

3) The stamen is called episepalous if the stamen remain attached with the petals.

   Ans. False.

4) Endosperm is a product of double fertilisation.

   Ans. True.

5) The corolla is called gamopetalous if the petals remain free.

   Ans. False.

IV) Match the column A with column B :

Column - A	Column – B
a) Ovary	i) Vexillary
b) Parthenocarpy	ii) Inferior ovary
c) Epigynous	iii) Jasmine
d) Keel	iv) Monocotyledonous seed
e) Cymose	v) Fruit
f) Scutellum	vi) Unfertilised fruit
Ans. a - v; b - vi; c - ii; d - i; e - iii; f - iv.	

B) Very short answer type questions. **[1 mark]**

1. What is rachis?

   Ans. Number of leaflets present on a common axis in a pinnately compound leaf is called rachis.

2. Give an example of a plant which shows whorled type phyllotaxy.

   Ans. Alstonia.

3. What is a bisexual flower?

   Ans. The flower which has both androecium and gynoecium is called bisexual flower.
   e.g. - Sunflower.

4. What is an actinomorphic flower?

   Ans. When a flower can be divided into two equal halves in any radius passing through the centre of symmetry, it is called as actinomorphic flower.
   e.g. - Datura.

5. What is micropyle?

   Ans. Micropyle is a small pore situated above the hilum in a dicotydonous seed.

DO IT YOURSELF

A) Short Answer Type Questions. **[2 marks]**

1. What are the two different types of compound leaves? Give an example of each. (1+1)
2. What are the two different types of inflorescence? Give an example of each. (1+1)
3. A flower is bisexual, zygomorphic, having five sepals, gamosepalous, sepals having valvate aestivation, corolla is polypetalous, having five petals in a vexillary aestivation. Write the floral formula for the flower. Name the family to which this flower belongs to. (1+1)

B) Short Answer Type Questions. [3 marks]

1. Briefly describe the different types of phyllotaxy. (3)

2. Briefly describe the different types of flowers on the basis of position of ovary with respect to other floral parts. (3)

3. Draw a labelled diagram of dicotyledonous seed. (Drawing-1; Labelling-2)

C) Long Answer Type Questions. [5 marks]

1. Briefly describe the different types of root system. Draw a labelled diagram to show the different regions of the root tip. [3+2 (Drawing-1; Labelling-1)]

2. What is aestivation? Briefly describe the vexillary aestivation and twisted aestivation. (1+2+2)

3. What is placenta? Briefly describe parietal placentation and axial placentation. (1+2+2)

4. Describe the Solanaceae family. Give its floral formula. Draw its floral diagram. (3+1+1)

Teacher's Note

In the "Do it yourself" section, take care of the following points :

- Give examples for answering the definitions.
- Give diagrams and examples also while answering Q.A.1, Q.A.2, Q.B.1, Q.B.2, Q.C.1, Q.C.2 & Q.C.3.
- Refer and draw all the diagrams of figure. 5.22 (a - e) of textbook for answering first part of Q.C.4

** Example and diagrams will help you to fetch more marks.

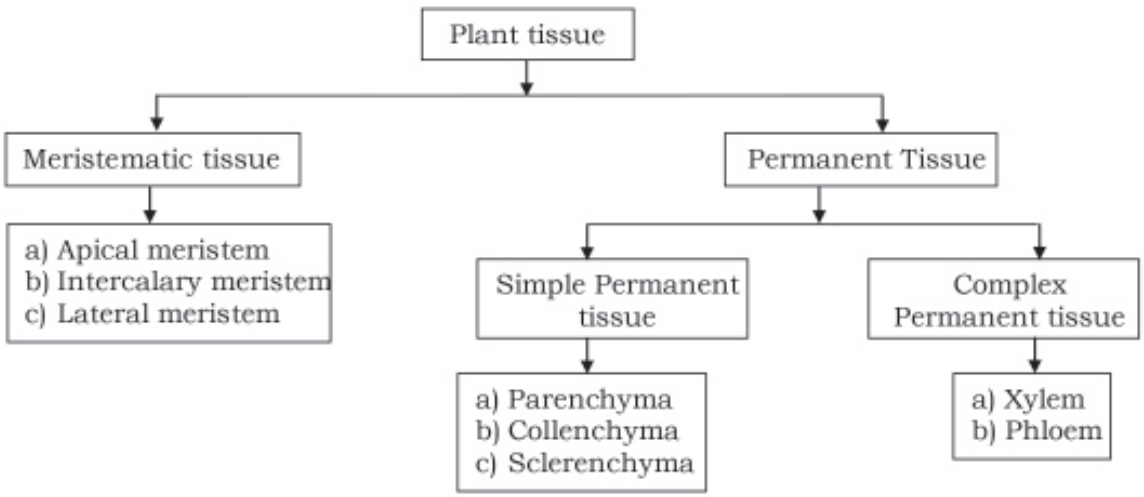
UNIT - II

CHAPTER - 6

ANATOMY OF FLOWERING PLANTS

IMPORTANT CONCEPTS

- The study of internal structure of organisms is called anatomy. Study of plant anatomy includes study of organisation and structure of tissues in plants.
- A group of cells having a common origin and usually performing common function are called tissues. A plant is made up of different kind of tissues.



- **Meristematic tissue** is simple tissue composed of group of similar and immature cells which can divide to form new cells.
  The meristem which occurs at tips of roots and shoots are called **apical meristem.**

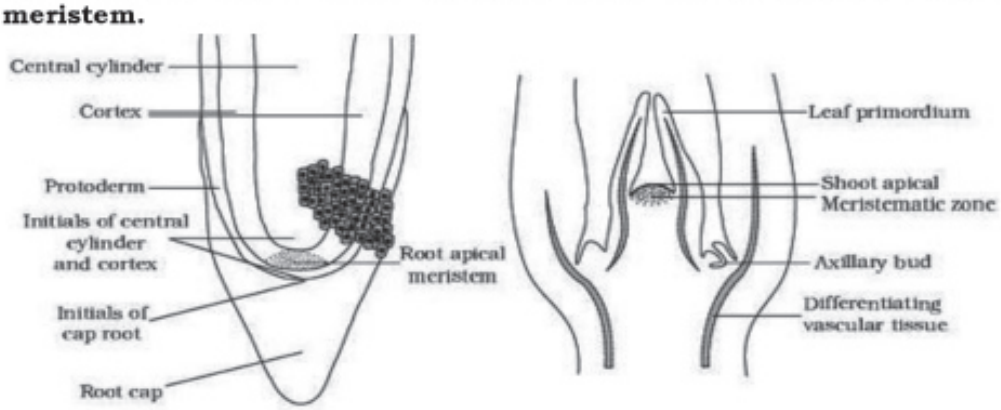


Figure: 6.1 Apical meristem of root and shoot.

- **Intercalary meristem** occurs between mature tissues. Example - Grasses.

- ♦ The meristem which occurs on the sides and takes part in increasing girth of the plants are called lateral meristem. Example - Intrafascicular cambium in the primary lateral meristem.
- ♦ Both apical meristem and intercalary meristems are primary meristems since they appear early in life of a plant and help to form the primary plant body.
- ♦ The cells that have become structurally and functionally specialised and lose the ability to divide are called permanent tissue.
- → Permanent tissues having all cells similar in structure and function are called simple permanent tissues and those having different kinds of cells are called complex tissue.

Simple permanent tissues

Parenchyma
- Made up of thin **isodiametric** cells.
- Each cell encloses a large central vacuole and peripheral cytoplasm containing nucleus.
- Found in woody and soft areas of stem, root, leaves, fruits and flowers.
- Store food and provide turgidity to softer parts of plant.

Collenchyma
- Cells are much thickened at corner due to **cellulose, hemicelluloses** and **pectin.**
- Oval, spherical or polygonal; often contain chlorophyll.
- Provide mechanical support to the growing parts of plants.

Schlerenchyma
- Supportive tissue having thick walled cells with **little or no protoplasm** due to deposition of **cellulose** or **lignin.**
- 2 types- Fibres and sclereids.
- Provide mechanical support to mature plant organs to tolerate bending, shearing, compression, etc.

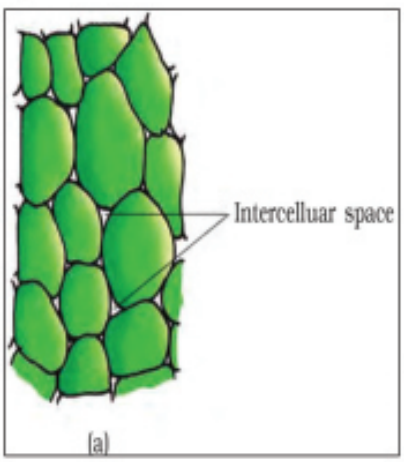


Figure: 6.2 Parenchyma

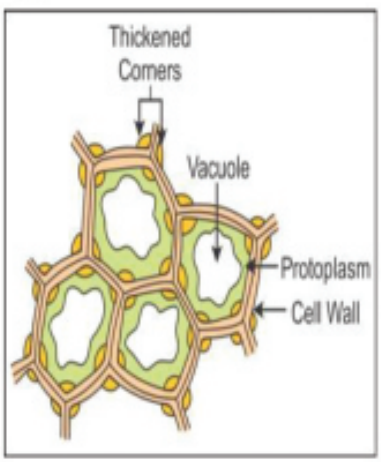


Figure: 6.3 Collenchyma

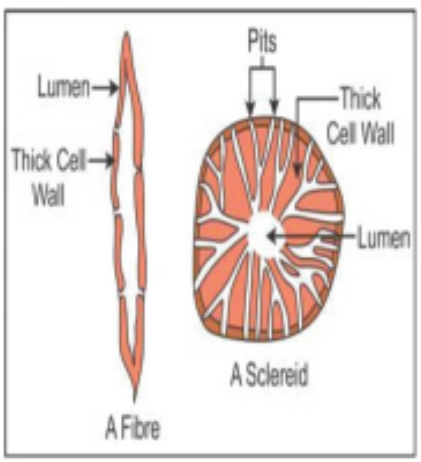


Figure: 6.4 Schlerenchyma

Complex tissues

Xylem
- Conducts water or sap.
- Provides mechanical strength to the plant.
- Made up of vessels, tracheids, xylem fibre and xylem parenchyma.

Pholem
- Conducts organic food materials.
- Does not provide mechanical support to the plant.
- Made up of sieve tubes, companion cells, phloem parenchyma and phloem fibres.

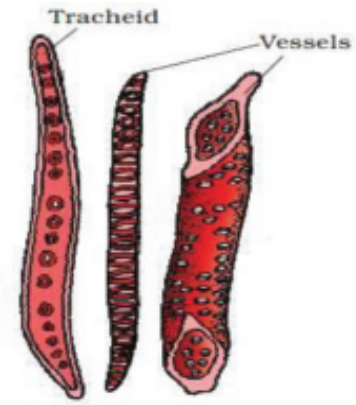
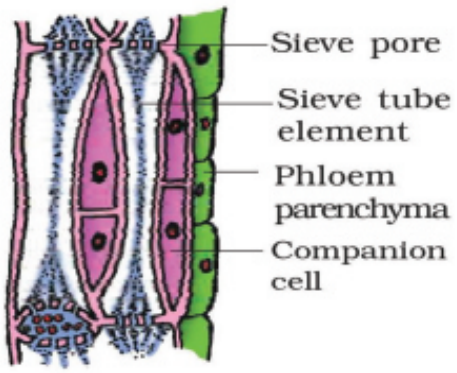


Figure 6.3 (a) Xylem

Figure: 6.5 Xylem.



(b)

Figure: 6.6 Phloem.

- Primary xylem is of two types - protoxylem and metaxylem. In stem, protoxylem lies in the centre and metaxylem lies towards the periphery. This type of arrangement of primary xylem is called endarch.
- In roots, protoxylem lies in the periphery and metaxylem lies towards the centre. This type of arrangement of primary xylem is called exarch.
- In the gymnosperms, albuminous cells and sieve cells lack sieve tube and companion cells.
- 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 metapholem.

Tissue System

Epidermal tissue system | Ground tissue system | Vascular tissue system

♦ **Epidermal tissue system**

→ It forms the outermost covering of whole plant body, which consists of epidermal cells, stomata, epidermal appendages (trichomes and hair).

→ Epidermis is single layered, parenchymatous with waxy thick layers of cuticle to prevent water toss.

→ Stomata is present in the epidermis of leaves. It regulates the transpiration and gaseous exchange. Stomata are bean shaped and dumbbell shaped in dicot and monocot respectively.

♦ **Ground tissue system**

→ All the tissues between epidermic and vascular bundle forms the ground tissues. It consists of simple permanent tissues. Parenchyma is present in pericycle, cortex, pith and medullary rays in stem and roots.

→ The mesophyll and chloroplast containing cells form the ground tissues in the leaves.

♦ **Vascular tissue system**

→ It consists of complex tissues, xylem and phloem that together forms the vascular bundles.

→ Cambium is present between phloem and xylem in dicotyledonous stems. Because of the presence of cambium, the vascular bundles possess the ability to form secondary xylem and phloem tissues, hence called as open vascular system. The monocotyledons do not have cambium in their vascular bundles, and hence do not form secondary tissues. They are called closed vascular bundles.

→ When xylem and phloem are arranged alternately along different radii within a vascular bundle, the arrangement is called radial type vascular bundle (roots). And, when the xylem and phloem are jointly situated along the same radius of the vascular bundle, it is called conjoint type vascular bundle (stem and leaves).

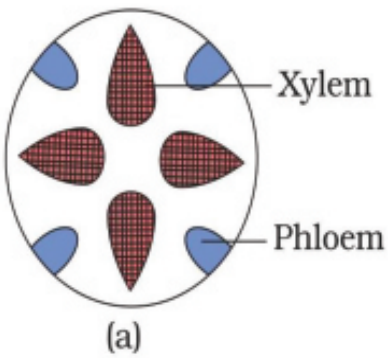


Figure: 6.7 Radial type vascular. system.

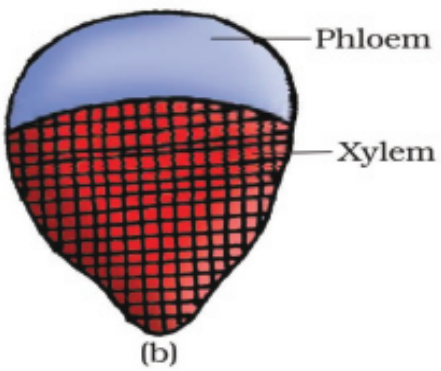


Figure: 6.8 Conjoint type vascular system.

♦ **Dicotyledonous root**

→ Outermost layer is epidermis containing unicellular root hair.

→ Cotex consists of several layers of thin walled parenchyma cells.

→ Innermost layer of cortex is called endodermis having waxy material suberin as casperian strips, which is impermeable to water.

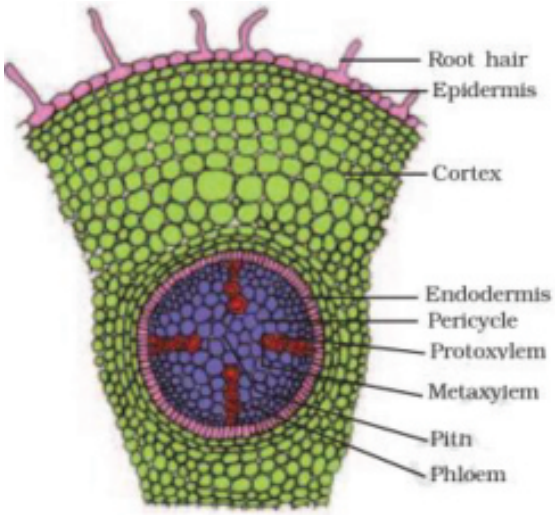


Figure: 6.9 T.S. of dicot root.

♦ **Monocotyledonous root**

→ Anatomy of monocot root is similar to that of dicot root in many aspects.

→ It has epidermis, cortex, endodermis, pericycle, vascular bundles and pith.

→ More than six xylem bundles (polyarch) are present.

→ Pith is large and well developed.

→ Do not undergo any secondary growth.

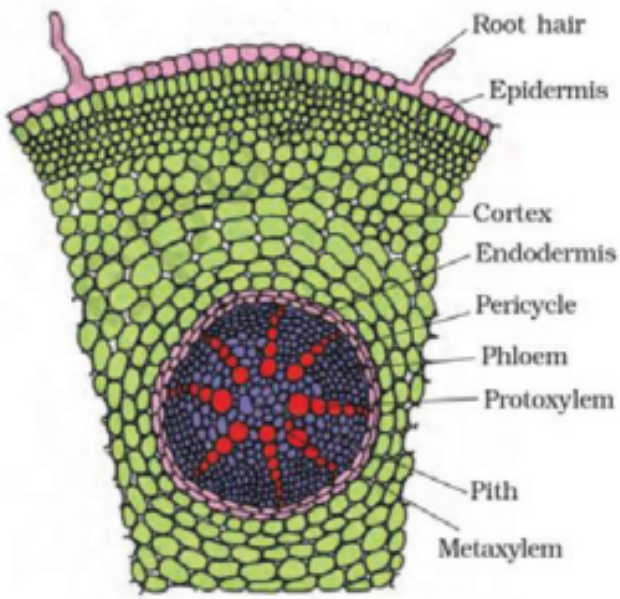


Figure: 6.10 T.S. of monocot root.

♦ **Dicotyledonous stem**

→ Epidermis is covered with a thin layer of cuticle and may have trichomes and stomata.

→ Cortex is made up of multiple layers of cells (hypodermis), middle layer of parenchyma cells and innermost layers called endodermis.

→ Endodermis cells are called starch sheath. Pericycle is present on the inner side of endodermis

→ Layers of radially placed parenchyma between the vascular bundles are called medullary rays.

→ A large number of vascular bundles are arranged in a ring. Each vascular bundle is conjoint, open and with endarch protoxylem.

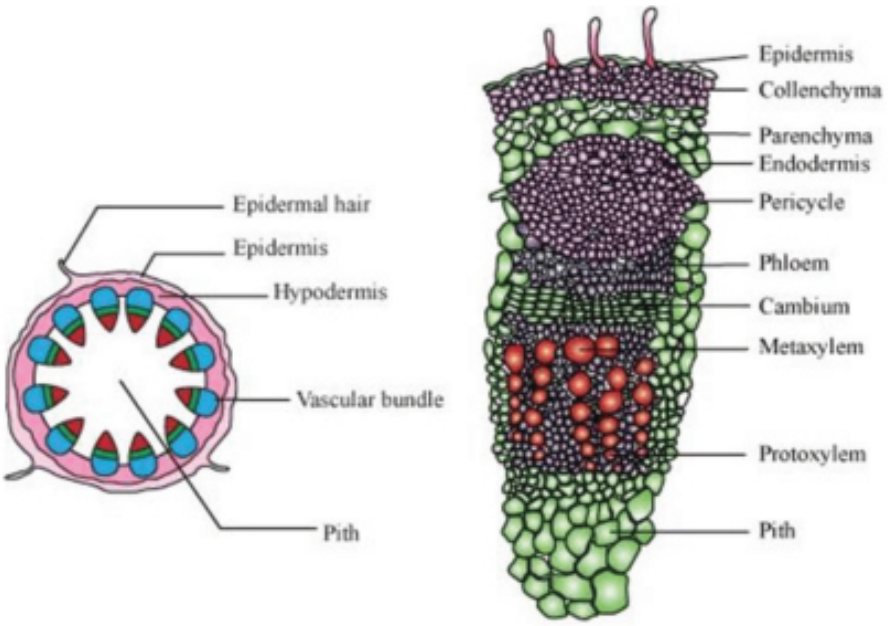


Figure: 6.11 T.S. of dicot stem.

♦ Monocotyledonous stem

→ Hypodermis is made up of sclerenchyma. Vascular bundles are conjoint, closed and scattered. Each vascular bundle is surrounded by a sclerenchymatous bundle sheath.

→ Phloem parenchyma is absent. Water-containing cavities are present within the vascular bundles.

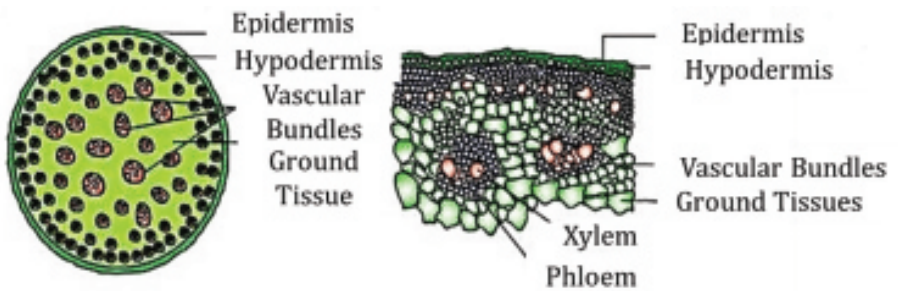


Figure: 6.12 T.S. of monocot stem.

- ♦ Dorsiventral (Dicotyledonous) leaf
- → Leaf lamina has 3 parts: epidermis, mesophyll and vascular system.
- → Upper epidermis is called adaxial epidermis and the lower epidermis is called abaxial epidermis (more stomata).
- → There are two types of cells in the mesophyll: Pallisade parenchyma and spongy parenchyma.
- → Vascular bundles are surrounded by a layer of thick-walled bundle sheath cells.

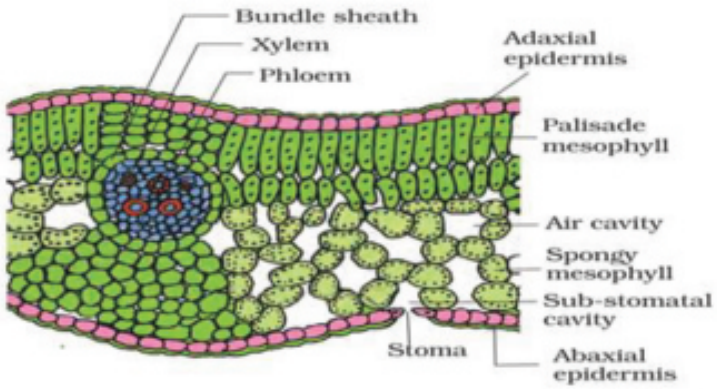


Figure: 6.13 T.S. dicot leaf.

- ♦ Isobilateral (Monocotyledonous) leaf
- → Stomata are present almost equally on both the surfaces of an isobilateral leaf. The mesophyll is not differentiated into palisade and spongy parenchyma.
- → Some adaxial epidermal cells in grasses are modified into large, empty cells called bulliform cells.

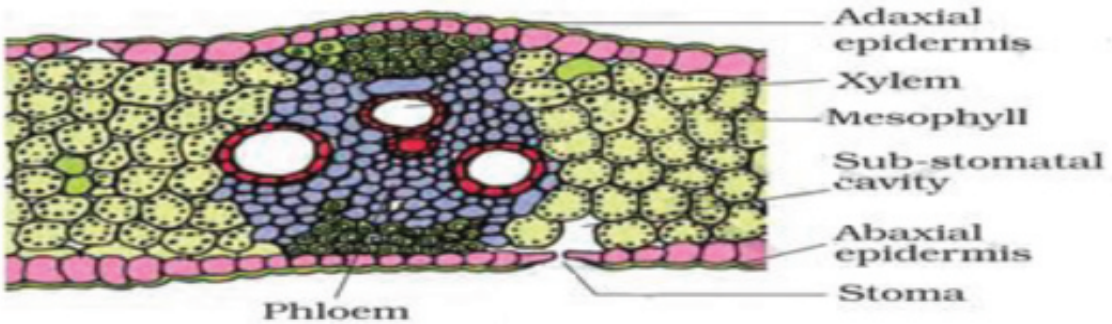


Figure: 6.14 T.S. of monocot leaf.

- ♦ The increase in girth of a plant body is called secondary growth. The tissues involved in this are vascular cambium and cork cambium.
- ♦ Vascular cambium is present in patches as a single layer between the xylem and phloem.

→ In dicot stems, the cells of cambium present between primary xylem and primary phloem forms the intra facicular cambium. The cells of medullary rays, adjoining these intra fascicular cambium become meristematic and form the inter fascicular cambium. Thus, a continuous ring of cambium is formed.

→ The cambium ring becomes active and begins to cut off new cells, both towards pith, mature into secondary xylem. The cells which are cut off towards periphery mature into secondary phloem.

→ At some places, the cambium forms a narrow band of parenchyma, which passes through the secondary xylem and the secondary phloem in the radial directions. These are the secondary medullary rays.

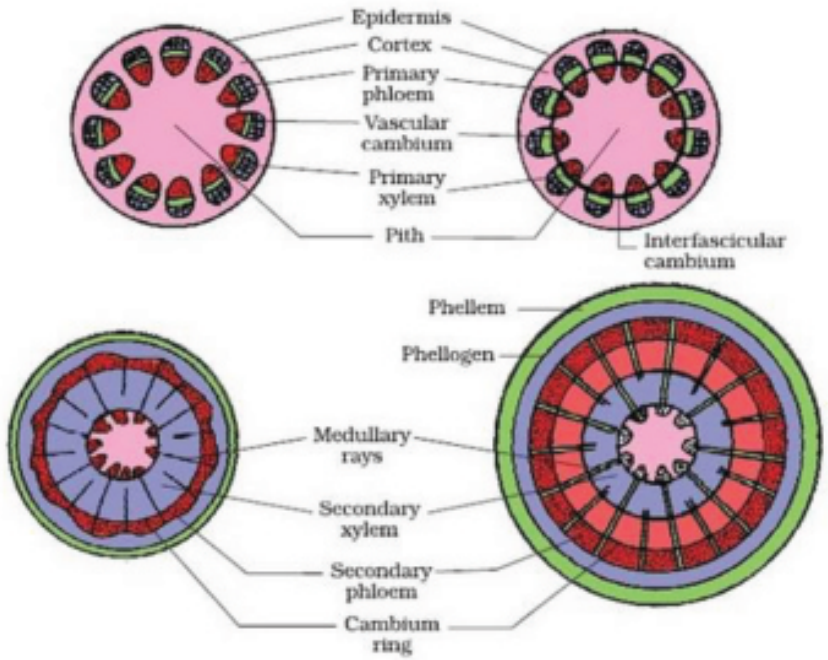


Figure: 6.15 Secondary medullary rays.

→ In winter, cambium activity shows down and gives rise to narrower xylem elements. The wood thus formed is called autumn wood (late wood).

→ In spring, cambium becomes more active and forms plenty of xylem vessels with wider cavities known as spring wood (early wood).

→ The xylem in the central part of the inner part of the wood (dark coloured) is called heartwood. The peripheral part of the wood (light coloured) is called sapwood.

♦ Meristematic tissue which develops in the cortex region is called cork cambium or phellogen.

♦ In dicot root, the vascular cambium is completely secondary in origin. It originates from the tissue located just below the phloem bundles, a portion of pericycle tissue, above the protoxylem

forming a complete and continuous wary ring, which later becomes circular. Further events of secondary growth in dicot root are similar to those which occurs in dicot stem.

QUESTION AND ANSWER

A) Objective Questions. **[1 mark]**

I) Choose the most appropriate option from the following:

1. Identify the simple tissue from the following -

   (a) Collenchyma (b) Epidermis (c) Xylem (d) Phloem

   Ans. (a) Collenchyma

2. Epiblema of roots is equivalent to -

   (a) Pericycle (b) Epidermis (c) Endodermis (d) Stele

   Ans. (b) Epidermis

3. Intercalary meristem occurs between which tissues?

   a) Young tissues b) Lateral tissues c) Mature tissues d) None of these

   Ans. (c) Mature tissues

4. A conjoint and open vascular system is observed in the transverse section of -

   a) Dicot root b) Dicot stem c) Monocot root d) Monocot stem

   Ans. (b) Dicot stem

5. Cork cambium is formed due to -

   a) Redifferentiation b) Cell division c) Cell differentiation d) Cell dedifferentiation

   Ans. (d) Cell dedifferentiation

II) Fill in the blanks:

1) Phellogen denotes the _____

   Ans. Cork cambium

2) The meristem which occurs at the tip of roots is called ____ meristem.

   Ans. Apical

3) _____ are supportive tissue having thick-walled cells with little or no protoplasm.

   Ans. Sclerenchyma.

4) Parenchyma are made up of this _____ cells.

   Ans. Isodiametric

5) _____ is present between phloem and xylem.

Ans. Cambium

III) Match the given columns :

Column - A	Column – B
a) Cuticle	i) Guard cells
b) Stomata	ii) Late wood
c) Bulliform cells	iii) Dark coloured
d) Heartwood	iv) Waxy layer
e) Autumn wood	v) Empty colourless cell
Ans. (a) - (iv); (b) - (i); (c) - (v); (d) - (iii); (e) - (ii).	

IV) State whether the following statements are true or false:

1) Phloem is a complex permanent tissue.

Ans. True.

2) Primary xylem is of two types - protoxylem and metaxylem.

Ans. True.

3) Metaphloem has narrow sieve tubes.

Ans. False.

4) Layers of radially placed sclerenchyma between the vascular bundle are called medullary rays.

Ans. False.

5) Stomata are present almost equally on both the surfaces of an isobilateral leaf.

Ans. True.

B) Very short answer type questions. [1 mark]

1. Write the other name for cork.

Ans. Phellem.

2. What is spring wood?

Ans. In spring, cambium becomes more active and forms plenty of xylem vessels with wider cavities called spring wood.

3. What are medullary ryas?

Ans. Layers of radially placed parenchyma between the vascular bundles are called medullary rays.

4. What is polyarch?

Ans. When more than six xylem bundles are present, it is called polyarch.

5. Name the waxy material present in casperian strips.

Ans. Suberin.

6. What is exarch?

Ans. In roots, protoxylem lies in the periphery and metaxylem lies towards the centre. This type of arrangement of primary xylem is called exarch.

DO IT YOURSELF

A) Short Answer Type Questions. [2 marks]

1. Write the difference between endarch and exarch. (2)
2. What is cambial ring? (2)
3. What are bulliform cells? Write its function. (1+1)

B) Short Answer Type Questions. [3 marks]

1. Draw a labelled diagram of shoot apical meristem. (Drawing-1; Labelling-2)
2. Differentiate between xylem and phloem? (3)
3. Briefly discuss about the different types of simple permanent tissue. (1+1+1)

C) Long Answer Type Questions. [5 marks]

1. Describe the structure of a dicotyledonous stem with the help of a labelled diagram of T.S. of a dicot stem. (2+3)
2. Why are phloem and xylem known as complex tissues? Differentiate between xylem and phloem. (2+3)
3. Draw a diagram to show secondary growth in a dicot stem. Differentiate between dorsiventral and isobilateral leaf. (3+2)

Teacher's Note

In "Do it yourself" section, take care of the following points:

- Draw a simple diagram to show cork cambium while answering Q.A.2.
- Draw diagrams and give examples while answering Q.B.3.

UNIT - II

CHAPTER - 7

STRUCTURAL ORGANISATION IN ANIMALS

IMPORTANT CONCEPTS

- In multicellular animals, a group of similar cells along with intercellular substances perform a specific function. Such an organisation is called tissue.
- According to function, there are four types of tissue present in multicellular animals (vertebrates):

  i) Epithelial tissue

  ii) Connective tissue

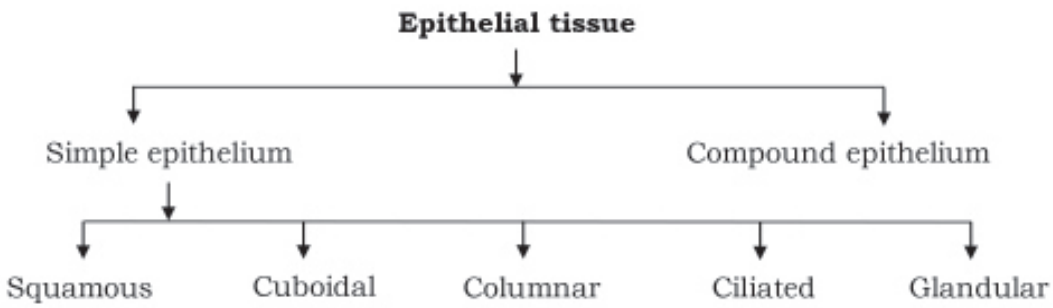
  iii) Muscular tissue

  iv) Neural tissue

I) Epithelial tissue

→ This tissue has a free surface, which faces either a body fluid or the outside environment.

→ The cells are compactly packed with little intercellular matrix.



A) Simple epithelium : Simple epithelium is composed of a single layer of cells and functions as a lining for body cavities, ducts and tubes.

Simple epithelium is further divided into three types -

(I) Squamous epithelium :

→ These tissues are composed of squamous cells. The cells are thin and flattened.

→ They are found in oral cavity, the walls of blood vessels and air sac of lungs.

→ They are involved in providing immunity.

(II) Cuboidal epithelium :

→ These are composed of a single layer of cube like cells.

→ This is commonly found in ducts of glands and tubular parts of nephrons in the kidneys.

→ They are involved in secretion and absorption.

(III) Columnar epithelium :

→ It is composed of single layer of tall and slender cells.

→ Their nuclei are located at the base.

→ They are found in the lining of stomach and intestine.

→ They help in secretion and absorption.

(IV) Ciliated epithelium :

→ The cells of these epithelium bear cilia on their free surface.

→ The cells are cuboidal and columnar in shape.

→ Basal granules are present at the base of the cilia.

→ They help in the movement of different particles. For example, the motion of cilia helps in the movement of mucus and ovum.

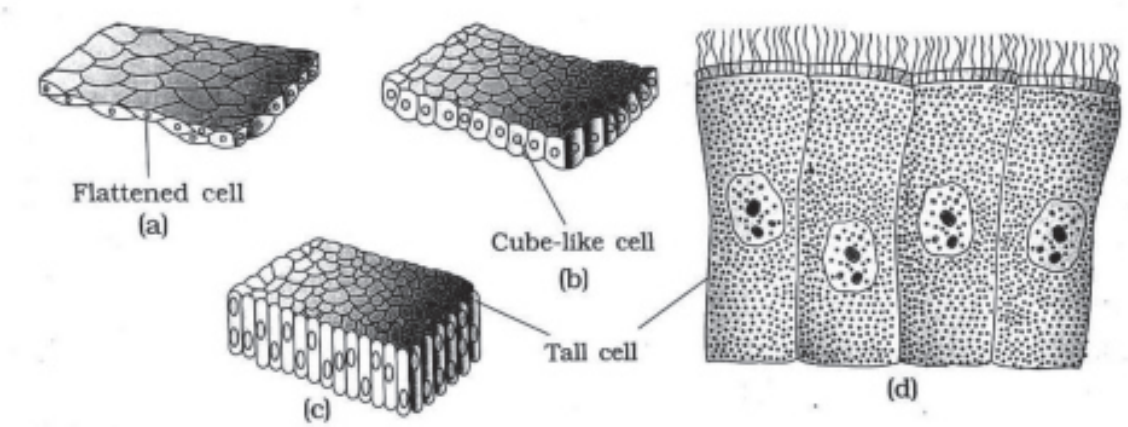


Figure : 7.1 Simple epithelium: (a) Squamous (b) Cuboidal (c) Columnar (d) Ciliated

(V) Glandular epithelium :

→ The cells of these epithelium are cuboidal, columnar and single-layered.

→ They are found in salivary glands, mammary glands, thyroid gland, sweat glands, etc.

→ They help in secretion of different substances.

→ Glandular epithelium are two types:

(a) Based on the number of cells -

1. **Unicellular gland :** They are made of single cell. e.g.- goblet cells.
2. **Multicellular glands :** These consists of cluster of cells. e.g.- salivary glands.

(b) Based on the secretion -

1. **Exocrine glands :** The secreted products are released through ducts. e.g.- salivary glands, sweat glands, mammary glands.

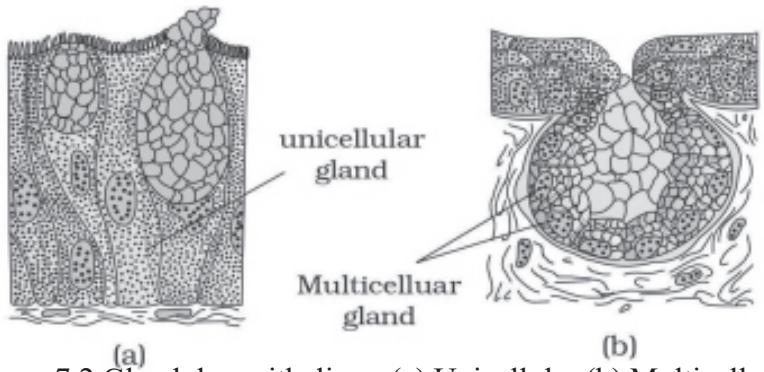


Figure: 7.2 Glandular epithelium: (a) Unicellular (b) Multicellular

2. Endocrine glands: They do not have ducts. Hormones are secreted through these glands. e.g.- thyroid gland, pituitary gland.

B) Compound epithelium :

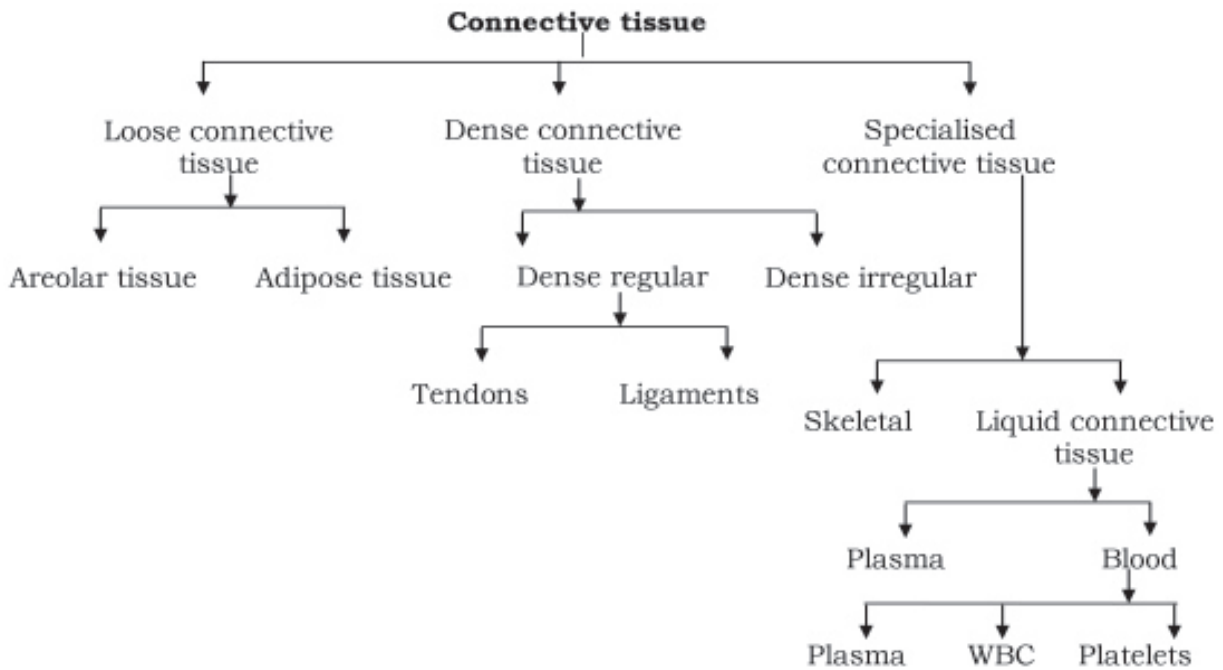
→ Compound epithelium is made up of more than one layer of cells (multi-layered).

→ Their main function is to provide protection against chemical and mechanical stresses.

ii) Connective tissue :

→ Connective tissues help in linking and supporting other tissues/organs of the body.

→ In all connective tissues except blood, the cells secrete fibres of structural proteins called collagen or elastin.



→ Loose connective tissue has cells and fibres loosely arranged in a semi-fluid ground substance.

→ The matrix of areolar tissues contains fibroblasts, macrophages and mast cells.

→ The spread of the infection from one part of the body to another part is inhibited by areolar tissue.

→ Adipose tissue is located beneath the skin where the excess of unused nutrients are converted into fats.

→ Tendons attach skeletal muscles to the bones.

→ Ligaments attach one bone to another.

Muscle tissue :

Each muscle is made of many long, cylindrical fibres arranged in parallel arrays.

These tissues are of three types -

(i) Skeletal muscle (ii) Smooth muscle (iii) Cardiac muscle.

I) Skeletal muscle :

→ These tissues are closely attached to skeletal bones and can get contracted voluntarily.

→ Many lines or bands are present horizontally inside the cell.

→ These muscles are bundled together.

II) Smooth muscle :

→ The smooth muscle fibres taper at both ends.

→ Smooth muscles are involuntary.

III) Cardiac muscle :

→ Cardiac muscle tissue is a contractile tissue present only in the heart.

Neural Tissue :

→ The unit of neural system is called neuron.

→ When a neuron is suitably stimulated, an electrical disturbance is generated which swiftly travels along its plasma membrane.

→ These tissues are involved in receiving stimulus, conducting stimulus and responding to stimulus in animals.

Earthworm

→ Earthworm is a reddish brown terrestrial invertebrate that inhabits the upper layer of the moist soil.

→ The common Indian earthworms are Pheretima and Lumbricus.

→ Earthworms have long cylindrical body. The body is divided into more than hundred short segments which are called as metameres.

→ A lobe which serves as a covering for the mouth is called as prostomium.

→ The first body segment of earthworm is called the peristomium. Segments 14-16 are covered by a prominent dark band of glandular tissue called clitellum.

→ A single female genital pore is present in the mid-ventral line of 14th segment and a pair of male genital pores are present on the ventrolateral sides of the 18th segment.

→ Nephridiopores open on the surface of the body.

→ In each body segment, except the first, last and clitellum, there are rows of S-shaped setae, which helps in locomotion.

→ The alimentary canal is a straight tube and runs from first to last segment of the body.

→ Pheretima exhibits a closed type of blood vascular system, consisting of blood vessels, capillaries and heart.

→ Earthworms lack specialised breathing devices. Respiratory exchange occurs through moist body surface into their blood stream.

→ The excretory organ of earthworm is nephridia. Nephridia are of three types:

i) Septal nephridia

ii) Integumentary nephridia

iii) Pharyngeal nepheridia.

→ Earthworm is hermaphrodite (bisexual), i.e., testes and ovaries are present in the same individual.

→ There are two pairs of testes present in the 10th and 11th segments.

→ The prostatic duct and spermatic duct act as a common duct.

→ Four pairs of spermathecae receive and store spermatozoa during copulation. They are present in 6th to 9th segment.

→ One pair of ovaries is attached at the intersegmental septum of the 12th and 13th segments.

→ The ova (eggs) are fertilised by the sperm cells within the cocon which is deposited in or on the soil. After about 3 weeks, each cocon produces two to twenty baby worms.

Cockroach

→ The body of the cockroach is segmented and divisible into three distinct regions - head, thorax and abdomen.

→ The entire body is covered by a hard chitinous exoskeleton.

→ The head capsule bears a pair of compound eyes and a pair of thread like antennae.

→ The mouth parts consists of a labrum, a pair of mendibles, a pair of maxillae and a labium.

→ Thorax consists of three parts - prothorax, mesothorax and metathorax.

→ The abdomen in both males and females consists of 10 segments.

→ The first pair of wings arises from mesothorax and the second pair from metathorax.

Alimentary canal of cockroach :

- → The alimentary canal is divided into three regions: foregut, midgut and hindhut.
- → Crop is used for storing of food. The next part is gizzard which helps in grinding the food particles.
- → Malpighian tubules help in the removal of excretory products from heamolymph.
- → The hindgut is differentiated into ileum, colon and rectum.
- → The rectum opens out through anus.

Blood vascular system of cockroach :

- → Blood vascular system is open type.
- → The haemolymph is composed of colourless plasma and haemocytes.
- → The heart is differentiated into funnel shaped chambers with ostia on either side.

Respiratory system of cockroach :

- → The respiratory system of cockroach consists of a network of trachea, that opens through 10 pairs of small holes called spiracles present on the lateral side of the body.

Reproductive system of cockroach :

- → Cockroaches are dioecious and both sexes have well developed reproductive organs.
- → Male reproductive system consists of a pair of testes, one lying on each lateral side in the 4th - 6th abdominal segments.
- → The female reproductive system consists of two large ovaries, lying laterally in the 2nd - 6th abdominal segments.
- → Fertilised eggs are encased in capsules called oothecae. On an average, females produce 9-10 oothecae.

Frogs *(Rana tigrina)* **:**

- → Frogs are amphibians and their body temperature varies. They have the ability to change the colour to hide them from their enemies.
- → Body of a frog is divisible into head and neck. Eyes are bulged and covered by a nictitating membrane that protects them while in water.
- → Male frogs have sound producing vocal sacs and also a copulatory pad on the first digit of the fore limbs.
- → The digestive system consists of alimentary canal and digestive glands.
- → Partially digested food called chime is passed from stomach to the first part of the small intestine, the duodenum. Final digestion takes place in the intestine. Digested food is absorbed by the numerous finger like folds in the inner wall of intestine called villi and microvilli.
- → Frogs respire through their skin inside water. On land, the buccal cavity, skin and lungs act as the respiratory organs.

→ The vascular system of frog is well developed closed type and bears incomplete double circulation.

→ The nervous system of frog is organised into a central nervous system, a peripheral nervous system and an autonomic nervous system.

→ Frogs have well organised male and female reproductive systems. Male reproductive organs consist of a pair of yellowish ovoid testes. The female reproductive organs include a pair of ovaries. A mature female can lay 2500 to 3000 ova at a time. Development of frog involves a larval stage called tadpole. Tadpole undergoes metamorphosis to form the adult.

QUESTION AND ANSWER

A) Objective Questions. **[1 mark]**

I) Chose the most appropriate option from the following:

1. Which tissues are present in large number in our body?

   (a) Epithelial tissue (b) Muscular tissue (c) Connective tissue (d) Neural tissue

   Ans. (c) Connective tissue

2. What type of blood vascular system is present in cockroach?

   (a) Open type (b) closed type (c) Peritrophic (d) None of these

   Ans. (a) Open type.

3. In which segment of earthworm, female genital pore can be seen?

   a) 18th b) 14th c) 11th d) None of these

   Ans. (b) 14th

4. Adipose tissue belongs to which of the following group of tissues?

   a) Epithelial tissue b) Connective tissue c) Muscular tissue d) Neural tissue

   Ans. (b) Connective tissue

II) Match the column A with column B:

Column - A	Column – B
a) Epithelial tissue	i) Divisible
b) Sclerenchyma	ii) Connective tissue
c) Meristem	iii) Animal tissue
d) Ligament	iv) Simple permanent tissue
Ans. (a)- (iii); (b) - (iv); (c) - (i); (d) - (ii).	

III) Find the odd one out :

1) Loose connective tissue, blood, neuron, tendon.

Ans. Neuron.

2) Maxilla, mandible, labrum, antennae.

Ans. Antennae.

B) Very short answer type questions. **[1 mark]**

1. Which tissue helps in secretion?

Ans. Cuboidal epithelium.

2. Write one example for each of the following glands:

Endocrine gland, exocrine gland, mixed gland.

Ans. Exocrine gland ' Salivary gland

Endocrine gland ' Thyroid gland

Mixed gland ' Pancreas.

3. In which part of the body of the cockroach, ovary is present?

Ans. 2nd - 6th segment.

C) Short answer type questions. **[2 marks]**

1) Where is cuboidal epithelium found? Write their function and characteristics?

Ans. Cuboidal epithelium is found in salivary glands and pancreas.

They plays an important role in absorption. The characteristics of the cells are cuboidal.

2) Why are blood, bone and cartilage called as connective tissue?

Ans. They have connection with different cells and organs. They help in structure formation of different organs and protect the body. They help in transformation of hormones, enzymes, and vitamins in different cells and organs.

DO IT YOURSELF

A) Short Answer Type Questions. **[2 marks]**

1. What are the cellular components of blood? (2)
2. Write the special characteristics of the eye of cockroach? (2)
3. How can you identify male frog? (2)
4. Write the functions of mast cells? (2)
5. What are tergum and sternum? (1+1)

B) Short Answer Type Questions. **[3 marks]**

1. What are tendons and ligaments? (1½+1½)
2. Differentiate between simple and compound epithelium? (3)
3. What is goblet cell? Where are they found? Write one function of the goblet cells? (1+1+1)
4. Draw a labelled diagram of digestive system of frog? (3)

5. Write the functions of the following: (1+1+1)

a) Ureters of frog.

b) Malpighian tubule.

c) Body wall of earthworm.

C) Long Answer Type Questions. [5 marks]

1. Describe different types of epithelium with labelled diagram. (5)

2. Write the characteristics of connective tissue. Differentiate between bone and cartilage based on their structure and function. (3+2)

3. Explain the digestive system of cockroach with labelled diagram. (3+2)

4. What is nephridia? How many types of nephridia are there? Why is earthworm called as 'farmer's friend'? (1+2+2)

Teacher's Note

To the answer you can take the help of different figures of textbook. Study the different types of animal tissue in a tabular form. For answering Q.B.1 of "Do it yourself" section refer paragraph - 7.1.2 of page no. - 103 of textbook. For answering Q.C.2. of "Do it yourself" section refer paragraph - 7.1.2. of page no. - 102-104 (Figure-7.6 - a,b).

UNIT - III

CHAPTER - 8

CELL : THE UNIT OF LIFE

IMPORTANT CONCEPTS

Cell

- All living organisms are composed of cells. Cell is the structural and functional unit of all living organisms.
- Some organisms are single celled and some are multicellular organisms.
- Robert Hooke discovered cell and Robert Brown discovered the nucleus of cell.

Cell Theory

- Scientists Matthias Schleiden and Theodor Schwann, together formulated the cell Theory.
- Rudolf Virchow, modified the theory of Schleiden and Schwann and gave it a final shape.

Cell theory at present

i) All living organisms are composed of cells and products of cells.

ii) All cells arise from pre-existing cells.

- The smallest cell is mycoplasma, the largest cell unit is egg of ostrich and longest cell is nerve cell.

Prokaryotic Cells

- Prokaryotic cells are represented by bacteria, blue -green algae, mycoplasma and PPLO (Pleuro Pneumonia Like Organisms,
- Except the mycoplasma, all prokaryotic cells have a cell wall surrounding the cell membrane.
- They do not have well defined nucleus.
- Many bacteria have small circular DNA outside the genomic DNA. These smaller DNA are called plasmids. One of the important characteristics of it is resistance to antibiotics.
- In prokaryotic cells consists of 70s ribosome and some cell organelle, such as mitochondria, golgi bodies, etc.
- A specialised differentiated form of cell membrane is called mesosome. It is the characteristics of prokaryotic cells.
- Bacterial cells have a chemically complex cell envelope consisting of a tightly bound three layered structure i.e., the outermost glycocalyx followed by cell wall and then plasma membrane.
- Glycocalyx in the form of loose sheath called the slime layer and forms thick and tough sheath

called the capsule.

- Mesosome is formed by the extensions of plasma membrane into the cell in the form of vesicles, tubules and lamellae. They help in cell formation, DNA replication and distribution to the daughter cells.
- Besides flagella, pili and fimbriae are also found in bacteria. They are known to help the bacteria to attach to rocks in the streams and also to the host tissues.
- In prokaryotes, ribosomes that synthesises proteins is made up of two subunits - 50s and 30s, together forming 70s.
- Several ribosomes may attach to a single mRNA and form a chain called polyribosomes or polysome.
- Reserve materials in prokaryotic cells are stored in the cytoplasm in the form of inclusion bodies.
- Gas vacuoles are found in blue green, purple and green photosynthetic bacteria.

Eukaryotic Cells

- Eukaryotic cells possess an organised nucleus with a nuclear envelope.
- Their genetic material is organised into chromosomes.
- The plant cells possess cell wall, plastids and a large central vacuole which are absent in animal cells. On the other hand, animal cells have centrioles which are absent in almost all plant cells.

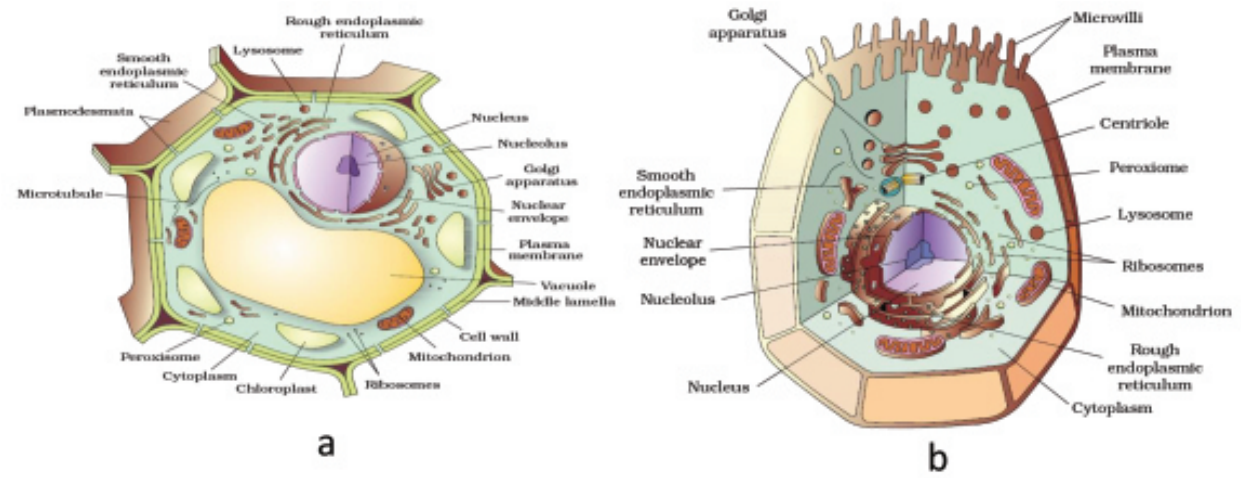


Figure : 8.1 Diagram showing : (a) Plant cell (b) Animal cell.

Structure and function of various cell organelles :

1. Cell Membrane

- Cell membrane is mainly composed of lipids and proteins.
- Mainly the lipids are phospholipids and are arranged in a bilayer. These are arranged within the

membrane with the polar head towards the outer sides and the hydrophobic tails towards the inner part.

- The lipid component of the membrane mainly consists of phosphoglycerides.
- The ratio of proteins and lipid varies considerably in different cell types.
- An improved model of the structure of cell membrane was proposed by the scientists Singer and Nicolson which is widely accepted as Fluid Mosaic Model.
- The function of the plasma membrane is to transport of molecules across it.
- Water moves across this membrane by simple diffusion from its higher to lower concentration.

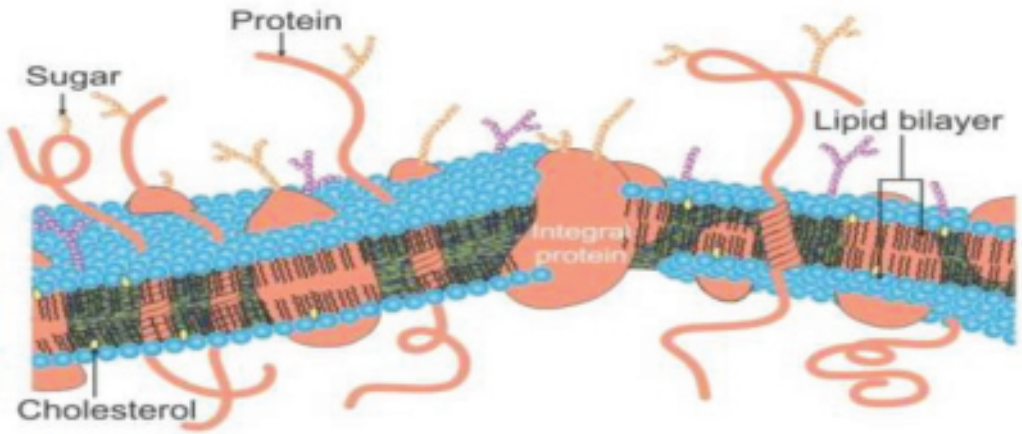


Figure: 8.2 Fluid mosaic model of plasma membrane.

2. Cell Wall

- It is the outer covering of the plasma membrane in plant cells, which is made up of cellulose. Cell wall is not present in animal cell.
- Cell wall protects the cell from mechanical damage and infection.
- The cell wall and middle lamella maybe traversed by plasmodesmata which connects cytoplasm of neighbouring cells.

3. The Endoplasmic Recticulum (ER)

- The Endoplasmic Recticulum (ER) bearing ribosomes on their surface is called rough endoplasmic recticulum. Without the presence of ribosomes they appear smooth and are called smooth endoplasmic recticulum (SER).
- RER is frequently observed in the cells actively involved in protein synthesis and secretion.

4. Golgi apparatus

- Densely stained recticular structures present near the nucleus.
- It is formed by cisternae, vacuoles and micro vesicles.
- Golgi apparatus principally performs the function of packaging materials to be delivered either

to intra-cellular targets or secreted outside the cell.

5. Lysosome

- These are membrane bound vesicular structures formed by the process of packaging in the golgi apparatus.
- Mainly found in animal cells.
- It destroys many organelles of its cell, hence called suicide bag.
- The enzymes present in lysosomes like lipases, proteases, carbohydrase, nuclease are capable of digesting lipids, proteins, carbohydrates and nucleic acids respectively.

6. Vacuoles

- Vacuoles occupy 90% of the volume of the cell.
- It contains water, sap, excretory product and other waste materials of the cell.
- Vacuole is bounded by a single membrane, called tonoplast.

7. Mitochondria

- Mitochondria is a double membrane bound structure; outer membrane is located towards outside and the inner membrane forms a number of infoldings called the cristae towards the matrix.
- ATP is synthesized in mitochondria.
- The matrix possesses single circular DNA molecule, a few RNA molecules, ribosomes (70s).
- Mitochondria is called the **'power house'** of cell.

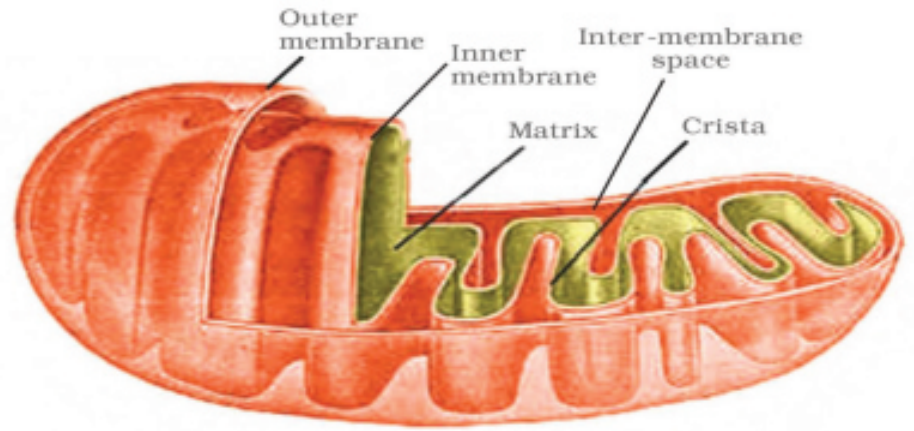


Figure: 8.3 structure of mitochondria.

8. Plastids

- Plastids are classified into 3 types -

  (i) Chloroplasts (ii) Chromoplasts and (iii) Leucoplasts.
- Chloroplast contains chlorophyll and carotenoid pigments.

- Different types of pigments are there in chloroplasts which are of different colours e.g.- chlorophyll, carotenoids, .
- Colourless plastids for example, amyloplasts, elaioplasts and aleuroplasts store starch, oil fat and protein.
- There are two thylakoids in chloroplasts _____ stroma and grana.

9. Ribosome

- Ribosome is composed of RNA and protein, and is not surrounded by any membrane.
- The eukaryotic ribosomes are 80s while prokaryotic ribosomes are 70s.
- 70s ribosome are made of two subunits - 50s and 30s and 80s ribosome are made of two subunits - 60s and 40s.

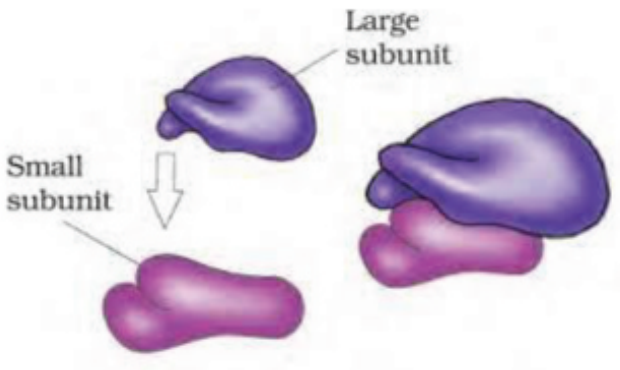


Figure: 8.4 Ribosome.

10. Cytoskeleton, Cilia and Flagella

- An elaborate network of filamentous proteinaceous structures that provides mechanical support, helps in motility and maintaining the shape of the cell.
- Cilia and Flagella help in cell movement. Flagella are comparatively longer than cilia.

11. Centrosome and Centrioles

- Centrosome is an organelle usually containing two cylindrical structures called centrioles. The centrioles lie perpendicular to each other.
- They are made up nine evenly spaced peripheral fibrils of tubulin protein.
- The centrioles form the basal body of cilia or flagella and spindle fibres.
- The spindle fibres help in cell division in animals.

12. Nucleus

- Nucleus is made up of nuclear membrane and nucleoplasm.
- Nucleoplasm contains nucleolus and chromatin.
- Nucleoplasm is the site for active ribosomal RNA synthesis.
- The interphase nucleus has a loose and distinct network of nucleoprotein fibres called chromatin.

- Chromatin contains DNA and some basic proteins called histones and some non-histone proteins.
- Based on the location of centromere, chromosomes are of four types - metacentric, sub-metacentric, acrocentric and telocentric.

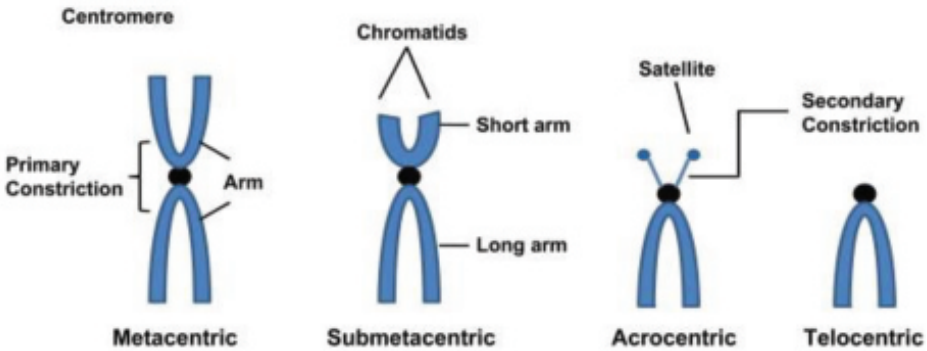


Figure: 8.12 Types of chromosomes based on the position of centromere.

Microbodies

Many membrane bound minute vesicles called microbodies containing various enzymes are present in both plant and animal cells.

QUESTION AND ANSWER

A) Very short answer type questions. [1 mark]

1. Write full form of PPLO.

   Ans. Pleuro - Pneumonia Like Organisms.

2. What is the function of nucleolus?

   Ans. Nucleolus helps in forming r-RNA.

3. What is the meaning of the letter 'S' in Ribosome 70s and 80s?

   Ans. Svedberg constant.

4. Which cell organelles are found only in the animal cells?

   Ans. Lysosome and centrosome.

5. Which scientist first observed the living cells?

   Ans. Anton Von Leeuwenhoek.

B) Choose the most appropriate option from the following: [1 mark]

1. New cells are produced by -

i) Fermentation by bacteria

ii) Regeneration of pre-existing cells

iii) Arise from pre-existing cells

iv) From abiotic things

Ans. (iii) Arise from pre-existing cells.

2. Which one of the following is not eukaryotic in nature?

   (a) Euglena (b) Anabaena (c) Spirogyra (d) Agaricus

   Ans. (b) Anabaena.

3. Which characteristic is common in both prokaryotic and eukaryotic cells?

   (a) Chromatin (b) Cell wall (c) Nuclear membrane (d) Mitochondria.

   Ans. (b) Cell wall.

4. Who presented the fluid mosaic model of the cell membrane or plasma membrane?

   (a) Benda (b) Schleiden and Schwann (c) Singer and Nicolson (d) Robert brown.

   Ans. (c) Singer and Nicolson.

C) Short answer type questions. [2 marks]

1) What is nuclear pore? What is its function?

   Ans. Many pores present in the nuclear membrane are called nuclear pores. These are formed by two nuclear membranes.

   Nuclear pores are the passage through which movement of RNA and protein molecules takes place in both directions between the nucleus and the cytoplasm.

2) Differentiate between centriole and centromere.

Centriole	Centromere
(a) Centriole is the part of centrosome	(a) It is the part of chromosome
(b) Centriole forms spindle fibres during cell division	(b) Centromere connects the chromosomes with spindle fibres.

3) What is polysome? Write its function.

   Ans. When several ribosomes attach to a single mRNA and form a ribosome chain is called polysome.

   The ribosome of polysome translate mRNA into proteins.

DO IT YOURSELF

A) Short Answer Type Questions. [2 marks]

1. Differentiate between Eukaryotic cells and prokaryotic cells. (2)
2. Which cell organelle is called the powerhouse of cell? Why? (1+1)
3. What is vacuole? Write its function? (1+1)
4. Name two double layered cell organelles. Write one characteristics of each of these organelles. (1+1)
5. Write the smallest and largest cell of human body. (1+1)

B) Short Answer Type Questions. **[3 marks]**

1. Write the functions of elaioplast, mesosome and lysosome. (3)
2. Describe the structure of the nucleus with the help of a labelled diagram. (1+2)
3. Differentiate between rough endoplasmic reticulum (RER) and smooth endoplasmic reticulum (SER). (3)
4. Draw a labelled diagram of a plant cell. (Drawing- 1; Labelling- 2)
5. Who gave cell theory? Explain the cell theory. (1+2)

C) Long Answer Type Questions. **[5 marks]**

1. Write the characteristics and functions of mitochondria and centrosome. Draw a labelled diagram of mitochondria. (1½+1½+2)
2. What is plastid? How many types of plastids are there and what are those? Write the functions of each. (1+2+2)
3. What is centromere? How are the chromosomes divided according to the location of the centromere? Draw the different types of chromosomes showing the location of centromere. (1+2+2)
4. Write the functions of the following cell organelles: (1+1+1+1+1)

   (i) Golgi apparatus (ii) Cell wall (iii) Ribosome (iv) Centriole (v) Nucleoid.

Teacher's Note

- Take the help of diagrams while studying about different cell organelles.
- Write the differences in a tabular.
- In "do it yourself" section, refer paragraph no. - 8.5.5 (second paragraph) of the text book for answering Q.C.2 and Q.C.3.

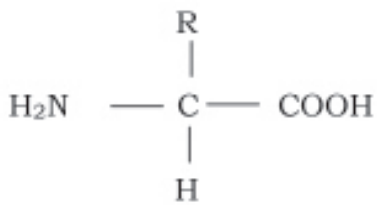
UNIT - III
CHAPTER - 9
BIOMOLECULES

IMPORTANT CONCEPTS

- All the carbon compounds that we get from living tissues can be called biomolecules.
- The elemental analysis gives elemental composition of living tissues in the form of hydrogen, oxygen, chlorine, carbon etc.
- Analysis for compounds gives an idea of the kind of organic and inorganic constituents.
- From a chemistry point of view, one can identify functional groups like aldehydes, ketones, aromatic compounds etc.

Amino Acid

- Amino acids are organic compounds containing an amino group and an acidic group as substituents on the same carbon i.e., the -carbon.
- Four substituent groups occupies the four valency positions. These are hydrogen, carboxyl group, amino group and a variable designated as R-group.

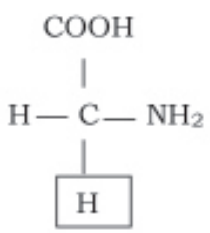


- Only twenty types of amino acids take part in the formation of protein.
- Proteinaceous amino acids of various types based on the R-group:

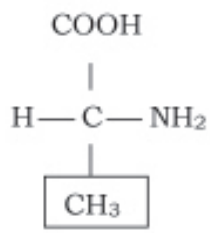
  a) Hydrogen (glycine)

  b) Methyl group (alanine)

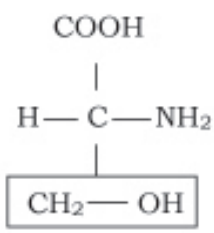
  c) Hydroxy methyl (Serine)



a) Glycine



b) Alanine



c) Serine

♦ Based on chemical and physical properties:

a) Based on the number of amino acid carboxyl groups:

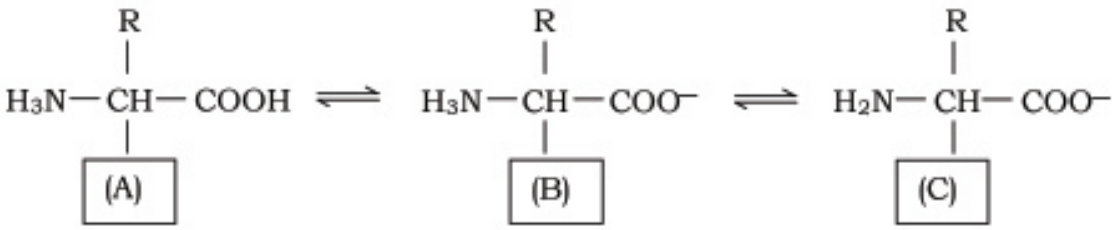
→ Acidic (glutamic)

→ Basic (lysine)

→ Neutral (valine)

Aromatic amino acids: tyrosine, phenylalanine, tryptophan.

A particular property of amino acids is the ionisable (-NH2) nature and carboxyl (-COOH) group.



B is called zwitterionic form.

Lipid

Lipids are generally water insoluble.

A fatty acid has a carboxyl group attached to a R group.

Fatty acids could be saturated (without double bond) or unsaturated (with one or more C = C double bonds)

Some lipids have phosphorous and a phosphorylated organic compound in them. These are called phospholipids. They are found in cell membrane.

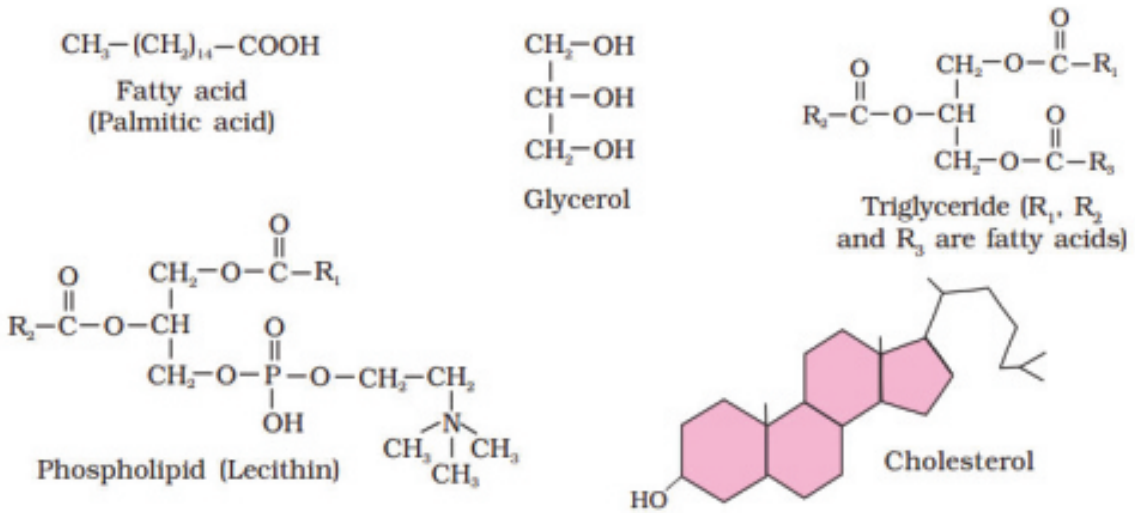


Figure: 9.1 Fats and oils (lipids).

Nucleoside

- When sugar remains attached to Nitrogen base, it is called nucleoside.

  e.g. - adenosine, guanosine, thymidine, uridine and cytidine.

Nucleotide

- Nitrogen base attached with sugar and phosphate group is called nucleotide.

  e.g. - adenylic acid, thymidylic acid, etc.

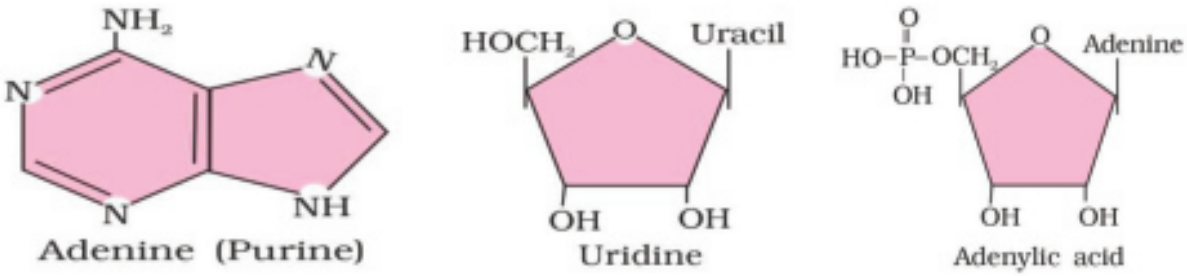


Figure: 9.2 Nitrogen base, Nucleoside, Nucleotide.

Primary metabolites

- These are organic compounds like amino acids, sugar etc.

Secondary metabolites

- These are metabolites found in plants and microbial cells. Thousands of such compounds can be seen such as alkaloids, flavonoids, rubber, essential oil, antibiotics, coloured pigments, etc.
- The acid insoluble fraction has only four types of organic compounds i.e., proteins, nucleic acids, polysaccharides and lipids.
- The molecules that weigh less than one thousand Dalton are called as micromolecules.
- The acid insoluble fraction which weighs in the range of ten thousand daltons and above are called biomacromolecules.
- Water is the most abundant chemical in living organisms.

Component	% of the total cellular mass
Water	70-90
Proteins	10-15
Carbohydrates	3
Lipids	2
Nucleic Acids	5-7
Ions	1

Table: 9.1 Average Composition of cells.

Proteins

- Proteins are polypeptides. Many amino acids combined together form polypeptides.

Proteins	Functions
Collagen	Intercellular ground substance
Trypsin	Enzyme
Insulin	Hormone
Antibody	Fights infections agents
Receptor	Sensory reception (smell, taste, hormone, etc.
GLUT-4	Enables Glucose transport into cells.

Main functions of protein :

- Proteins transport nutrients across the cell membrane. .
- Proteins fight infectious organisms.
- Proteins synthesise enzymes and hormones.
- Proteins helps in body building.
- Collagen is the most abundant protein in the animal world.

Polysaccharides

- Polysaccharides are long chains of sugar.
- Cellulose is consisting monosaccharide i.e. glucose.
- Starch is present as a store house of energy in plant tissues.
- Glycogen is present in animal body.
- Insulin is a polymer of fructose.
- In a polysaccharide chain, the right end is called the reducing end and the left end is called non-reducing end.

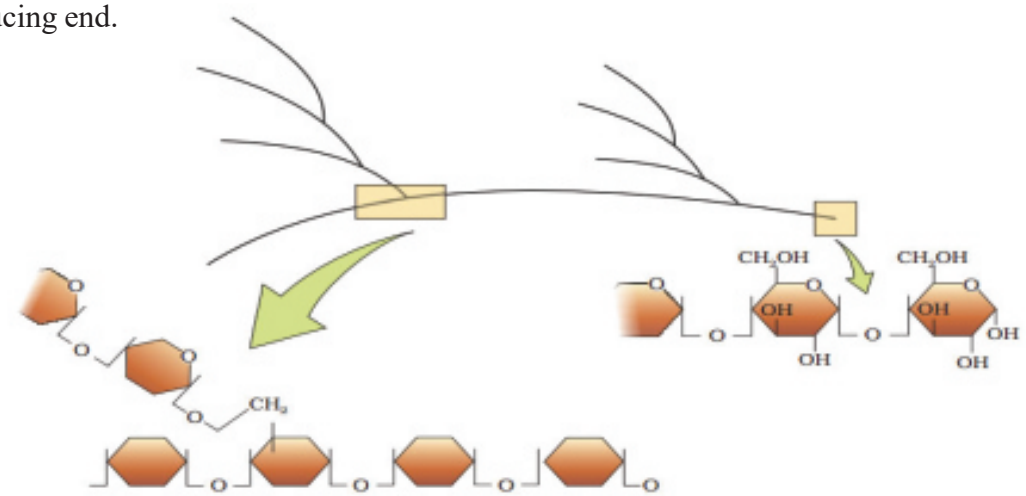


Figure: 9.3 Diagrammatic representation of a portion of glycogen.

Nucleic Acid

- The acidic base present in the nucleus of each living cell is called nucleic acid.
- The structural unit of nucleic acid is called nucleotide.
- The heterocyclic compounds in nucleic acids are adenine, guanine, uracil, cytosine and thymine. The skeletal heterocyclic ring is formed with purine and pyrimidine.
- Monosaccharide is either ribose or deoxyribose sugar. Deoxyribose sugar is present in DNA. Ribose sugar is present in RNA.
- Phosphoric acid or phosphate is also one of the components of nucleotide.

Structure of Protein

Four structures of Protein are found:

i) Primary structure - Many amino acids together form polypeptides. The first amino acid at the left end is called N-terminal and the last amino acid at the right end is called the C-terminal amino acid.

ii) Secondary structure - Amino acid chains are arranged in the form of helix (in right direction) containing ? pleated sheets.

iii) Tertiary structure - A long protein chain is folded upon itself like a hollow woollen ball.

iv) Quaternary structure - Some polypeptides or sub units form quaternary structure.

- Haemoglobin is formed by two sub units are of type and two sub units are ? type polypeptides.

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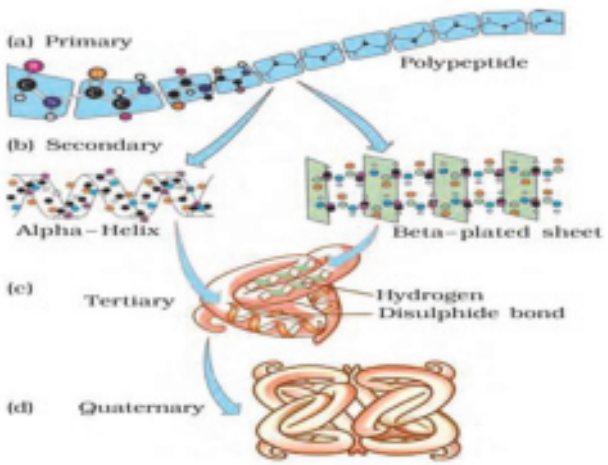


Figure: 9.4 Primary structure of a portion of a hypothetical protein.

Peptide Bond

- In a protein, amino acids are linked by a peptide bond.
- The carboxyl (-COOH) group of one amino acid reacts with the amino (-NH2) group of the next amino acid and eliminates a water moiety (the process is called dehydration).

Glycosidic Bond

- In a polysaccharide the individual monosaccharides are linked by glycosidic bond. This bond is formed between two carbon atoms of two adjacent monosaccharides.

Phosphodiester Bond

- The bond between the phosphate and hydroxyl group of sugar is called an ester bond. As there is one such ester bond on either side of the phosphate moiety, it is called phosphodiester bond.

Structure of DNA

Characteristic of Watson and Crick model :

- DNA exists as double helix.
- The two strands of polynucleotides are antiparallel i.e. run in the opposite direction.
- The backbone of DNA is formed by the sugar - phosphate - sugar chain.
- Adenine and guanine of one strand compulsorily base pairs with thymine and cytosine, respectively, on the other strand.
- These are two hydrogen bonds between adenine and thymine and three hydrogen bonds between guanine and cytosine. The diameter of DNA molecule is 20?.
- One full turn of the helical strand involves ten base pairs.

Metabolic Basis

Anabolic - Metabolic pathways can lead to formation of a more complex structure from a simpler structure. For example, acetic acid becomes cholesterol.

Catabolic - Metabolic pathways can lead to formation of a simpler structure from a complex structure. For example, glucose becomes lactic acid. The most important form of energy currency in living systems is the bond energy in a chemical called adenosine triphosphate (ATP).

Enzyme

Characteristic of Enzymes :

- Almost all enzymes are proteins.
- Enzymes work as catalyst and remain unchanged after the reaction.
- Efficiency of enzyme is optimum 200C - 400C temperature, while enzymes get damaged at high temperature; in low temperature it does not get destroyed but its efficiency decreases.

Chemical Reactions:

When bonds are broken and new bonds are formed during transformation, this is called chemical reaction.

For example, in the following inorganic chemical reaction, some bonds are broken and new bonds are formed:

$Ba(OH)_2 + H_2SO_4 \rightarrow BaSO_4 + 2H_2O$

In an organic chemical reaction, glucose is formed from starch by the process of hydrolysis. The presence and absence of enzymes determine the rate of chemical reaction.

For example, $CO_2 + H_2O \xrightarrow{\text{Carbonic anhydrase}} H_2CO_3$

Carbonic acid.

In the absence of any enzyme this reaction is very slow. 200 molecules of H2CO3 are formed in an hour.

However, by using the enzyme present within the cytoplasm called carbonic anhydrase, the reaction speeds up dramatically with about 600,000 molecules of H2CO3 being formed every second.

Functions of enzyme:

- The chemical which is converted into a product is called a substrate.
- Enzymes i.e., proteins with three dimensional structures including an 'active site', converts a substrate(s) into a product(p).

  $S \rightarrow P$
- Substrate (S) binds with the enzyme at its 'active site'. Thus, there is an obligatory formation of an 'ES' complex.
- During the state where substrate in bound to the enzyme's active site, a new structure of the substrate called transition state structure is formed.
- The breaking and making of the bond is completed and the product is released from the active site.

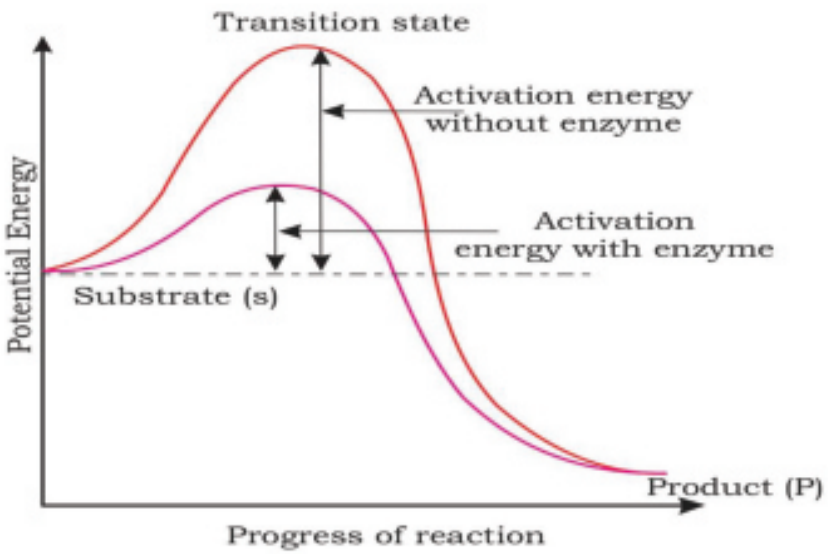
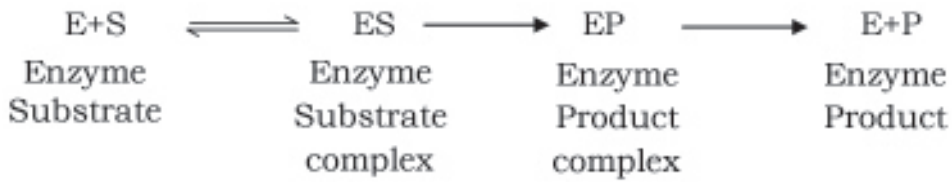


Figure: 9.5 Concept of activation energy Y-axis represents the potential energy content.

The X-axis represents the progression of the structural transformation or states through the 'transition state'.

- If the energy level of 'P' is lower than 'S' the reaction is an exothermic reaction.
- The difference in average energy content of 'S' from that of this transition state is called activation energy.

Nature of Enzyme Action:



The catalytic cycle of an enzyme action can be described by the following steps :

- First, the substrate binds to the active site of the enzyme, fitting into the active site.
- The binding of the substrate induces the enzyme to alter its shape, fitting more tightly around the substrate.
- The active site of the enzyme, when in close proximity of the substrate breaks the chemical bonds of the substrate and the new enzyme product complex is formed.
- The enzyme releases the products of the reaction and the free enzyme is ready to bind to another molecule of the substrate and run through the catalytic cycle.

Factors Affecting Enzyme Activity:

Temperature and pH

The activity of enzyme declines when the temperature and pH becomes below or above the optimum level. Low temperature preserves the enzyme in a temporarily inactive state whereas high temperature destroys enzyme activity.

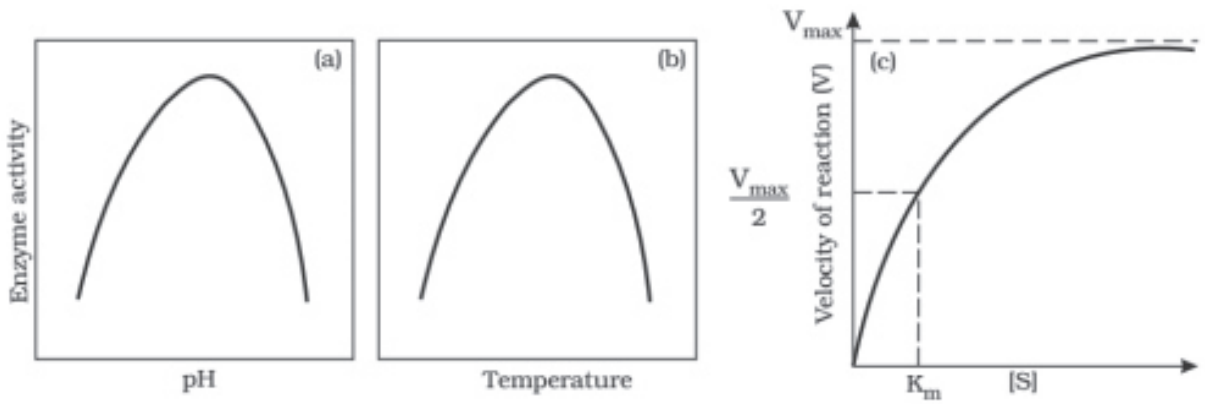


Figure: 9.6 Effect of change in PH and Temperature.

Concentration of substrate:

With the increase in substrate concentration the velocity of the enzymatic reaction rises at first. The reaction ultimately reaches a maximum velocity (Vmax) and becomes constant.

Classification of enzymes

International Union of Biochemists (IUB) classified the enzymes into six types -

Class - I → Oxidoreductases /dehydrogenases

Class - II → Transferases

Class - III → Hydrolases

Class - IV → Lyases

Class - V → Isomerases

Class - VI → Ligases

Co-factors

There are three types co-factors -

i) Prosthetic group

ii) Co-enzyme

iii) Metal ions

Catalytic activity is lost when the co-factor is removed from the enzyme.

QUESTION AND ANSWER

A) Objective type questions. **[1 mark]**

I. Choose the most appropriate option from the following:

1. Which of the following is a homo polysaccharide?

   (a) Maltose (b) Chitin (c) Sucrose (d) Cellulose

   Ans. (d) Cellulose.

2. Protein is formed by

   (a) Glucose molecule (b) Nucleoside (c) Amino acid (d) Nucleotide

   Ans. (c) Amino acid.

3. Which of the following is an amino acid?

   (a) Formic acid (b) Glycerol (c) Glycolic acid (d) Glycine

   Ans. (d) Glycolic acid

4. The chemical substance present in living cells in large amount -

   (a) Protein (b) Water (c) Sugar (d) Nucleic acid

   Ans. (d) Nucleic Acid.

II. Fill in the blanks :

1. In a polysaccharide the individual monosaccharides are linked by a _____ bond.

Ans. Glycosidic bond.

2. Each enzyme has a _____ binding site to which molecules bind to form enzyme substrate complex.

   Ans. Substrate.

3. In the formation of DNA in the nucleotide bond there is carbohydrate, nitrogenous base and _____

   Ans. Phosphate.

III. Find the odd one out:

1. Cytosine, arginine, thymine, adenine.

   Ans. Arginine.

2. Lipid, polysaccharide, protein, nucleic acid.

   Ans. Lipid.

B) Short answer type questions. **[2 marks]**

1. What are essential amino acids? Give examples.

   Ans. The amino acids that are not synthesised in the body, but have to be taken through food, are called essential amino acids.

   Example - Leucine, isoleucine, etc.

2. What is the unit of nucleic acid? What are the components of nucleic acid?

   Ans. Nucleotide is the unit of nucleic acid. The components of nucleic acid are phosphate group, nitrogenous base and 5 carbon sugar.

3. Which bond is present in starch and protein?

   Ans. Glycosidic bond is present in starch and peptide bond is present in protein.

DO IT YOURSELF

A) Short Answer Type Questions. **[2 marks]**

1. What are apoenzyme and co-enzyme? (1+1)
2. Draw the structure of the amino acid alanine. (2)
3. What is Michaelis constant? (2)
4. What are the important properties of enzymes? (2)
5. Differentiate between primary and secondary metabolites. (2)

B. Short Answer Type Questions. **[3 marks]**

1. What do you mean by glycosidic, peptide and phosphodiester bond? (1+1+1)
2. Explain the composition of triglyceride. (3)

3. What do you mean by secondary and tertiary structure of protein? (1½+1½)

4. Explain the substrate level of enzyme activity with a diagram. (3)

C. Long Answer Type Questions. [5 marks]

1. How many types of nucleic acids are there? What are its components? Differentiate between Nucleotide and Nucleoside. (1+1+3)

2. What are the different types of enzymes? With two chemical reactions, show how enzymes act as catalysts? (2+3)

3. Write in full form of DNA. Explain the Watson and Crick model of DNA helix. (1+4)

4. What is lipid? Write the name of two saturated and unsaturated fatty acids. Write two functions of lipids. (1+2+2)

5. Write three sources of carbohydrate. How many types of compound carbohydrates are there and what are those? Write the nutritional significance of carbohydrate. (1+2+2)

Teacher's Note

- For this chapter, read the chemical composition and metabolic reactions properly.
- Refer to paragraph no. 9.12.4 of textbook for answering Q.B.3 of "Do it Yourself" section.
- Refer to paragraph no. 9.8 (page 151 and 152) of textbook for answering Q.C.3 of "Do it Yourself" section.

UNIT - III
CHAPTER - 10
CELL CYCLE AND CELL DIVISION

IMPORTANT CONCEPTS

- Cell division is an important process in all living organisms. DNA replication and cell growth takes place during cell division.
- The sequence of events by which a cell duplicates its genome, synthesises the other constituents of the cell and eventually divides into two daughter cells is called cell cycle.
- **Phases of cell cycle -**

→ Cell cycle is divided into two phases -

(I) Interphase (II) Mitotic phase or M-phase.

- Interphase is divided into three phases namely, G1, S and G2 phases.
- M-phase is divided into karyokinesis and cytokinesis. Karyokinesis is further divided into prophase, metaphase, anaphase and telophase.

(I) Interphase : It is divided into three phases.

1) **G_1 phase :** The interval between mitosis and initiation of DNA replication is called G1 phase. In this phase, the cell divides rapidly and remains metabolically active.

2) **S-phase or synthesis phase :** DNA synthesis or replication takes place. The amount of DNA gets doubled in each cell. But, the number of chromosomes remain unchanged.

3) **G_2 phase :** Proteins are synthesised as a preparation for mitosis while cell growth continues. Synthesis of different RNA molecules (t-RNA, m-RNA, r-RNA) occurs.

G_0 phase : In adult animals, some cells do not appear to exhibit division and many other cells divide occasionally. These cells do not divide further, hence exit G1 phase and enters an inactive stage called quiescent stage or G0 phase of the cell cycle.

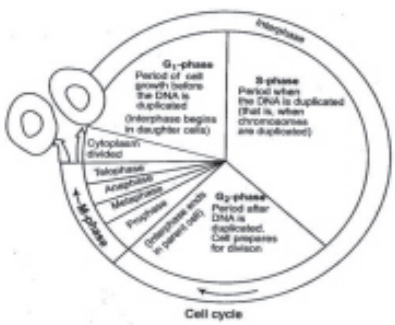


Figure: 10.1 Cell Cycle.

(II) M-phase :

- After interphase, the cell enters the M-phase or mitotic phase.
- Mitotic phase is called equational division. Since number of chromosomes in the parent and progeny is same.

  Mitosis can be divided into 4 stages :

1) Prophase :

- Prophase is the first stage of mitosis which follows S and G2 phase of interphase.
- Chromosomal material condenses to form compact mitotic chromosomes.
- In this stage, the centrioles start moving towards opposite poles.
- Chromosome gets divided longitudinally along the centromere and forms two chromatids which remains attached together at the centromere region.
- At the end of prophase, the cells do not show golgi complexes, endoplasmic reticulum, nucleolus and the nuclear envelope.

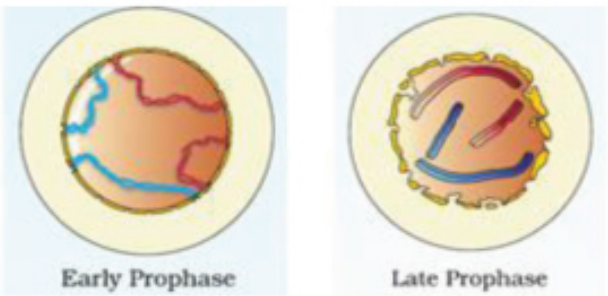


Figure: 10.2 Prophase.

2) Metaphase:

- Complete disintegration of nuclear envelope occurs at the beginning of metaphase.
- Morphology of chromosomes can be easily studied.
- Spindle fibres attach to the kinetochores of chromosomes.
- Chromosomes are moved to spindle equator and gets aligned along metaphase plate through spindle fibres to both the poles.

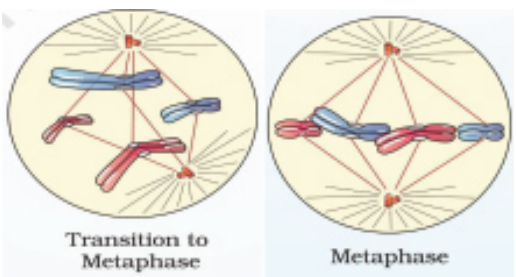


Figure:10.3 Metaphase.

3. Anaphase :

- Centromere gets spitted and chromatids get separated.
- Chromatids move towards opposite poles.
- The chromosomes remain in V, L, J and I shapes based on the position of the centromere.

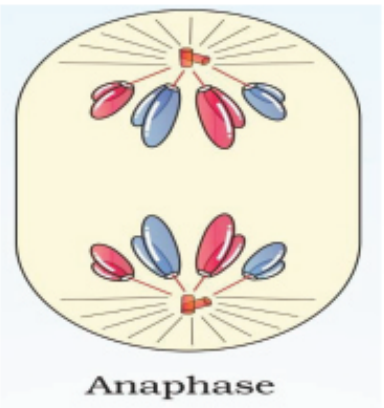


Figure: 10.4 Anaphase.

4. Telophase :

- It is the last phase of mitosis.
- Chromosomes cluster at opposite spindle poles and their identity is lost as discrete elements.
- Nuclear envelope assembles around the chromosome cluster.
- Nucleolus, golgi complex and endoplasmic reticulum gets reformed.

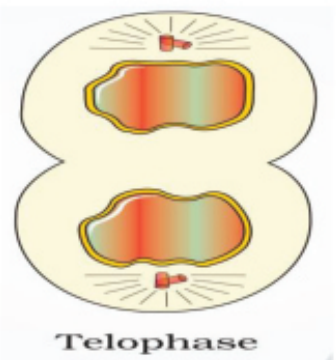


Figure : 10.5 Telophase.

Cytokinesis :

- After karyokinesis, the two daughter cells are formed by the division of the cytoplasm present in between two daughter nuclei.
- In animal cells, a furrow appears in the plasma membrane and gradually deepens, ultimately reaching the centre, hence dividing the cell cytoplasm into two equal parts.
- In plant cells, cell wall formation starts from the centre of the cell and grows outward to meet the

existing lateral walls, and forms the cell plate.

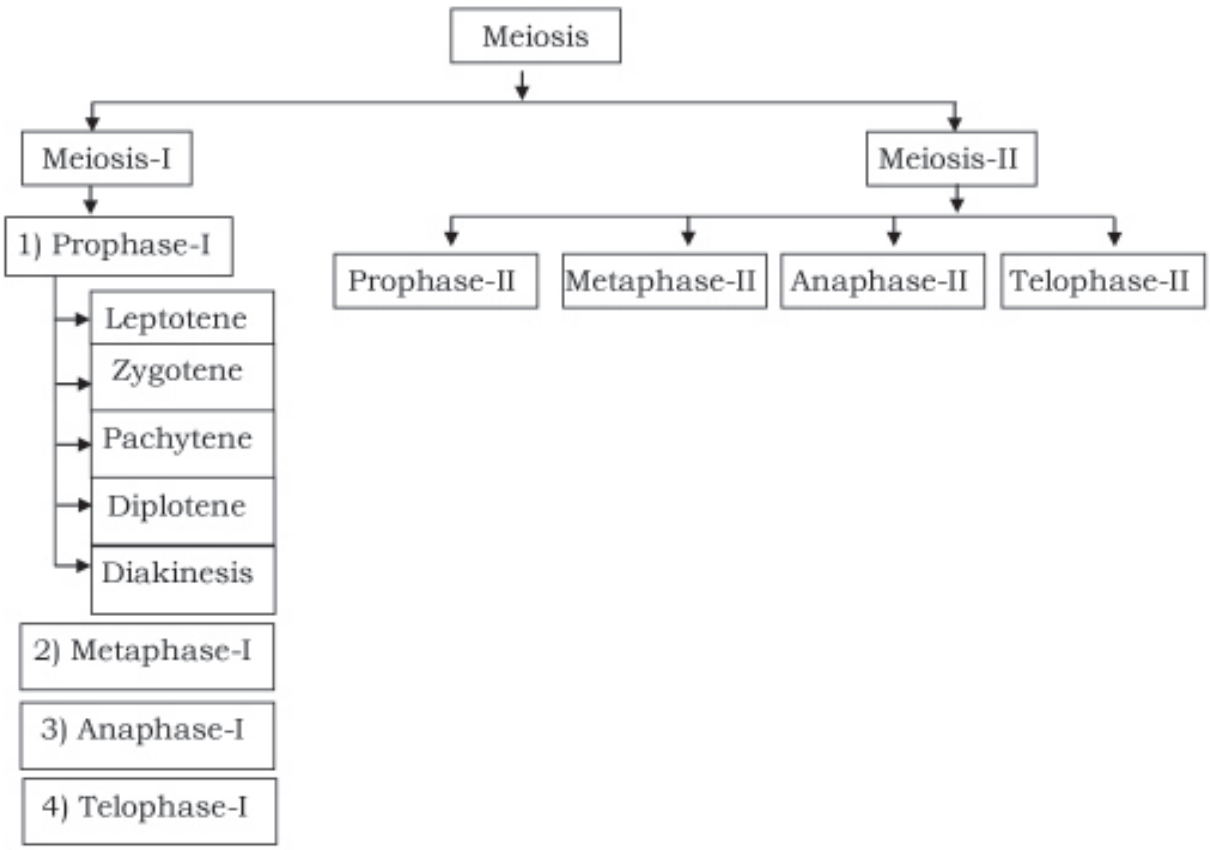
- Cellulose gets accumulated around two sides of the cell plate forming the cell wall, and cytoplasm divides to form two daughter cells.

Significance of mitosis :

- Mitosis or equational division results in the production of diploid daughter cells with identical genetic component.
- Regeneration of multicellular organisms, cell repair, etc. occurs as a result of mitosis.
- Growth of apical meristem and lateral cambium occurs as a result of mitosis.

Meiosis :

- In this type of cell division, the diploid mother cell divides two times, one after another to produce four haploid daughter cells.
- Meiosis-I is reductional division and meiosis-II is equational division.
- Meiosis involves pairing of homologous chromosomes and recombination between them.



A) Meiosis-I : It has been divided into 5 subphases.

1) Leptone:

- Compaction of chromosome continues.

- Nuclear membrane and nucleolus are clearly visible.
- Astral rays are formed from the two centrioles in animal cells.

2) Zygotene :

- Chromosomes start pairing together, which is called as synapsis.
- Paired chromosome are called homologous chromosomes.

The synapsed homologous chromosomes form a complex called bivalent or tetrad.

3) Pachytene :

- In this sub-phase, crossing over occurs between the non-sister chromatids of homologous chromosomes resulting in the exchange of genetic material between two homologous chromosomes.

4) Diplotene :

- Dissolution of synaptonemal complex takes place, and recombined homologous chromosomes of the bivalents tend to separate from each other except at the sites of crossing over.
- X- shaped structures called chiasmata is formed by crossing over between homologous chromosomes.

5) Diakinesis :

- Terminalisation of chiasmata occurs continuously. Condensation of chromosomes takes place.
- The nuclear envelope breaks down and nucleolus disappears.

Metaphase-I:

- Bivalent chromosomes align on the equatorial plate of the cell.
- Microtubules from the opposite poles of the spindle attach to the pair of homologous chromosomes.

Anaphase - I :

- The homologous chromosomes separate. Sister chromatids remain associated at their centromeres.

Telophase - I :

- Nuclear membrane and nucleolus reappear.
- Cytokinesis follows, which is called as dyad of cells.
- The stage between two meiotic divisions is called interkinesis.

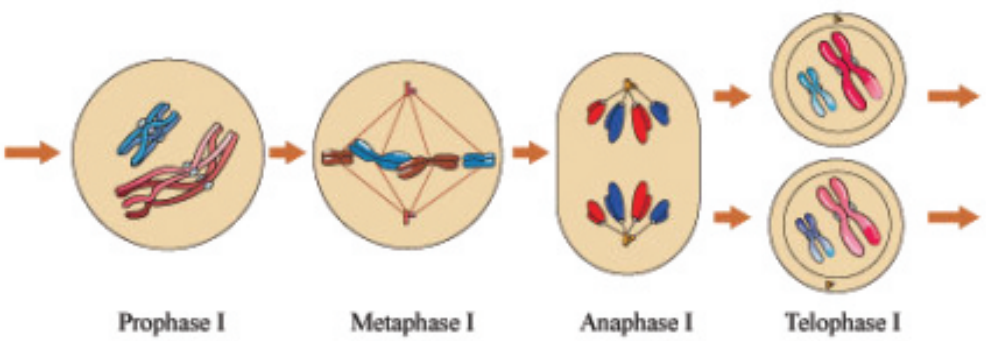


Figure:10.6 Stage of Meiosis-I.

B) Meiosis-II :

- Meiosis-II division is like mitotic division.
- Meiosis-II has four sub-phases, which are prophase-II, metaphase-II, anaphase-II and telophase-II.

1) Prophase - II :

- Nuclear membrane disappears.
- The chromosomes become compact again.

2) Metaphase - II :

- Chromosomes align at the equator and the microtubules from the opposite poles of the spindle get attached to the kinetochore of sister chromatids.

3) Anaphase - II :

- Simultaneous splitting of centromere of each chromosome occurs in the beginning of this sub-phase, and the chromosomes move towards the opposite poles of the cell.

4) Telophase - II :

- Daughter chromosomes accumulate at the poles. Nuclear membrane is formed.
- Nucleolus is reformed, astral rays and spindle fibres disappear.
- Cytokinesis follows resulting in the formation of tetrad of cells i.e., four haploid daughter cells.

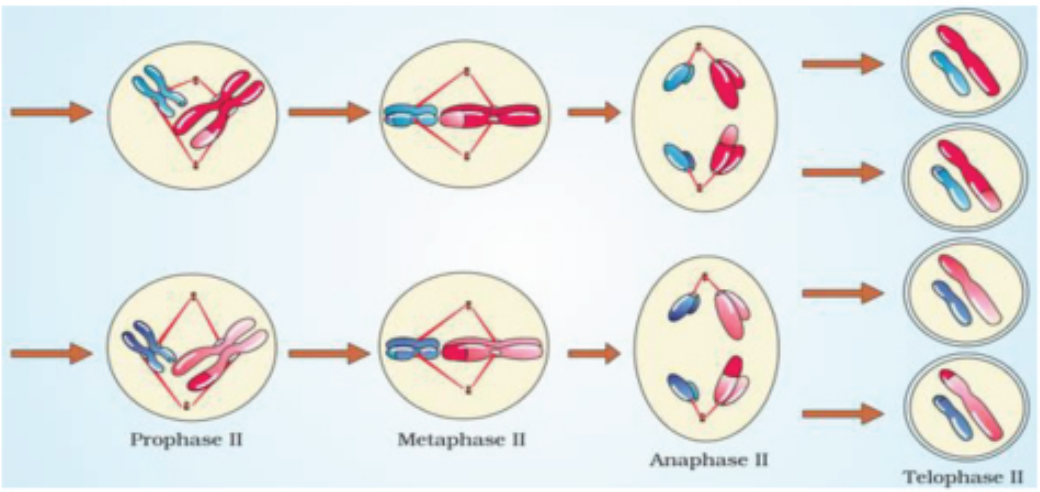


Figure: 10.7 Different stage of Meiosis-II.

Significance of Meiosis:

- It helps in formation of reproductive cells by the process of gametogenesis. In lower plants, haploid (n) gametes are produced by the process of sporogenesis.

- ♦ It is a mechanism by which conservation of chromosome number in each species is achieved.
- ♦ It increases the genetic variability in the population of organisms from one generation to another. Variations are very important for the process of evolution.

QUESTION AND ANSWER

A) Objective type questions. **[1 mark]**

I) Choose the most appropriate option from the following:

1) Generally, the structural constituents of spindle fibres are -

a) Actin b) Myosin c) Tubulin d) None of these.

Ans. (c) Tubulin.

2) During which of the following phases, the chromosomes are seen as thread like structures?

a) Leptotene b) Zygotene c) Pachytene d) Diplotene

Ans. (a) Leptotene.

3) During which phase of meiosis, does centromere get divided?

a) Anaphase-I b) Anaphase-II c) Telophase-I d) Telophase -II.

Ans. (b) Anaphase-II.

4) The pairing of chromosomes during zygotene phase is called as ____

a) Crossing over b) Synaps is c) Terminalisation d) None of the above.

Ans. (b) Synaps is.

II) Fill in the blanks :

1) Nuclear division is called as ____

Ans. Karyokinesis.

2) The phase between meiosis-I and meiosis-II is called ____

Ans. Interkinesis

3) In synthesis phase or S-phase, synthesis of ____ takes place.

4) Chromosomes are moved to spindle equator in ____ of mitosis.

III) State whether the following are true or false:

1) Mitotic cell division is called equatienal division.

Ans. True.

2) The cell cycle time of human cells is 24 hours.

Ans. True.

3) Nucleolus gets reformed in anaphase of mitosis.

Ans. False.

4) At the end of meiosis-II, 8 nos. of haploid cells are produced.

Ans. False.

B) Very short answer type questions. [1 mark]

1. Which type of cell division is called reductional division?

Ans. Meiosis.

2. Between prokaryotic cell and eukaryotic cell, which bears shorter length of cell division?

Ans. Prokaryotic cell.

3. In which part of plant and animal cells meiosis is found?

Ans. Gamete producing diploid cells.

4. When is nueclear membrane appeared in cell division?

Ans. In Telophase.

C) Short answer type questions. [2 marks]

1) Write the difference between cytokinesis and karyokinesis.

Ans. Cytoplasmic division is called cytokinesis. On the other hand, nuclear division is called karyokinesis. In cytokinesis, cytoplasm of mother cell divides to produce two daughter cells. In karyokinesis, mother nucleus divides to produce two daughter nucleus.

2) What is Go phase? Name a cell which never ever undergoes cell division.

Ans. Go phase is such a phase where the cell does not undergo division, but remains metabolically active.

Neuron does not undergo cell division ever.

3) A cell has 32 chromosomes. If this cell undergoes mitotic division, then -

a) What will be the number of chromosomes in metaphase?

b) What will be the amount of DNA in anaphase?

Ans. a) The number of chromosomes in metaphase will be 32.

b) The amount of DNA content will be same as that of the mother cell, that is 32.

DO IT YOURSELF

A) Short Answer Type Questions. [2 marks]

1. Name the phases of the cell cycle in which the below mentioned events get completed.

a) Chromosomes remains attached to the spindle fibres at the equational plate.

b) Division of centromere occurs and chromatids get separated. (1+1)

2. What is centriole? Write its function(s). (1+1)

3. What is kinetochore? Write its function(s). (1+1)

4. Write two significances of mitosis. (2)

5. Identify the labelled parts of the given diagram. (2)

B) Short Answer Type Questions. [3 marks]

1. Write the differences between mitosis and meiosis. (3)

2. Give a brief description of the following:

   a) Synapsis b) Bivalent c) Chiasmata. (1+1+1)

3. Write about mitosis cell division in brief. (3)

4. Write the difference between mitotic anaphase and meiotic anaphase-I. (3)

C) Long Answer Type Questions. [5 marks]

1. What is cell cycle? What are the different phases of cell cycle? Draw a labelled diagram of the cell cycle. (1+1+3)

2. What are the different sub phases of prophase-I of meiosis? Write two characteristic each of these sub phases. (1+4)

3. Analyse the events of each and every phase of the cell cycle, and notice how the following two parameters change:

a) Number of chromosomes (N) per cell.

b) Amount of DNA content (C) per cell. (2½+2½)

4. Draw a labelled diagram of anaphase of mitosis. Write any three characteristic features of this phase. What do you mean by interphase? (1+3+1)

Teacher's Note

- Draw the cell cycle properly to understand cell division.
- The characteristic features of each phase of mitosis and meiosis have to be studied with the help of diagrams.
- In 'Do It Yourself Section' –

  i) Q.II(3) is to be answered mentioning points for each phase with appropriate diagram.

  ii) Q.III(2) must be answered with appropriate diagram.

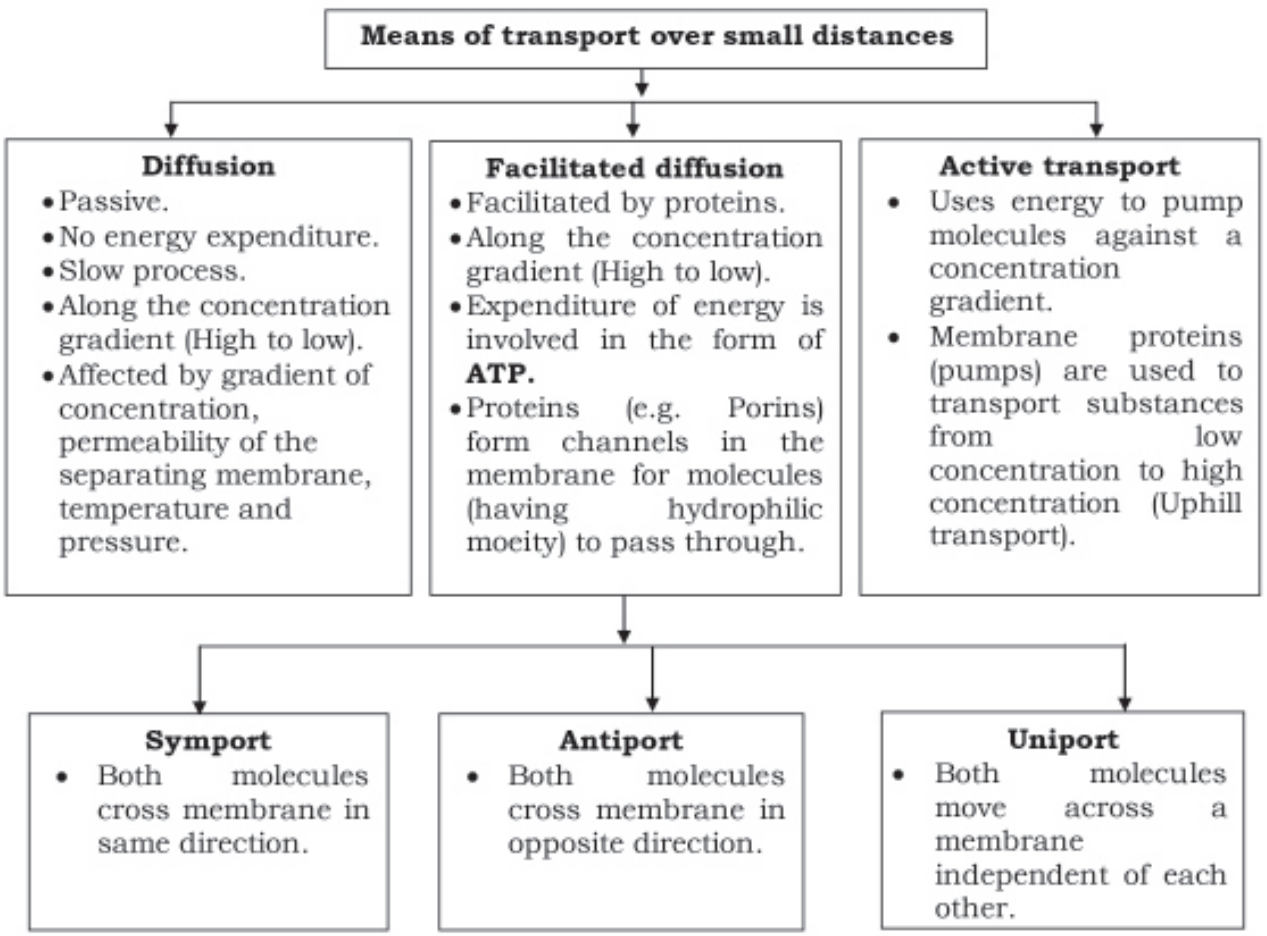
UNIT - IV

CHAPTER - 11

TRANSPORT IN PLANTS

IMPORTANT CONCEPTS

- Substances like water, mineral nutrients, organic nutrients and plant growth regulators need to be transported in flowering plants.
- Transport of substances over short distances occur by diffusion, cytoplasmic streaming, supplemented by active transport.
- Transport of substances over long distances proceeds through the vascular system (xylem and phloem). This is known as translocation.



- Some carrier protein allow diffusion only if two types of molecules move together.

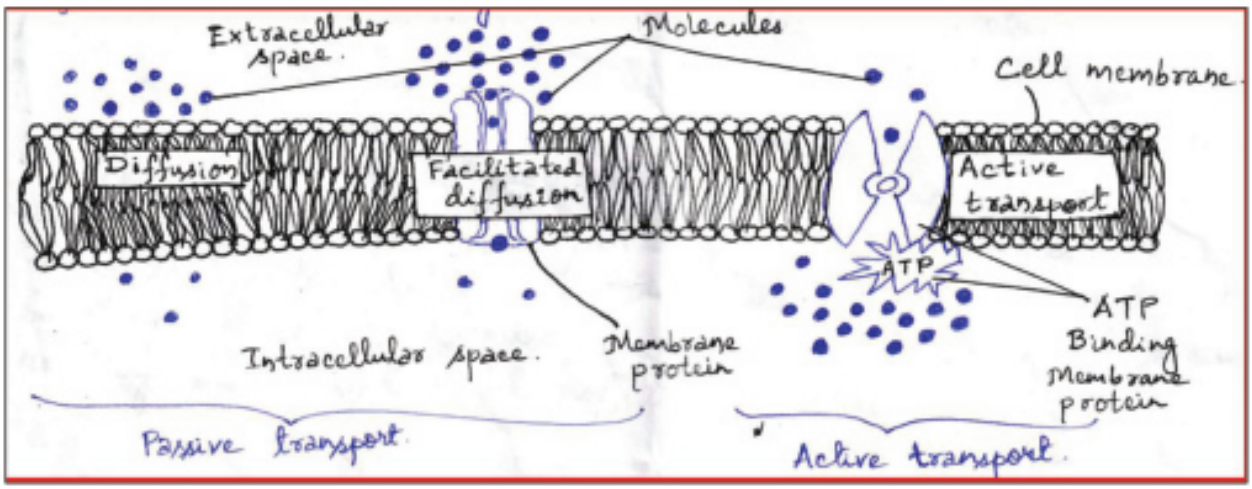


Fig 11.1 Different means of transport over short distances.

- Loss of water into the air in the form of water vapour by evaporation from leaves is called as transpiration.
- Pure water at standard temperature, which is not under any pressure, water potential is taken to be zero. If a pressure greater than atmospheric pressure is applied to pure water, its water potential increases. Pure water will have greatest water potential(?w). If some solute is dissolved in pure water, its water concentration decreases, hence the water potential decreases. The magnitude of this lowering down of water potential due to dissolution of a solute is called as solute potential(?s), which is always negative. When water entres a plant cell due to diffusion, it causes a pressure build up against the cell wall, making the cell turgid. This increases the pressure potential(?p), which is usually positive. Water potential of a cell is affected by both solute and pressure potential. The relationship between them is as follows:
- Osmosis is referred to diffusion of water across a semi permeable membrane. Water will move from its region of higher concentration to its region of lower concentration until equilibrium is reached.
- The behaviour of the plant cell with regard to water movement depends on the surrounding solution. When the external solution is more dilute than the cytoplasm, then it is called as hypotonic solution. When the external solution is more concentrated, it is called as hypertonic solution. When the external solution balances the osmotic pressure of the cytoplasm, it is called as isotonic solution.
- Shrinkage of the cell membrane of a plant cell, when water moves out of the cell on putting it in a hypertonic solution, is called as plasmolysis. The process of plasmolysis can be reversed when the cells are placed in a hypotonic solution. During this, water diffuses into the cell causing the cytoplasm to build up a pressure against the wall, called as turgor pressure, resulting into turgid state of the cell.

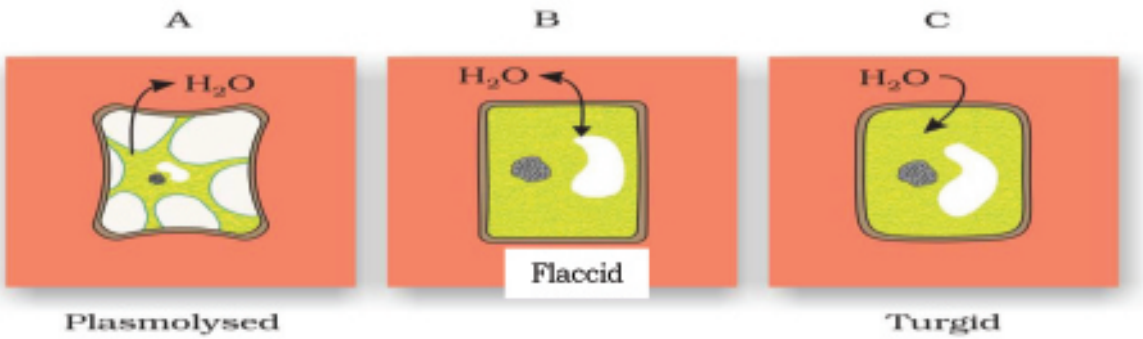


Fig 11.2 Plant cell plasmolysis.

♦ Sometimes, seeds and dry wood absorb water. This phenomenon of absorption of water by solids, causing them to increase their volume, is called as imbibition.

Means of transport over long distances

Water

Organic & Inorganic molecules

Inside the root
- Water along with mineral solutes is absorbed by root hair by diffusion.

Inside the xylem
- Water and minerals are generally moved by **mass flow or bulk flow.**

Inside the phloem
- Phloem sap (Water, sucrose, sugars, hormones, amino acids) are **translocated** through phloem by **pressure flow or mass flow.**

(Absorbed water can move deeper into root layers by two distinct pathways).

Root pressure
- Positive hydrostatic pressure used for pushing water to small heights.

Transpiration pull
- Water is pulled through plant by transpiration→ cohesion - tension - transpiration pull.

Apoplast
- System of adjacent cell walls, continuous throughout the plant, except at **casperian strips** of the endodermis.
- Along concentration gradient.
- Movement of water through intercellular spaces, does not involve crossing cell membrane.

Symplast
- System of inter connected protoplast.
- Cytoplasmic strands that extend through **plasmodesmata** connect neighbouring cells.
- Movement of water through cytoplasm and intercellular movement of water through plasmodesmata.
- Along the connection gradient.

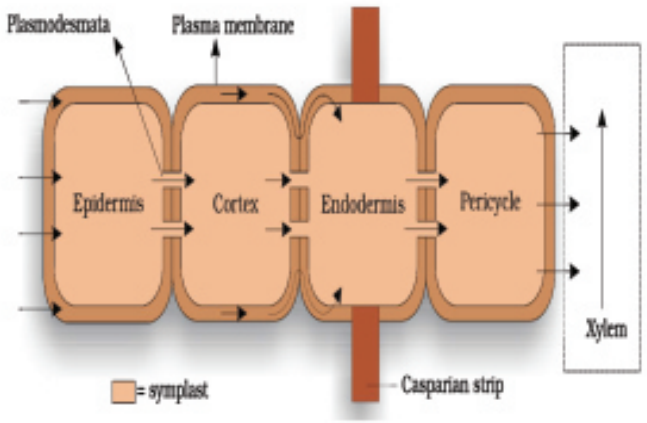


Fig 11.3 Pathway of water movement in the root.

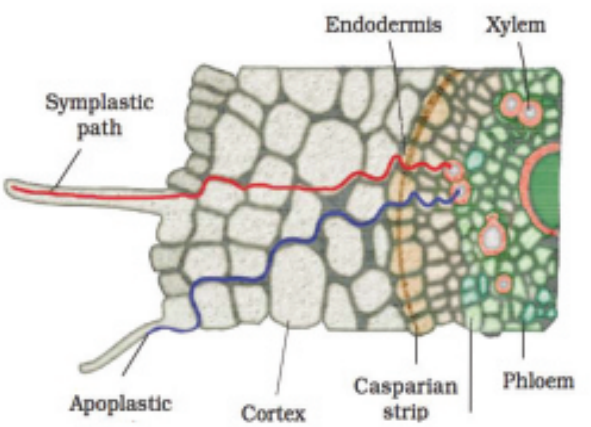


Fig 11.4 Water and ion movement from root hair to xylem by symplastic and apoplastic pathways.

- A mycorrhiza is a symbiotic association of a fungus with a root system. The fungus provides minerals and water to the root, in turn the roots provide sugars and nitrogen containing compounds to the mycorrhiza.
- Water loss by plants in the liquid form, from the open veins at the tip of the leaves is called as guttation.
- Loss of water by evaporation by the plants is called as transpiration. It mostly occurs through the stomata, when the stomatal aperture opens because of change in the turgidity of the guard cells of the stomata.
- Transpiration driven ascent of sap of the xylem depends on three important physical properties of water, mainly. These are -

i) Cohesion - Mutual attraction between water molecules.

ii) Adhesion - Attraction between water molecules and polar surfaces like surface of tracheary elements.

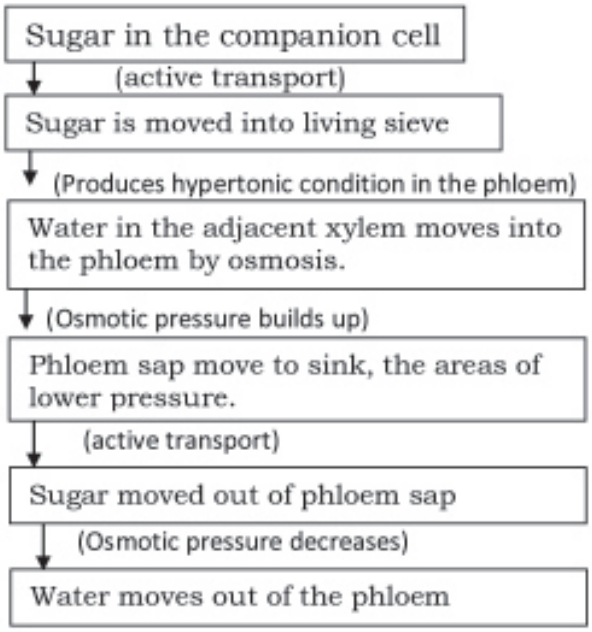
iii) Surface tension - Water molecules are attracted to each other in the liquid phase more than that of in gaseous phase.

All these properties given water high tensile strength (ability to resist a pulling force), and high capillarity (ability to rise in the tubes), aided by the tracheids and vessel elements of the xylem.

- Because of lower concentration of water vapour in the atmosphere, water evaporates through stomata, creating a transpiration pull of water, molecule by molecule, into the leaf from the xylem.
- Most minerals enter the root by active transport (absorption), since minerals are present in the soil as charged ions, which cannot move across the cell membrane. Also, the concentration of minerals is usually lower in soil than that of root.
- Phloem sap (primarily sucrose), is transported by the phloem from a source to a sink. A source is the part of the plant which synthesizes food, and sink is the part of the plant that needs or stores

the food. The direction of movement in the phloem can be upwards or downwards, i.e., bidirectional, since the source-sink relationship is variable. Whereas, the direction of movement in xylem is always unidirectional, i.e., upwards.

- Movement of sugars in the phloem begins at the source, where sugars are loaded into a sieve tube by active transport. This sets up a water potential gradient facilitating the mass movement in the phloem.



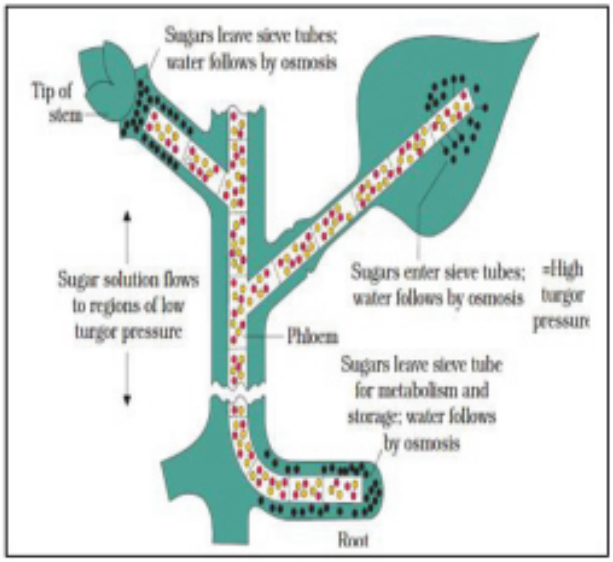


Figure: Flow diagram to show the mechanism of translocation.

QUESTION AND ANSWER

A) Objective Type Questions. **[1 mark]**

I) Choose the most appropriate option from the following:

1. Water potential is affected by -

a) Pressure potential (b) Solute potential (c) Both option (a) and (b) are correct
d) None of the above.

Ans. (c) Both option (a) and (b) are correct.

2. The cell is said to be plasmolysed when -

a) The cell is turgid

b) The cell is placed in a hypertonic solution

c) The cell is placed in an isotonic solution

d) The cell is placed in a hypotonic solution.

Ans. (b) The cell is placed in a hypertonic solution.

3. Cytoplasmic strands which extend through _____ are connecting the neighbouring cells

in a plant.

a) Plasmodesmata b) Cytoskeleton c) Casperian strip d) None of the above.

Ans. (a) Plasmodesmata.

4. Transpiration is affected by -

(a) Temperature (b) Light (c) Humidity d) All of the above.

Ans. (d) All of the above.

5. Diffusion occurs -

a) Along the concentration gradient

b) Against the concentration gradient

c) By protein pumps

d) By active transport.

Ans. (a) Along the concentration gradient.

II) Fill in the blanks:

1. During imbibition, water is absorbed by _____.

Ans. Solids.

2. Mutual attraction between water molecules is called as _____.

Ans. Cohesion.

3. Sucrose is moved from companion cells to sieve tubes by _____.

Ans. Active transport.

4. Direction of movement in phloem is _____.

Ans. Bidirectional.

5. Loss of water in liquid form is known as _____.

Ans. Guttation.

III) State whether the following statement are true or false:

1. Endodermis is impervious to water because of casperian strip.

Ans. True.

2. A mycorrhiza is a parasitic association of a fungus and roots.

Ans. False.

3. Active transport follows uphill transport.

Ans. True.

4. Facilitated diffusion does not require special membrane proteins.

Ans. False.

5. Water channels are made up of eight different aquaporins.

   Ans. True.

IV) Match column A with column B:

Column - A	**Column - B**
a) Xylem	i) Loss of water in liquid form
b) ATP expenditure	ii) Always negative
c) Solute potential	iii) Tracheids
d) Capillarity	iv) Unidirectional transport
e) Guttation	v) Against the concentration gradient

Ans. (a-iv; b-v; c-ii; d-iii; e-i).

B) Very Short Answer Type Questions. **[1 mark]**

1. What is translocation?

   Ans. Transport of water, minerals, organic materials, etc over long distances through xylem and phloem is called as translocation.

2. What is diffusion?

   Ans. Diffusion is passive movement of molecules over a short distance, like from cell to cell.

3. What do you mean by osmosis?

   Ans. Osmosis refers to diffusion of water through a semi permeable membrane where water moves from its region of higher potential to its region of lower potential.

4. What is an isotonic solution?

   Ans. When the external solution balances the osmotic pressure of the cytoplasm of the cell placed in it, the solution is called as isotonic solution.

5. What is transpiration?

   Ans. Loss of water in its vapour form by evaporation by the plants is called as transpiration.

DO IT YOURSELF

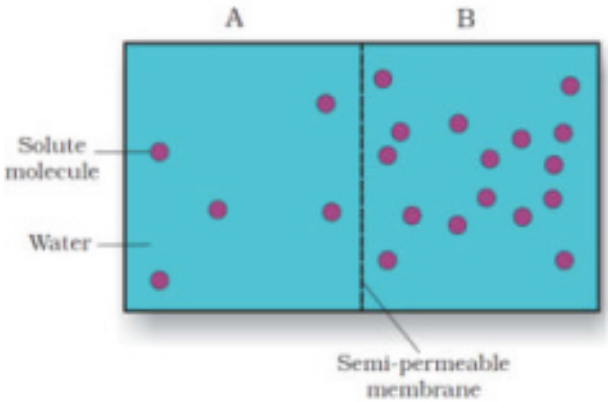
A) Short Answer Type Questions. **[2 marks]**

1. Describe the different pathways of water movement in the root in brief. (2)
2. Define plasmolysis. (2)
3. Explain water potential in reference to solute potential and pressure potential. (1+1)

B) Short Answer Type Questions. **[3 marks]**

1. Explain the three different physical properties of water which effects the transpiration driven ascent of xylem sap. (1+1+1)

2. In the given diagram-



a) Solution of which chamber has a lower water potential? (1)

b) Which solution has a higher solute potential? (1)

c) In which direction will osmosis occur? (1)

3. Transpiration has more than one purpose. Explain. (3)

C) Long Answer Type Questions. [5 marks]

1. Describe the mechanism of translocation with the help of a diagram. (2+3)
2. Explain different types of facilitated diffusion with the help of a diagram. (3+2)
3. What do you mean by capillarity in plants? Which tissues are responsible for capillarity in plants? Draw the diagram to show water movement in leaf. (1+1+3)

Teacher's Note

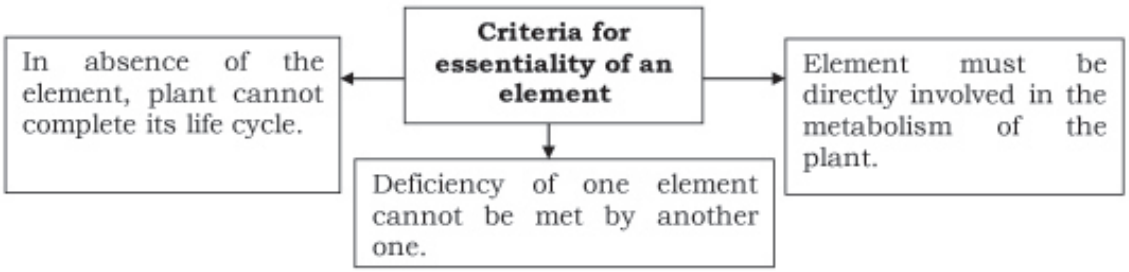
Take care of the following points in the 'Do it yourself' section:

- Draw diagrams while answering Q.A.1 and Q.A.2 (Refer figure 11.3 and 11.2 of this workbook for Q.A.1 and Q.A.2, respectively).
- In Q.A.3, don't forget to write the equation ?w = ?s + ?p
- Refer figure 11.6 of this book for answering Q.C.1.

UNIT - IV
CHAPTER - 12
MINERAL NUTRITION

IMPORTANT CONCEPTS

- The technique of growing plants in a nutrient solution in complete absence of soil, known as **hydroponics**, was demonstrated for the first time by **Julius Von Sachs** in **1860.**



- Based on the above criteria, only **17** elements have been found to be absolutely necessary for plant growth and metabolism. These elements have been broadly categorised into **two** based categories: **i) Macronutrients**; **ii) Micronutrients.**

Macronutrients (Large amount - in excess of 10 mmole kg^{-1} of dry matter).	Carbon, Hydrogen, Oxygen, Nitrogen, Phosphorus, Sulphur, Potassium, Calcium and Magnesium.
Micronutrients (Very small amount - less than 10 mmole kg^{-1} of dry matter).	Iron, Manganese, Copper, Molybdenum, Zinc, Boron, Chlorine and Nickel.
** Sodium, Silicon, Cobalt and Selenium are required by higher plants in addition to the essential elements.	

- Essential elements can be grouped into **four** broad categories on the basis of their functions:

Components of biomolecules	**Components of energy related chemical components**	**Activator or inhibitor of enzyme**	**Alter osmotic potential of a cell**
e.g. - Carbon, Hydrogen.	e.g. - Phosphorus in ATP.	e.g. - Zinc activates alcohol dehydrogenase.	e.g. - Potassium plays important role in opening and closing of stomata.

- Several functions of essential elements:

Nitrogen	Phosphorus	Potassium	Calcium	Magnesium	Sulphur	Iron
→ Needed in greatest amount. → Required by all plant parts, specially meristamatic tissues and metabolically active cells. → One of the major constituents of proteins, nucleic acids, vitamins and hormones.	→ Constituent of cell membranes, all nucleic acids, certain proteins, nucleotides. → Needed for all phosphorylation reactions.	→ Required more in meristematic tissues, buds, leaves and root tips. → Helps to maintain an anion-cation balance in cell. → Involved in protein synthesis, opening and closing of stomata, activation of enzymes, maintenance of turgidity of the cell.	→ Uses as calcium pectate during synthesis of cell wall during cell division. → Needed in formation of mitotic spindle. → Involved in normal functioning of cell membrane. → Activates certain enzymes and plays important role in regulating metabolic activities.	→ Activates enzyme for respiration, photosynthesis. → Involved in synthesis of DNA and RNA. → Helps to maintain ribosome structure. → Is a constituent of structure of ring of chlorophyll.	→ Present in two amino acids cysteine and methionine. → Main constituent of several coenzymes, vitamins (thiamine, biotin, coenzyme A and ferredoxin.	→ Important constituents of proteins. → Involved in transfer of electrons like ferredoxin. → Activates catalase enzyme. → Essential for formation of chlorophyll.

Manganese	Zinc	Copper	Boron	Molybdenum	Chlorine
→ Activates many enzymes involved in photosynthesis, respiration, nitrogen metabolism. → Splitting of water to liberate oxygen during photosynthesis.	→ Activates carboxylase. → Needed in synthesis of auxin.	→ Essential for overall metabolism of plants. → Associated with several enzymes involved in redox reactions.	→ Uptake and utilisation of calcium. → Membrane functioning. → Pollen germination. → Cell elongation and differentiation. → Carbohydrate translocation.	→ Component of several enzymes like nitrogenase and nitrate reductase.	→ Helps in determining solute concentrateion and anion-cation balance of cell. → Needed in water splitting reaction in photosynthesis.

♦ Limited supply of any essential element results in retardation in plant growth. And, the concentration below which plant growth is retarded, is called as critical concentration. When the element is present below critical concentration, it is said to be deficient. This leads to morphological changes in plants and are called as deficiency symptoms, for example - chlorosis.

- Moderate increase of essential elements in plants, lead to toxicity of micronutrients. For example, excess of manganese inhibits translocation of calcium in shoot apex.
- Absorption of elements by the plants are carried out in isolated cells, tissues or organs. It occurs in two phases- rapid uptake of ions into the outer space (apoplast) of cells in a passive process; then in the second phase, ions are taken slowly into the inner space (symplast) of the cells in an active process.
- The movement of ions into the cells is called flux. Influx is the inward movement into the cells; and efflux is the outward movement.
- Nitrogen cycle is a series of natural processes by which nitrogen is converted in multiple chemical forms as it circulates among atmosphere, terrestrial and marine ecosystems. Steps involved in nitrogen cycle:

i) Nitrogen fixation	Process of conversion of nitrogen into ammonia.
ii) Ammonification	Decomposition of organic nitrogen of dead plants and animals into ammonia.
iii) Nitrification	Ammonia is first converted into nitrite by the bacteria *Nitrosomonas* and/or *Nitrococcus*. $2NH_3 + 3O_2 \rightarrow 2NO_2^- + 2H^+ + 2H_2O$. Then, nitrite is oxidised to nitrate with the help of bacterium *Nitrobacter*. $2NO_2^- + O_2 \rightarrow 2NO_3^-$
iv) Denitrification	Nitrate present in the soil is reduced to nitrogen by the bacteria *Pseudomonas* and *Thiobacillus*.

- The process by which nitrogen is reduced to ammonia by living organisms, is called as biological nitrogen fixation. Nitrogen reduction is done by the enzyme nitrogenase, present exclusively in prokaryotes.
- Nitrogen fixing micro-organism could be free living like Azotobacter (aerobic), Rhodospirillum (anaerobic).
- Several nitrogen fixing microorganisms could be symbiotic. Most prominent symbiotic biological nitrogen fixing association is the legume - bacteria relationship. Most common association on the roots is in the form of nodules produced by micro-organisms like Frankia, for example.
- Steps involved in nodule formation:

a) Rhizobium contact a susceptible root hair, and divides near it.

b) Successful infection of the root hair leads to its curling.

c) Infected root hair carries the Rhizobium to the inner cortex.

d) The bacteria gets modified into rod-shaped bacteriods and causes inner cortical and pericycle cells to divide, leading to nodule formation.

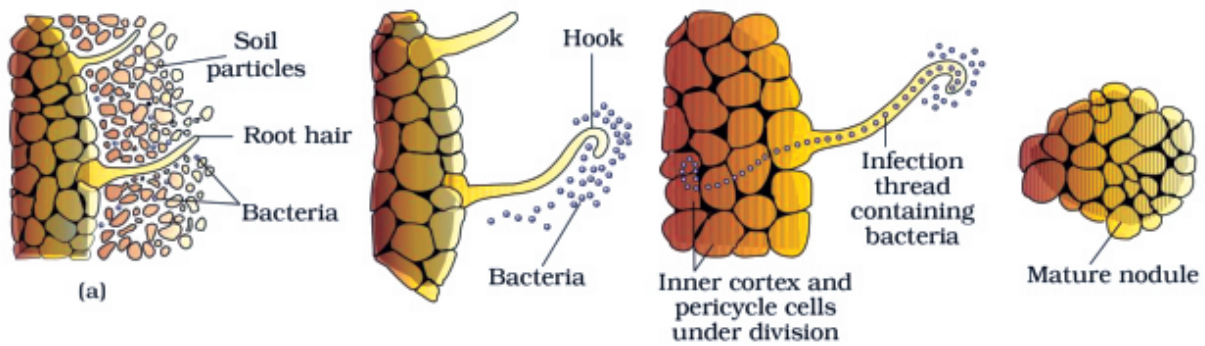


Fig.12.1 Development of root nodule in a leguminous plant.

- The nodule contains the enzyme nitrogenase, a Mo-Fe protein, catalyses the conversion of atmospheric nitrogen to ammonia. The reaction is as follows:

  $N2 + 8e + 8H+ + 16ATP \rightarrow 2NH3 + H2 + 16ADP + 16Pi.$

- The nodule also bears an oxygen scavenger called leg haemoglobin, which protects the enzyme nitrogenase from oxygen since nitrogenase is highly sensitive to molecular oxygen, and can function only in anaerobic conditions. Ammonia is the first stable product of Nitrogen fixation.

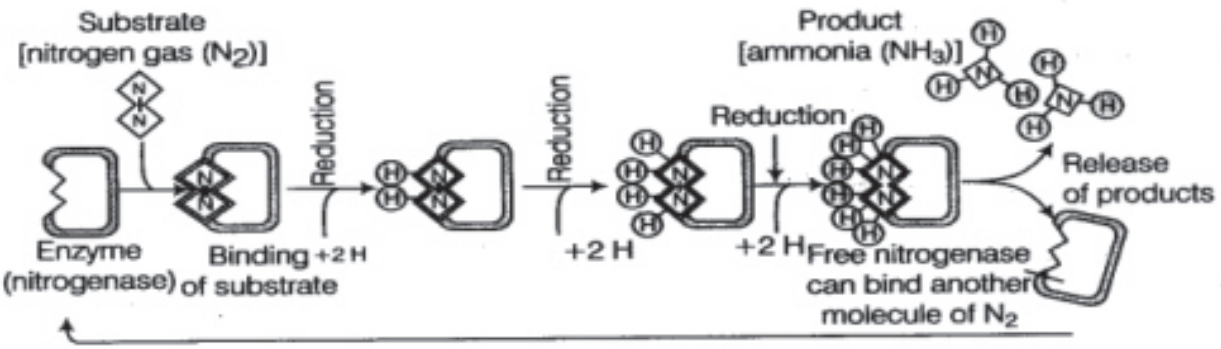


Fig.12.2 Steps of conversion of atmospheric nitrogen to ammonia by nitrogenase enzyme complex.

- The nodule is pink in colour because of the presence of leg-haemoglobin.
- Ammonia is protonated to form ammonium ion (NH4+) at physiological pH. But it is toxic for the plants, hence cannot get accumulated in plants. Hence, NH4+ is used to synthesise amino acids in plants by two main ways:

i) Reductive amination: Ammonia reacts with alpha ketoglutaric acids to form glutamic acid.

ii) Transamination: Involves transfer of amino group from one amino acid to the keto group of a keto acid.

♦ Aspargine and glutamine are the two most important amides found in plants. These are formed from two amino acids, aspartic acid and glutamic acid, respectively.

QUESTION AND ANSWER

I. Objective Questions. **[1 mark]**

Choose the most appropriate option from the following:

1. How many essential elements are required by the plants?

   a) 17 b) 20 c) 25 d) 15

   Ans. (a) 17

2. Nitrogen reduction is catalysed by the enzyme:

   a) Polymerase b) Nitrogenase c) Amylase d) None of these.

   Ans. (b) Nitrogenase

3. Aspargine is formed from :

   a) Glutamic acid b) Tartaric acid c) Maleic acid d) Aspartic acid

   Ans. (d) Aspartic acid

II. Fill in the blanks :

1. Yellowish edges appear in leaves deficient in _____ mineral.

   Ans. Potassium.

2. Complete the equating for reductive amination __?__ + NH4+ + NADPH (Glutamate)/ Dehydrogenase Glutamate + H2O + NADP.

   Ans. Alpha ketoglutaric acid.

3. Leg-haemoglobin is a _____ coloured pigment.

   Ans. Pink.

III. State whether the following statements are true or false :

1. Excess of manganese may induce deficiencies of iron and calcium.

   Ans. True.

2. Uptake of ions into the outer space of the cells (apoplast) is an active process.

   Ans. False.

3. Leguminous nodules protect the enzyme nitrogenase from oxygen.

   Ans. True.

iv. Match column A with column B:

Column – A	Column – B
a) Sulphur	i) One of the major constituents of nucleic acids, proteins.
b) Zinc	ii) Present in amino acid- cysteine.
c) Chlorine	iii) Auxin synthesis.
d) Nitrogen	iv) Water splitting reaction in photosynthesis.
Ans. a- ii; b- iii; c- iv; d- i	

B. Very Short Answer Type Questions. [1 mark]

1. Name the first stable product of nitrogen fixation.

   Ans. Ammonia is the first stable product of nitrogen fixation.

2. Which enzyme catalyses transamination reactions?

   Ans. The enzyme transaminase catalyses transamination reaction.

3. What is ammonification?

   Ans. The process of decomposition of organic nitrogen of dead plants and animals into ammonia is called as ammonification.

4. What is denitrification?

   Ans. Reduction of nitrate present in the soil into nitrogen by the bacteria Pseudomonas and Thiobacillus, is called as denitrification.

5. What is biological nitrogen fixation?

   Ans. The process by which nitrogen is reduced to ammonia by living organisms, is called as biological nitrogen fixation.

C. Short Answer Type Questions. [2 marks]

1. Describe the steps involved in nitrification.

   Ans. Nitrification occurs in two stages:

i) At first, ammonia is converted into nitrite by the bacteria Nitrosomonas and/or Nitrococcus, the reaction for which is $2NH_3 + 3O_2 \text{ ' } 2NO_2 + 2H^+ + 2H_2O$.

ii) Then, nitrite is oxidised to nitrate by the bacterium Nitrobacter, the reaction for which is $2NO_2 + O_2 \rightarrow 2NO_3$

D. Short Answer Type Questions. [3 marks]

1. What are the criterias for essentiality of an element?

   Ans. The criteria's for the essentiality of an element are as follows:

i) The plant cannot complete their life cycle in absence of that element. It is absolutely necessary for the normal growth and reproduction in plants.

ii) The requirement of the element must be specific and not replaceable by other element.

iii) The element must be directly involved in the metabolism of the plant.

DO IT YOURSELF

A) Short Answer Type Questions. **[2 marks]**

1. Nitrogen fixation is shown by prokaryotes and not by eukaryotes. Comment. (2)
2. What is role of Azotobacter for soil culture before growing maize? (2)
3. How are the terms 'critical concentration' and 'deficient' different from each other in terms of concentration of an essential element in plants? (2)

B) Short Answer Type Questions. **[3 marks]**

1. Carefully observe the following figure.

a) Name the technique shown in this figure and the scientist who demonstrated this technique for the first time. (1)

b) What is the significance of aerating tube in this setup? (1)

c) What is the use of feeding funnel in this set up? (1)

2. Comment on the fate of ammonia at the end of biological nitrogen fixation. (3)

C) Long Answer Type Questions. **[5 marks]**

1. Describe the classification of essential elements based on the functions they perform with the help of suitable examples. (5)
2. Give the biochemical events occurring in the root nodule of a leguminous plant. Write the reaction for ammonia formation from atmospheric nitrogen. Show the steps of conversion of atmospheric nitrogen to ammonia by nitrogenase enzyme complex diagrammatically. (2+1+2)
3. Trace the events starting from the coming in contact of Rhizobium to a leguminous root till nodule formation. Add a note on importance of leg haemoglobin. (3+2)
4. Describe the events of Nitrogen cycle. Draw a diagram to illustrate the nitrogen cycle. (3+2)

Teacher's Note

In the section "Do it yourself", take care of the following points.

- In Q.A.1., mention name of at least one prokaryote.
- In Q.B.2., show the chemical reactions also while answering.
- In Q.C.1., write the answer point wise.
- In Q.C.2., write the events systematically, point wise. Refer page no. - 203 of textbook for the reaction and the diagram (12.5).
- In Q.C.3., write the events sequentially. Draw the diagram (12.4) from page no. - 203 of textbook.
- In Q.C.4., write the events point wise. Mention the ammonification reactions (i & ii) from page no. - 201 of textbook.

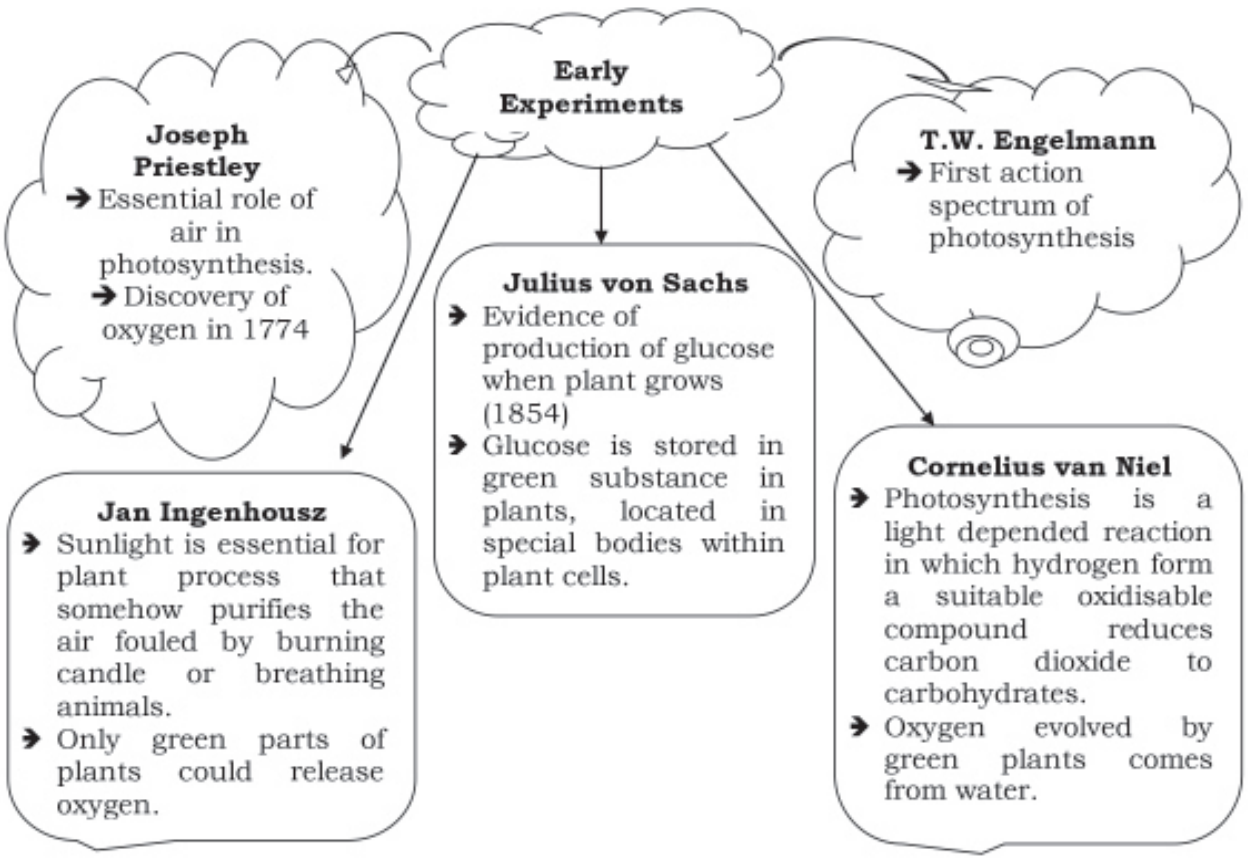
UNIT - IV

CHAPTER - 13

PHOTOSYNTHESIS IN HIGHER PLANTS

IMPORTANT CONCEPTS

- Simple experiments like looking for starch formation in leaves, requirement of CO2 and light for photosynthesis led to a gradual development in our understanding of photosynthesis.



- The correct equation representing the overall process of photosynthesis is:

$$6CO_2 + 12H_2O \xrightarrow{Light} C_6H_{12}O_6 + 6H_2O + 6O_2$$

where, C6H12O6 represents glucose.

- Mesophyll cells have a large number of chloroplasts aligned along the walls of the mesophyll cells, such that they get the optimum quantity of incident light.
- The chloroplast is having a membranous system consisting of grana, the stroma lamellae, and the fluid stroma.

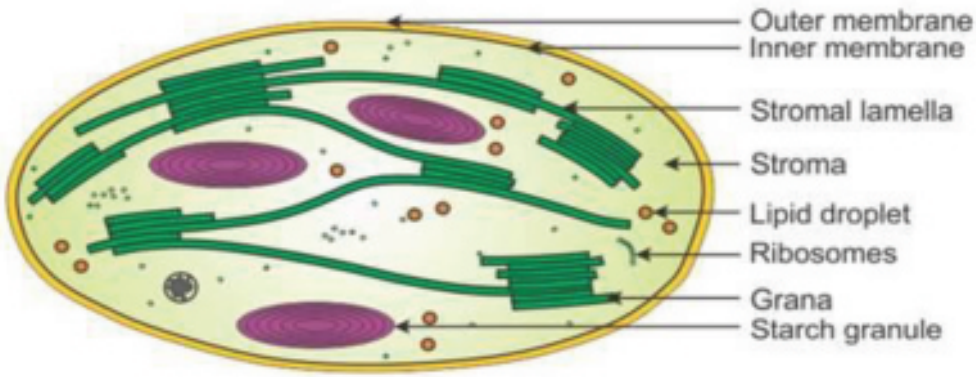


Figure: 13.1 Digramatic representation of an electron micrograph of a section of chloroplast.

- Light energy is trapped by the membrane system of the chloroplast. Synthesis of ATP and NADPH occurs in this membrane system, the set of reactions being called as light reactions, since they are directly light driven.
- Enzymatic reactions incorporating CO2 into the plant leads to the synthesis of sugar, which in turn forms starch. These reactions are not directly light dependent, but are dependent on the products of the light reactions. These are called as dark reactions.
- The colour that we see in leave is due to four pigments which can be separated by using the technique of paper chromatography. The pigments along with their colour in the chromatogram have been listed below:

Leaf pigments	**Colour in the chromatogram**
Chlorophyll a	Bright or blue green
Chlorophyll b	Yellow green
Carotenoids	Yellow to yellow - orange
Xanthophylls	Yellow

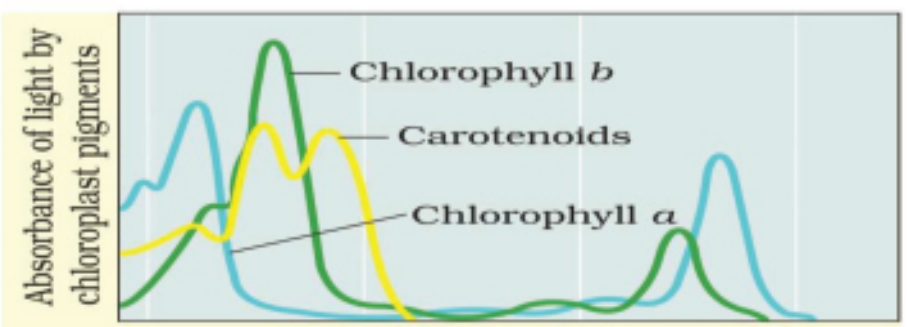


Figure: 13.2 Graph showing absorption spectrum of chlorophyll a, b and carotenoids.

- Chlorophyll a is the chief pigment associated with photosynthesis.
- Most of the photosynthesis occur in the blue and red regions of the spectrum. This can be

understood by the fact that maximum absorption by chlorophyll a occurs in the blue and red region of the spectrum, where the rate of photosynthesis is also higher.

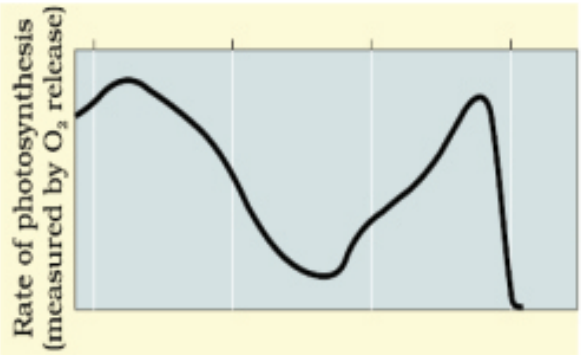


Figure: 13.3 Graph showing action spectrum of photosynthesis.

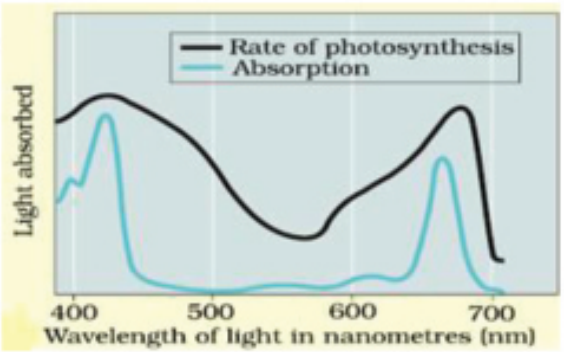


Figure: 13.4 Graph showing action spectrum of photosynthesis superimposed on absorption spectrum of chlorophyll a.

- Thylakoid pigments like chlorophyll b, xanthophylls and carotenoids are called as accessory pigments. These also absorb light and transfer the energy to chlorophyll a, hence enabling a wider range of wavelength of incoming light to be utilised for photosynthesis. These pigments also protect chlorophyll a from photo-oxidation.
- Photochemical phase involves the light reactions, which include light absorption, water splitting, oxygen release, and the formation of high energy chemical intermediates, ATP and NADPH.
- The pigments are organised into two discrete photo chemical light harvesting complexes (LHC) within the photosystem I (PS I) and Photosystem II (PS II). Each photosystem has all the pigments except one molecule of chlorophyll a forming a LHC, also called as antennae. The single chlorophyll a molecule forms the reaction centre, which is different in both the photosystems. The reaction centre chlorophyll a has an absorption peak at 700nm and 680nm for PS I and PS II, respectively. Hence, the reaction centre of PSI and PSII are also known as P700 and P680, respectively.

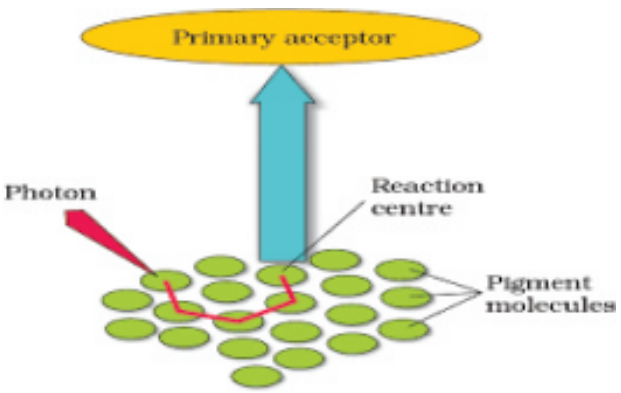


Figure: 13.5 The light harvesting complex.

- The whole scheme of transfer of electrons, starting from PS II, uphill to the acceptor, down the electron transport chain to PS I, excitation of electrons, transfer to another acceptor, and finally

downhill to NADP+ causing it to be reduced to NADPH + H+ is called as Z-scheme, due to its characteristic shape.

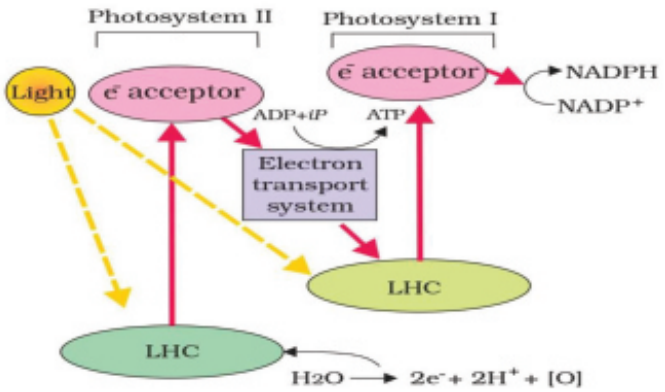


Figure: 13.6 Z-scheme of light reaction.

- Splitting of water is associated with PS II. Water is split into H+, [O] and electrons. Hence, electrons needed to replace those removed from PS I, are provided by PS II.

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

- Phosphorylation is the process of ATP synthesis in mitochondria and chloroplasts. And the synthesis of ATP from ADP and inorganic phosphate in the presence of light, is called as photo-phosphorylation.
- When PS I and PS II works together in a series, one after another, then a process called non-cyclic photo-phosphorylation occurs. The two photosystems are connected through an electron transport chain (as seen in Z-scheme). Both ATP and NADPH + H+ are synthesised by this kind of electron flow.
- When only PS I is functional, the electron is circulated within the photosystem, and phosphorylation occurs in a process called cyclic photo-phosphorylation. It results only in the synthesis of ATP since stroma lamella membrane is the possible location for cyclic photo-phosphorylation. The stroma lamellae membrane unlike grana lamellae, lacks PS II and NADP reductase.

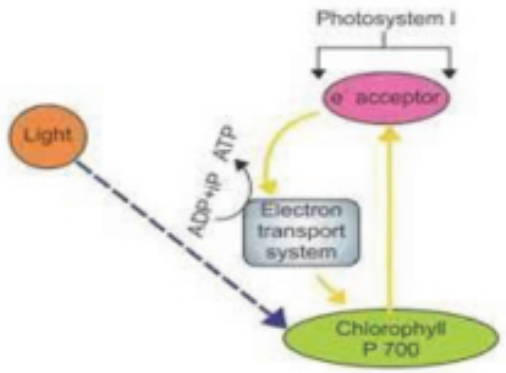


Figure: 13.7 Cyclic photophosphorylation.

- ATP synthesis can be explained by chemiosmotic hypothesis. It is linked to the development of a proton gradient towards the inside of the thylakoid membrane. The activation and transport of electrons determine the steps that cause a proton gradient to develop.

a) Hydrogen ions produced by splitting of water molecule accumulates within the lumen on the thylakoids, since water splitting takes place on the inner side of the membrane.

b) Protons are transported across the membrane as electrons move through the photosystems. Because, the primary acceptor of the electron located towards the outer side of the membrane, transfer its electron to a hydrogen carrier. Hence, this molecule removes a proton from the stroma while transporting an electron carrier. This molecule passes its electron to the electron carrier on the inner side of the membrane, and the proton is released into the inner side of the membrane.

c) Along with electrons coming from the acceptor of electrons of PSI, protons are necessary for the reduction of NADP+ to NADPH + H+. These protons are removed from the stroma (NADP reductase enzyme is located on the stroma side of the membrane).

Hence, within the chloroplast, protons decrease in the stroma and increases in the lumen. Now, the breakdown of proton gradient will lead to the synthesis of ATP. The protons move to the stroma through the transmembrane channel of F0 of the ATPase by facilitated diffusion. The other portion of the ATPase enzyme, known as F1 protrudes on the surface of the thylakoid membrane facing the stroma. This breakdown of the proton gradient causes conformational change in the F1 particle of the ATPase leading to the synthesis of ATP by the ATPase enzyme.

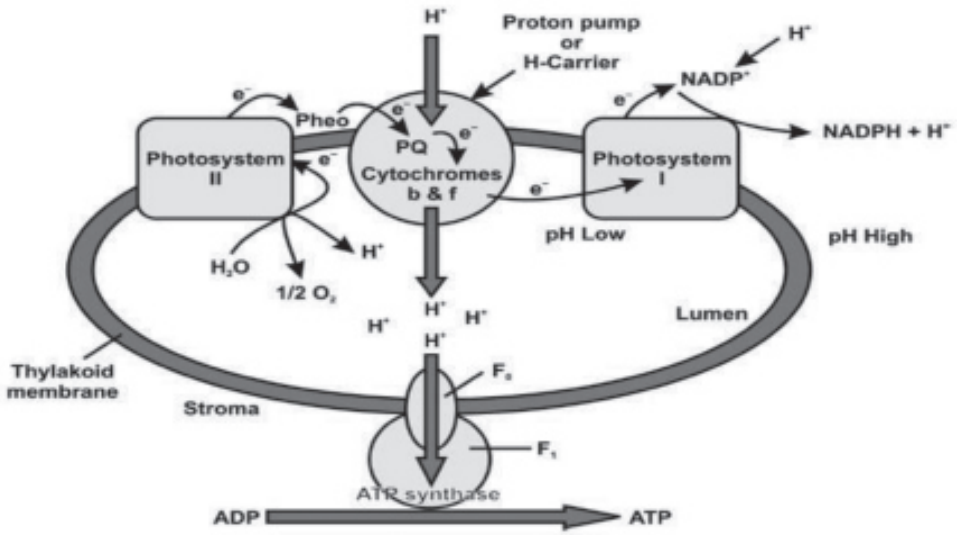


Figure: 13.8 ATP Synthesis through chemiosmosis.

- ATP and NADPH are then used in the biosynthetic (synthesis of sugars) phase of photosynthesis. This involves the dark reaction, where fixation of CO2 takes place to produce 3-phosphoglyceric acid (PGA) through a biosynthetic pathway, called as Calvin Cycle. 3-PGA, which is a 3 carbon compound, is the first stable product of the Calvin cycle.
- But in some plants, the first stable product of CO2 fixation was found to be a 4-carbon organic

acid called as oxaloacetic acid (OAA). The biosynthetic pathway involved in this is known as Hatch and Slack Pathway.

- Thus, CO2 assimilation during photosynthesis are of two types:

  - C3 pathway: First product of CO2 fixation is a C3 acid.

  - C4 pathway: First product of CO2 fixation is a C4 acid.

- The primary acceptor of CO2 is a 5-carbon ketose sugar - Ribulose bisphosphate (RuBP).

- Calvin Cycle is a cyclic process that can be described under three stages:

a) Carboxylation - It is the most crucial step of Calvin cycle, where fixation of CO2 into a stable organic intermediate occurs. CO2 is utilised for the carboxylation of RuBP. RuBP carboxylase catalyses this reaction resulting in the formation of two molecules of 3-PGA. RuBP carboxylase is also called as RuBP carboxylase- oxygenase or RuBisCo, since it has an oxygenation activity also.

b) Reduction - 2 molecules of ATP for phophorylation and 2 molecules of NADPH for reduction of CO2 are used for the formation of glucose. Fixation of 6 molecules of CO2 and 6 turns of the cycle are required for the removal of 1 molecule of glucose from the pathway.

c) Regeneration - Regeneration of RuBP occurs for the uninterrupted continuation of the cycle. 1 ATP for phosphorylation is required to form RuBP.

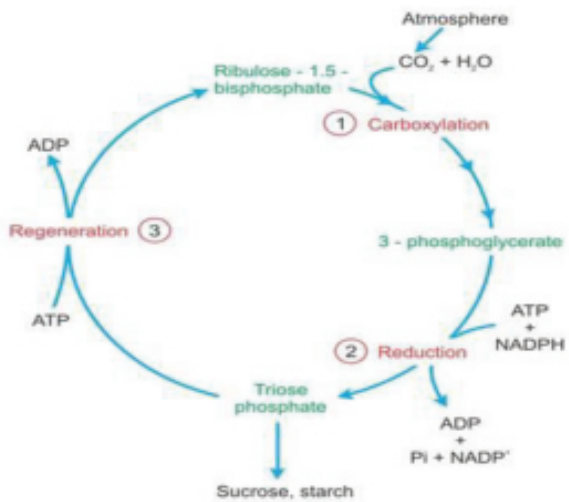


Figure: 13.9 The Calvin Cycle.

- Hence, for every CO2 molecule entering the Calvin cycle, 3 molecules of ATP and 2 molecules of NADPH are needed. 6 turns of the cycle occur to make 1 molecule of glucose. Hence, to make 1 molecule of glucose through the Calvin cycle, 6 molecules of CO2, 18 molecules of ATP and 12 molecules of NADPH are required.

- Plants adapted to dry tropical region have C4 pathway. They have a special leaf anatomy in which they have large cells around the vascular bundle. These cells are called bundle sheath cells, and such anatomy is called as "Kranz" anatomy. Bundle sheath cells from several layers

around the vascular bundle and are characterised by having large numbers of chloroplasts, thick walls impervious to gaseous exchange and no intercellular spaces. Plants like maize show these features.

- C4 pathway has been named as Hatch and Slack pathway, and is a cyclic process. Here, the primary acceptor of CO2 is a 3-carbon molecule phosphoenol pyruvate (PEP), which is present in mesophyll cells. CO2 is fixed by the enzymatic action of PEP carboxylase (PEP case) and hence the C4 acid oxaloacetic acid (OAA) is formed in the mesophyll cells as the first stable product of the C4 pathway. The other 4-carbon compounds like malic acid or aspartic acids are transported to the bundle sheath cells, where these C4 acids are broken down to form C3 acids and release CO2. These C3 acids are transported back to the mesophyll cells, where these are converted to PEP again, hence completing the cycle. The CO2 released in the bundle sheath cells, enter the Calvin cycle. The bundle sheath cells are rich in RuBisco, but lacks PEP case. Whereas, mesophyll cells have PEP case, but lacks RuBisco enzyme. Thus, the basic Calvin cycle is common to both C3 as well as C4 plants.

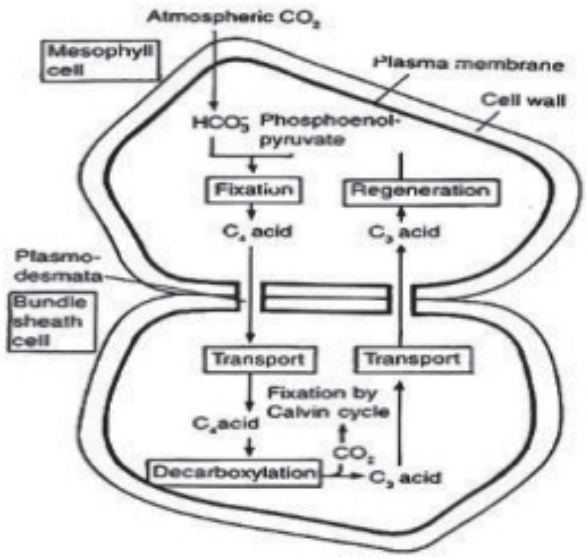


Figure: 13.10 Hatch and Slack Pathway.

- In C3 plants, some O2 binds to RuBisco, since its active site can bind to both O2 and CO2. This results in formation of 1 molecule of phosphoglycerate and phosphoglycolate in a pathway called photorespiration. In this pathway, no sugar or ATP and NADPH are synthesised. Rather, ATP is utilised and CO2 is released. Hence, photorespiration is a wasteful process.
- Photorespiration does not occur in C4 plants, because they have a mechanism that increases the concentration of CO2 at the enzyme site. And the binding of CO2 and O2 to the RuBisco is competitive. But, RuBisco has much greater affinity towards CO2 than that of O2. So, due to the increased concentration of CO2 at the RuBisco enzyme site in C4 pants, they do not undergo the process of photorespiration.
- Hence, C4 plants show greater productivity and higher yield as they lack photorespiration. These plants are also tolerant to higher temperatures, as well.

- ♦ Many internal (plant) and external factors affect the rate of photosynthesis in plants. Internal factors include number, size age and orientation of leaves, mesophyll cells, chloroplast, internal CO2 concentration and the amount of chlorophyll.
- ♦ When several factors affect any bio-chemical process, then Blackman's Law of Limiting Factors comes into effect. This law states that: If a chemical process is affected by more than one factor, then its rate will be determined by the factor which is nearest to its minimal value. It is a factor which directly affects the process if its quantity is changed.
- ♦ The external factors that affect the rate of photosynthesis are light availability, temperature, CO2 concentration and water.
- → Light - There is a linear relationship between incident light and CO2 fixation rates at low light intensities. At higher light intensities, gradually the rate does not show further increase as the other factors become limiting.
- → CO2 - It is major limiting factor for photosynthesis. At high light intensities, both C3 and C4 plants show increase in the rate of photosynthesis. Increase in concentration of CO2 upto 0.05% can cause increase in CO2 fixation rates, but beyond that concentration level, it can be damaging for the plants, if exposed for longer time.
- → Temperature - C4 plants show higher rate of photosynthesis in higher temperatures, while C3 plants have a much lower temperature optimum. And the dark reactions being enzymatic are temperature controlled.
- → Water - Water stress causes stomata to close, hence reducing the CO2 availability. Water stress also makes the leaves wilt, thus, reducing the surface area of the leaves affecting the photosynthesis rate.

QUESTION AND ANSWER

A) Objective Questions. **[1 mark]**

I) Choose the most appropriate option from the following:

1. Carbon fixation occurs during:

   a) Light phase b) Dark phase c) both option a and b are correct d) None of these.

   Ans. (b) Dark phase.

2. How many molecules of ATP are used to make 1 molecule of glucose through Calvin cycle?

   a)13 b) 14 c) 18 d) 16.

   Ans. (c) 18.

3. Oxygen evolved by green plants during photosynthesis comes from:

   a) H2O b) CO2 c) C6H12O6 d) H+

   Ans. (a) H2O.

II) Fill in the blanks:

1. _____ had discovered oxygen in 1774.

Ans. Joseph Priestley.

2. Chlorophyll b shows _____ colour in the chromatogram.

   Ans. Yellow green.

3. _____ molecule forms the reaction centre in the photosystem.

   Ans. Chlorophyll a.

III) State whether the following statements are true or false:

1. Reaction centre of PS II is known as P700.

   Ans. (False).

2. Chlorophyll b is the chief pigment associated with photosynthesis.

   Ans. (False).

3. Protons move to the stroma through transmembrane channel of F0 portion of ATPase enzyme by facilitated diffusion.

   Ans. (True).

IV) Match column A with column B:

Column A	Column B
a) Light reaction	i) PS I
b) Bundle sheath cells	ii) Oxaloacetic acid
c) Cyclic photo-phosphorylation	iii) Kranz anatomy
d) C4 pathway	iv) Synthesis of ATP and NADPH
Ans. (a - iv, b - iii, c- i, d - ii)	

B) Very Short Answer Type Questions. **[1 mark]**

1. Write the full form of RuBisco.

   Ans. Ribulose Bisphosphate Carboxylase Oxygenase.

2. What is the first stable product of Calvin cycle?

   Ans. 3-Phosphoglyceric acid.

3. In which part of the chloroplast does the dark reactions take place?

   Ans. Stroma.

4. In which biosynthetic pathway, oxaloacetic acid is formed as the first stable product?

   Ans. Hatch and Slack pathway.

5. Name the CO2 fixing enzyme found in mesophyll cells of C4 plants.

   Ans. Phospho enol pyruvate carboxylase.

6. In which cells of the C4 plants, RuBisCo is found?

Ans. Bundle sheath cells.

C) Short Answer Type Questions. **[2 marks]**

1. What do you mean by the photochemical phase of photosynthesis?

Ans. Photochemical phase of the photosynthesis process are the set of light reactions which include light absorption, water splitting, oxygen release and the formation of ATP and NADPH.

D) Short Answer Type Questions. **[3 marks]**

1. What do you mean by Z- scheme?

Ans. The whole scheme of election transfer, starting from PS II, uphill to the acceptor, down the electron transport chain to PS I, excitation of electrons, transfer to another acceptor, and finally downhill to NADP+ causing it to be reduced to NADPH+ + H+ is called as Z- scheme.

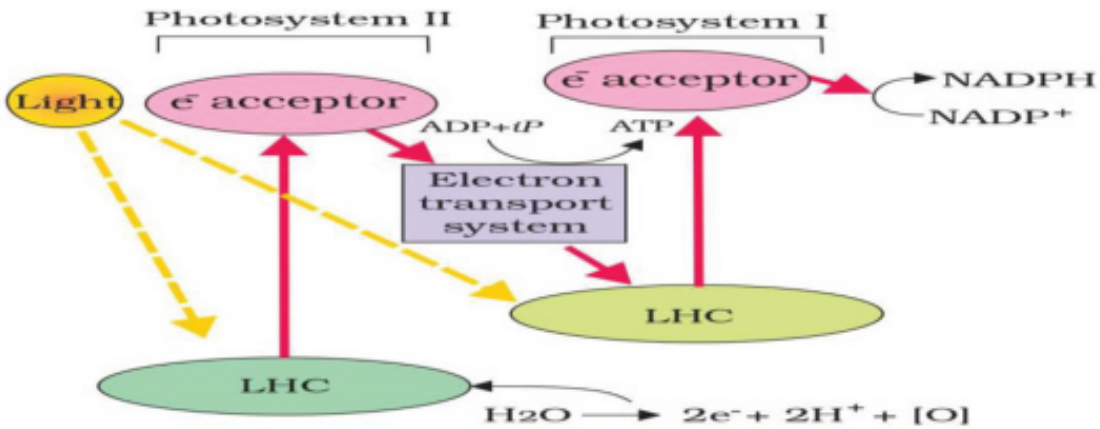


Figure: Z - scheme of light reaction.

DO IT YOURSELF

A) Short Answer Type Questions. **[2 marks]**

1) $2H_2O \rightarrow 4H^+ + O_2 + 4e^-$

Based on the above equation, answer the following questions.

a) Where does this reaction takes place? (1)

b) What is the significance of this reaction? (1)

2) What is Kranz anatomy? (2)

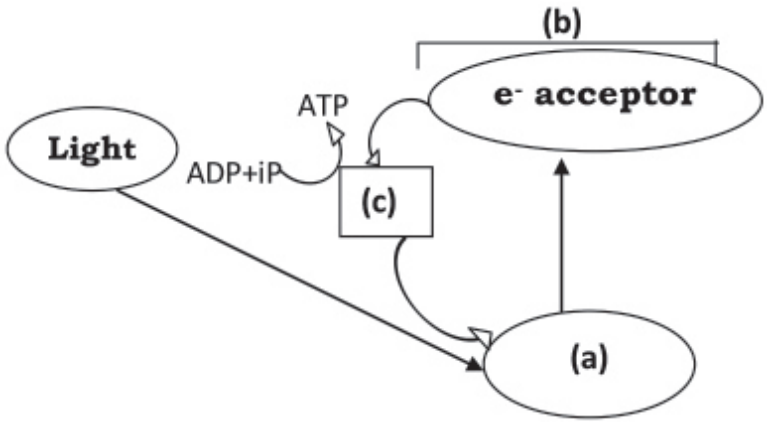
B) Short Answer Type Questions. **[3 marks]**

1) What is photorespiration? What are the advantages of C4 plants over C3 plants? (1+2)

2) Are the reactions involved in "dark reactions" of photosynthesis light independent? Explain. (3)

3) Photorespiration is a wasteful pathway Explain. (3)

4) In the given diagram, identify a, b, c. (1+1+1)



Cyclic photophosphorylation

C) Long Answer Type Questions. **[5 marks]**

1) Explain the steps involved in Calvin cycle. (5)

2) Explain the process of ATP synthesis through chemiosmosis. (5)

3) Differentiate between cyclic and non cyclic photophosphorylation with the help of diagrams. (5)

4) Explain the Hatch and Slack pathway of CO2 fixation. (5)

Teacher's Note

In the section "Do it yourself", take care of the following points:

- In Q.A.1.b should be answered with reference to continuous supply of electrons.
- For Q.C.1, Q.C.2, Q.C.4, answer should be written point wise along with diagrams. See page no. 217, 214, 219 of text book for answering Q.C.1, Q.C.2, Q.C.4, respectively.
- For Q.C.3, don't show the differences in tabular form, since differentiating counter points. Write about non-cyclic photophosphorylation at first in a point wise format along with diagram (Refer fig. 13.5 & fig. 13.6 of page no. 212 and 213 respectively of textbook). After that, write about cyclic photophosphorylation in similar manner, as you have written about the non-cyclic photophosphorylation.

UNIT - IV
CHAPTER - 14
RESPIRATION IN PLANTS

IMPORTANT CONCEPTS

- ♦ Breathing is very essential for living organisms, since the process of breathing is very much connected to the process of release of energy from food.
- ♦ Living organisms require energy for all life activities. And this energy is obtained from oxidation of food during respiration.
- ♦ The mechanism of breaking down of food materials within the cell in order to release energy for the synthesis of ATP, is known as cellular respiration.
- ♦ Breaking down of C-C bond of complex carbohydrates, fats and proteins through oxidation within the cells leading to release of energy is called respiration. And the compounds that get oxidized are called as respiratory substrates.
- ♦ The energy released during oxidation is not used directly, rather is utilised in the synthesis of ATP, which is broken down when energy is required. Hence, ATP is called the energy currency of the cells.
- ♦ Plants need oxygen for respiration. Plants take in oxygen through the stomata, lenticels and root hair.
- ♦ Plants can get along without any specialised respiratory organs because of the following reasons:

1) Each plant part takes care of its own gaseous exchange.
2) Plants do not have much demand for gaseous exchange.
3) Distance that gases need to diffuse in large plants is not great.
4) During photosynthesis, O2 is released, hence availability of O2 is not a problem.

- ♦ The partial oxidation of glucose into two molecules of pyruvic acid without the help of oxygen is called as glycolysis. The scheme of glycolysis has been given by Gustav Embden, Otto Meyerhof and J. Parnas. Hence, it is also called as EMP pathway. It involves a series of enzyme mediated reactions releasing some ATP and NADH + H+. It occurs in the cytoplasm.

→ In plants, glucose is derived from sucrose or from stored carbohydrates. Sucrose is converted into glucose and fructose by the enzyme invertase.

→ Glycolysis starts with the phosphorylation of glucose in presence of the enzyme hexokinase to form Glucose-6-phosphate. One molecule of ATP is used in this process.

→ Then, glucose-6-phosphate is converted to fructose-6-phosphate, catalysed by the enzyme phosphohexose isomerise.

→ Fructose-6-phosphate uses another molecule of ATP to form fructose-1,6-bisphosphate in presence of the enzyme phosphofructokinase.

→ Fructose-1,6-bisphosphate is split into dihydroxyacetone phosphate and 3-phosphoglyceraldehyde (PGAL). NADH + H+ is formed during conversion of PGAL to 1,3-bisphosphoglycerate (BPGA).

→ Conversion of BPGA to 3-phosphoglyceric acid (PGA) also utilises one molecule of ATP. 3-PGA is converted to 2-PGA, which is converted to phosphoenol pyruvate (PEP).

→ PEP is converted to pyruvic acid by utilising one molecule of ATP. Pyruvic acid is the key product of glycolysis.

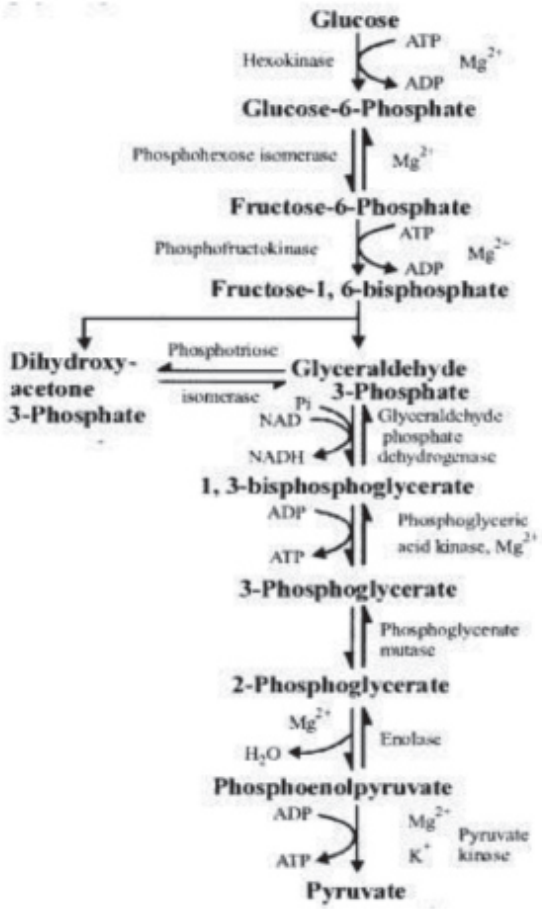
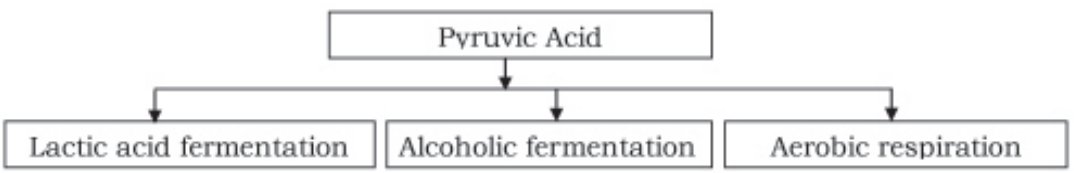


Figure: 14.1 Steps of glycolysis.

♦ The net gain in glycolysis is 8 ATP.

♦ The fate of the pyruvic acid depends upon the cellular need.



- In animal cells, when there is insufficient oxygen for aerobic respiration, lactic acid fermentation occurs in the muscles during exercise, for example. Pyruvic acid is reduced to lactic acid by the enzyme lactate dehydrogenase.
- In alcoholic fermentation, by yeast for example, pyruvic acid is converted to ethanol and CO2 by the action of the enzyme pyruvic acid dehydrogenase. This process occurs in absence of oxygen by incomplete oxidation of glucose.
- In both lactic acid fermentation and alcoholic fermentation, NADH + H+ is the reducing agent which is reoxidised to NAD+.

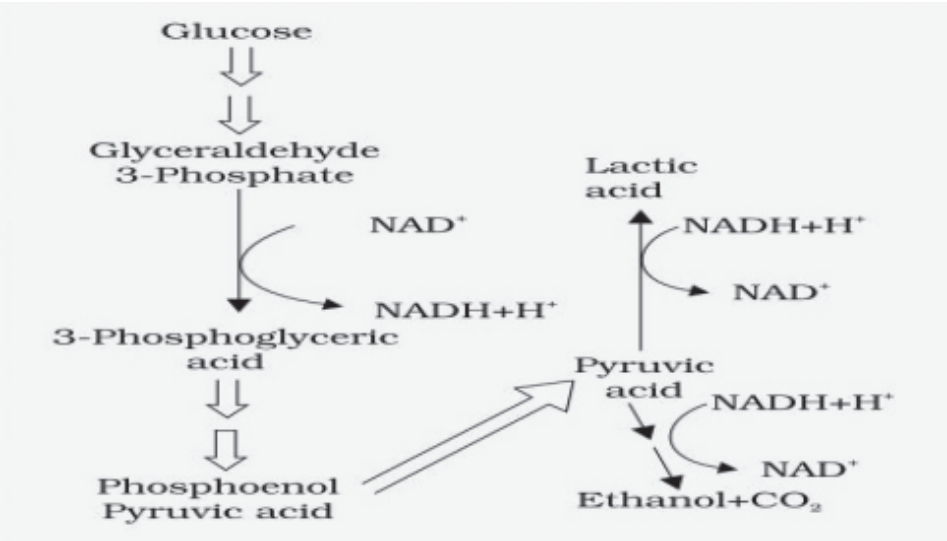


Figure: 14.2 Major pathways of anaerobic respiration.

- In both lactic acid fermentation and alcoholic fermentation very less amount of energy is released.
- For aerobic respiration to take place in the mitochondria, pyruvate is transported from the cytoplasm into the mitochondria. The crucial events of aerobic respiration are:

→ In the matrix of mitochondria, complete oxidation of pyruvate occurs by stepwise removal of all the hydrogen atoms, leaving three molecules of CO2.

→ Then, in the inner membrane of the mitochondria, passing on of the electrons removed as a part of the hydrogen atoms to molecular O2 along with synthesis of ATP takes place.

→ Oxidation of pyruvate to Acetyl-CoA is done to produce CO2 and NADH. The reaction is catalysed by pyruvate dehydrogenase and requires participation of several coenzymes, including NAD+ and coenzyme A. During this process, 2 molecules of NADH are produced from 2 molecules of pyruvic acid (produced from one molecule of glucose during glycolysis).

$$\text{Pyruvic acid} + \text{CoA} + \text{NAD}^+ \xrightarrow[\text{Pyruvate dehydrogenase}]{Mg^{2+}} \text{Acetyl CoA} + CO_2 + \text{NADH} + H^+$$

- The acetyl CoA enters a cyclic pathway called the tricarboxylic acid cycle (TCA cycle) or Krebs'

cycle, as discovered by Hans Krebs in 1940. It is called TCA cycle, since the initial product is citric acid.

→ Acetyl CoA combines with oxaloacetic acid (OAA) and water to yield citric acid in presence of enzyme citrate synthase.

→ Citrate is isomerised to isocitrate, followed by two successive steps of decarboxylation, leading to the formation of alpha ketoglutaric acid and then succinyl-CoA.

→ In the remaining steps, succinyl-CoA is oxidised to OAA allowing the cycle to continue.

→ In a coupled reaction, GTP is converted to GDP with simultaneous synthesis of ATP from ADP. There are three points in the cycle, where NAD+ is reduced to NADH + H+, and one point where FAD+ is reduced to FADH2.

The summarised equation for the phase of respiration is:

Pyruvic acid + 4NAD+ + FAD+ + 2H2O + ADP + Pi

$$\xrightarrow[\text{Matrix}]{\text{Mitochondrial}} 3CO_2 + 4NADH + 4H^+ + FADH_2 + ATP$$

♦ The metabolic pathway through which electron passes from one carrier to another inside the inner mitochondrial membrane is called electron transport chain (ETC). Releasing and utilisation of energy stored in NADH + H+ and FADH2 is accomplished when they are oxidised through the ETC and the electrons are passed on to O2 resulting in the formation of H2O.

→ Electrons from NADH (produced during TCA cycle) are oxidised by NADH dehydrogenase and electrons are transferred to ubiquinone located within the inner membrane. Ubiquinone also receives electrons from FADH2 which is transferred to cytochrome C via cytochrome bc1 complex.

→ During transfer of electron from one carrier to another via ETC, ATP is produced from ADP and inorganic phosphate.

→ Oxidation of one molecule of NADH gives rise to three molecules of ATP, and oxidation of one molecule of FADH2 produces two molecules of ATP.

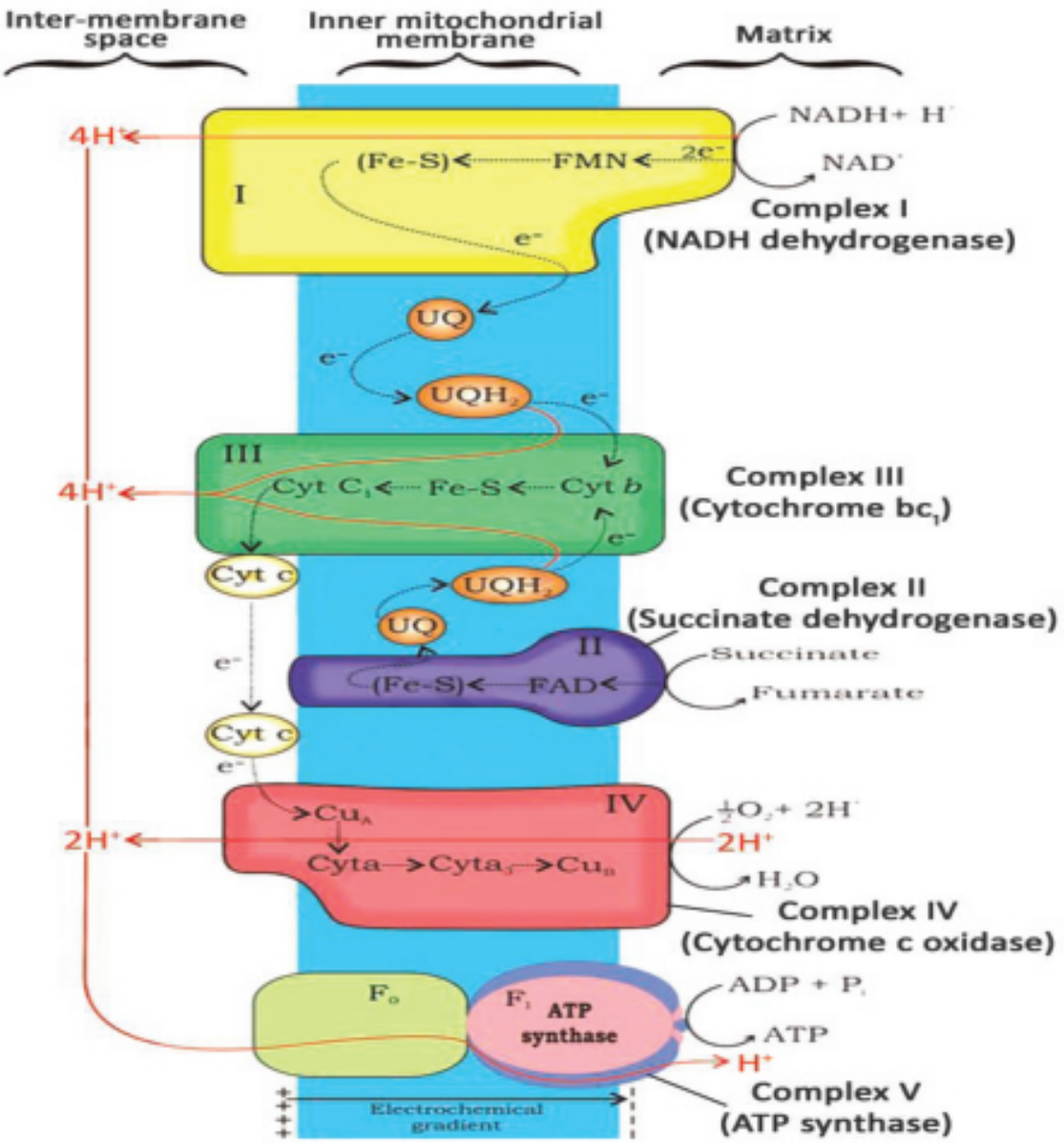


Figure: 14.3 Electron Transport System.

- ATP is synthesised by the process of oxidative phosphorylation during respiration. Unlike photosynthesis, in this type of phosphorylation, energy of oxidation-reduction is used for production of proton gradient.
- The energy released during ETC is used to make ATP with the help of ATP synthase, which consists of two major parts - F1 and Fo.
- Fo is the integral membrane protein that form channel for proton. And F1 is a peripheral membrane protein complex having site for ATP synthesis from ADP and inorganic phosphate. For each ATP produced, 2H+ passes through the Fo from the inner membrane space to the matrix down the electrochemical proton gradient.

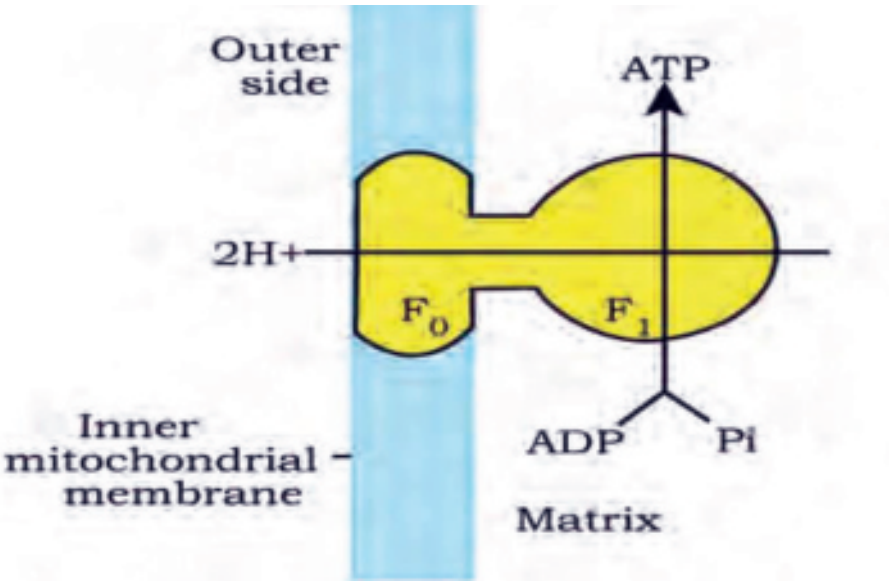


Figure: 14.4 ATP synthesis in mitochondria.

- There can be net gain of 36 ATP molecules during aerobic respiration of one molecule of glucose, whereas in fermentation of one molecule of glucose, only 2 molecules of ATP are formed.
- Comparison of fermentation and aerobic respiration:

Fermentation	Aerobic respiration
a) It occurs for incomplete oxidation of glucose.	a) It occurs for complete oxidation of glucose.
b) There is net gain of only 2 molecules of ATP.	b) There is more net gain of ATP (it can be up to 38 molecules of ATP).
c) NADH is oxidised to NAD^+ very slowly.	c) NADH is oxidised to NAD^+ very fast.

- Glucose is the favoured substrate for respiration. All carbohydrates are usually converted to Acetyl CoA and then enters the respiratory pathway.

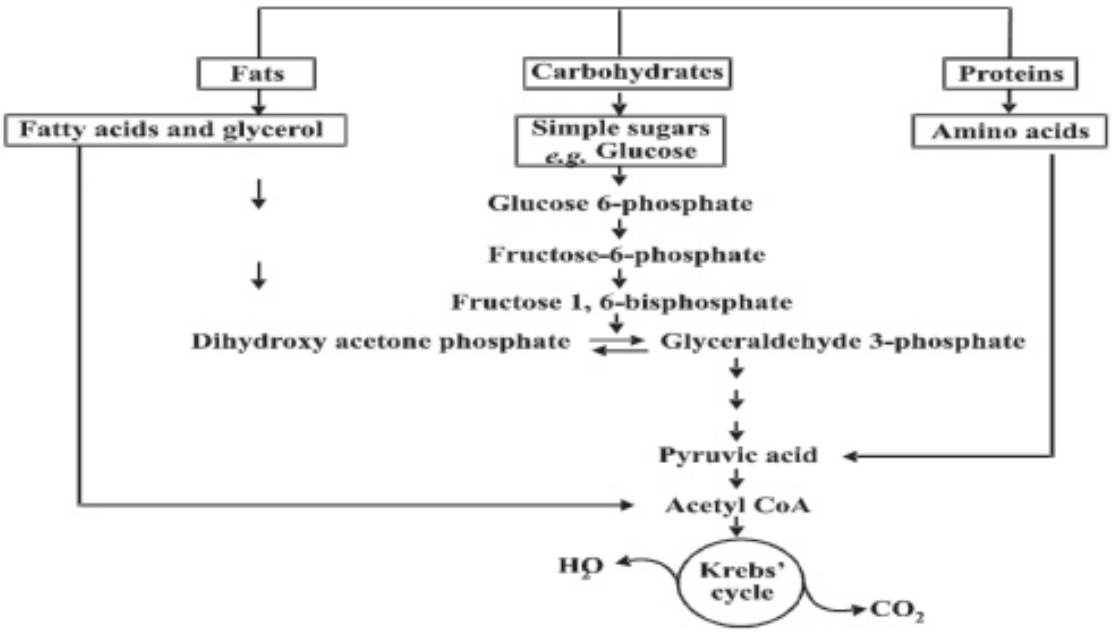


Figure: 14.5 Interrelationship among metabolic pathways showing respiration mediated breakdown of different organic molecules to CO2 and H2O.

♦ Respiratory quotient (RQ) is the ratio of the volume of carbon dioxide produced to the volume of oxygen consumed in respiration over a period of time.

$$RQ = \frac{\text{Volume of } CO_2 \text{ evolved}}{\text{Volume of } O_2 \text{ consumed}}$$

→ RQ for carbohydrate is equal to 1 and for proteins and fats, it is less than 1.

♦ Since respiratory pathway is involved in both anabolism and catabolism, it is called as amphibolic pathway.

QUESTION AND ANSWER

A. Objective Questions. **[1 mark]**

I. Choose the most appropriate option from the following:

Glycolysis is also known as:

a) TCA pathway (b) EMP pathway (c) Carbon sequestration

Ans. (b) EMP pathway

2. The process of cellular respiration is carried out by:

a) Mitochondria (b) Chloroplast (c) Nucleus.

Ans. (a) Mitochondria

3. Which of the following is a product of aerobic respiration?

a) Malic acid (b) Pyruvate (c) Lactose.

Ans. (a) Malic acid

II. Fill in the blanks:

1. Oxidation of 1 molecule of glucose, _____ molecules of ATP is produced through aerobic respiration.

   Ans. 36.

2. Acetyl CoA forms a 6-C compound after combining with _____.

   Ans. Oxaloacetic acid

3. Oxidation of 1 molecule of NADH gives rise to _____ molecules of ATP.

   Ans. 3

III. State whether the following statements are true or false:

1. One molecule of $FADH_2$ gives rise to two molecules of ATP.

   Ans. True

2. Lactic acid fermentation occurs in the presence of oxygen.

   Ans. False

3. ATP is called the energy currency of the cell.

   Ans. True

4. Match column A with column B:

Column - A	Column - B
a) Lactate dehydrogenase	i) Acetyl CoA + OAA + Water ' Citric acid
b) Citrate synthase	ii) Peripheral membrane protein
c) F1 complex	iii) Integral membrane protein
d) F0 complex	iv) Pyruvic acid ' Lactic acid
Ans. (a-iv, b-i, c-ii, d- iii).	

B. Very Short Answer Type Questions. [1 mark]

1. Which enzyme catalyses the phosphorylation of glucose during glycolysis?

   Ans. Hexokinase.

2. ETS is located in which part of mitochondria?

   Ans. Mitochondrial inner membrane.

3. What is the end product of oxidative phosphorylation?

   Ans. ATP + H2O.

4. Why is Krebs' cycle called as TCA cycle?

   Ans. Krebs' cycle is called as TCA cycle since its initial product is citric acid.

C. Short Answer Type Question. [2 mark]

1. What do you mean by substrate level phosphorylation?

   Ans. Substrate level phosphorylation is the process of ATP synthesis directly from ADP and inorganic phosphate, without electron transport system or chemiosmosis.

D. Short Answer Type Question. [3 mark]

1. Do you think that aerobic respiration is more efficient than anaerobic respiration? Justify your answer.

   Ans. Yes, aerobic respiration is more efficient than anaerobic respiration. In aerobic respiration, complete oxidation of glucose occurs. Whereas in anaerobic respiration, incomplete oxidation of glucose occurs. In aerobic respiration, upto 36 molecules of ATP can be produced from 1 molecule of glucose. Whereas, only 2 molecules of ATP can be produced from 1 molecule of glucose in anaerobic respiration, which is very less in comparison to aerobic respiration.

DO IT YOURSELF

A. Short Answer Type Question. [2 marks]

1. Why is the respiration pathway referred to as an amphibolic pathway? (2)
2. Write any two energy yielding reactions of glycolysis. (2)

B. Short Answer Type Questions. [3 marks]

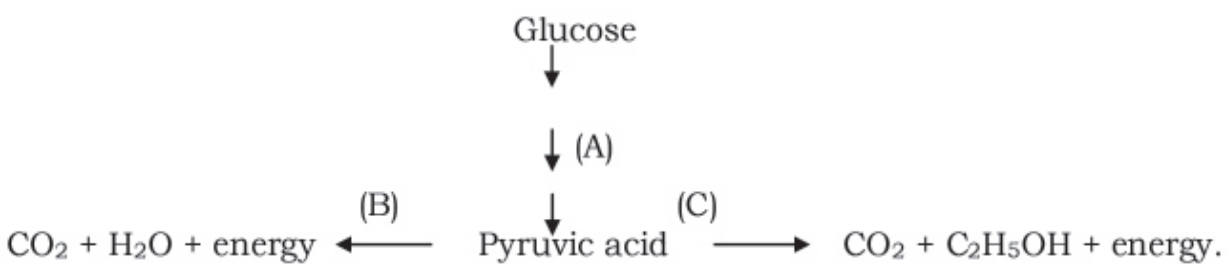
1. Name the site of pyruvate synthesis. Complete the given chemical reaction.

   Pyruvic + 4NAD+ + FAD+ + 2H2O + ADP +Pi → ?

   Also, name the enzyme which catalyses the above mentioned reaction. (1+1+1)
2. What is respiratory quotient (RQ)? Calculate the RQ for the fatty acid tripalmitin, used as a substrate. (1+2)

C. Long Answer Type Questions. [5 marks]

1. Study the given flow chart and answer the following questions :



a. Identify A, B, C.

b. Where does B take place in the human body?

c. Name an organism where C takes place. (3+1+1)

2. Explain the role of oxygen with respect to electron transport system. (5)

3. Explain the reactions involved in Krebs' cycle. (5)

4. Give an account of the different enzymes involved in glycolysis. (5)

Teacher's Note

In the section "Do it yourself", take care of the following points:

- In Q.B.2, refer page no. - 237 of textbook; write the equation and show the calculation.
- While answering Q. C.2, Q.C.3, Q.C.4, draw the diagrams from page no. 233, 232, 229, respectively of textbook. Answer should be written point wise, maintaining the proper sequence of the steps involved.

UNIT - IV

CHAPTER - 15

PLANT GROWTH AND DEVELOPMENT

IMPORTANT CONCEPTS

- ♦ Plant parts like root, stem, leaves, flowers, fruits, seeds arise in orderly manner. The sequence of growth shows that plants complete their vegetative phase to move into reproductive phase in which flowers and fruits are formed for continuation of life cycle of plants.
- ♦ Development is the sum of growth and differentiation. These are controlled by intrinsic and extrinsic factors.
- ♦ Growth is intrinsic process in living beings. It is a permanent increase in dry weight, size, mass or volume of cell, organ or organism.
- ♦ Plant growth is generally indeterminate due to capacity of unlimited growth throughout the life.
- → The plant growth in which new cells are always being added to the plant body due to meristem is called open from of growth.
- → Root apical meristem and shoot apical meristem are responsible for primary growth and elongation of plant body along the axis.
- → Inter calary meristem located at nodes produce buds and new branches in the plants.
- → Secondary growth in plants is the function of lateral meristem that is vascular cambium and cork cambium.

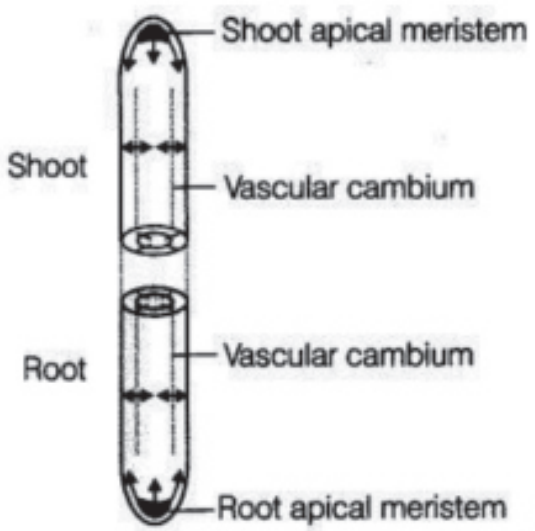
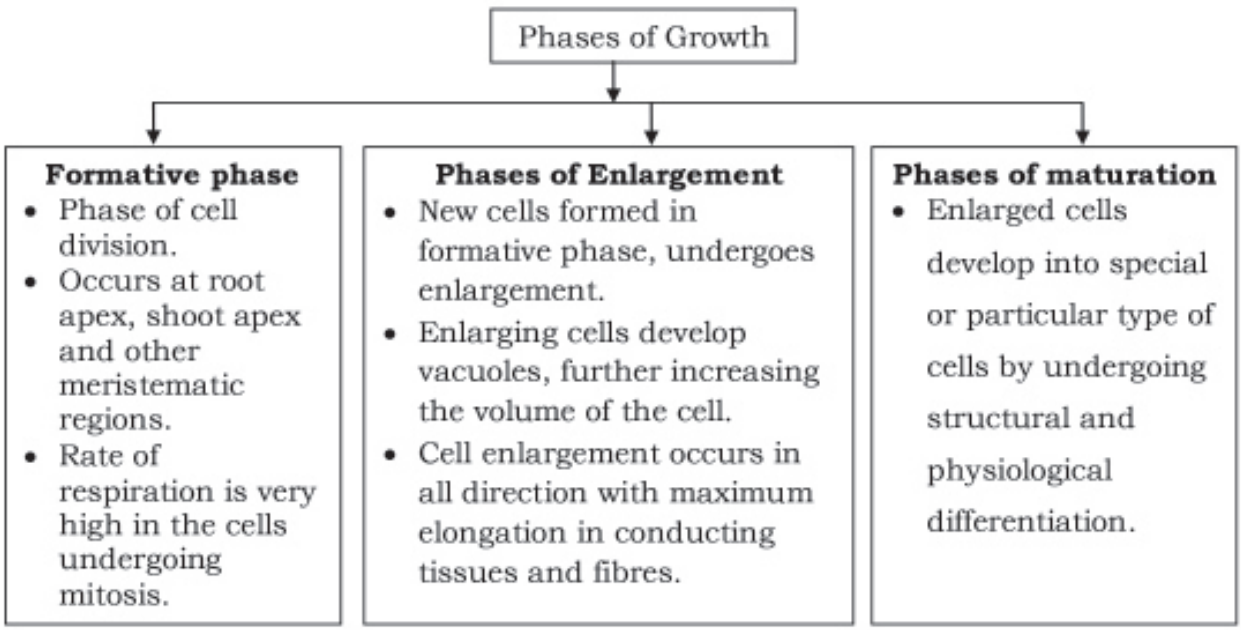


Figure: 15.1 Diagramatic representation of locations of root apical meristem, shoot apical meristem and vascular cambium. Arrows exhibit the direction of growth of cells and organ.

- ♦ At cellular level, growth is the increase in amount of protoplasm, which is difficult to measure. But, it is possible to measure the increase in cell, cell number and cell size. Hence, growth is measurable.
- ♦ Parameters like increase in fresh weight, dry weight, length, area, volume and cell numbers are used to measure growth of plants.



- ♦ Increase in growth per unit time is called growth rate.
- → Arithmetic growth is the rate of growth that is constant, and increase in growth occurs in arithmetic progression ' 2, 4, 6,8 ..... It is found in root and shoot elongation. On plotting the length of the organ against time, a linear curve is obtained. (Figure: 15.3). Mathematically, it is expressed as:

$L_t = Lo + rt$

Where, Lt = Length at time 't' Lo = Length at time 'zero'

R = growth rate / elongation per unit time.

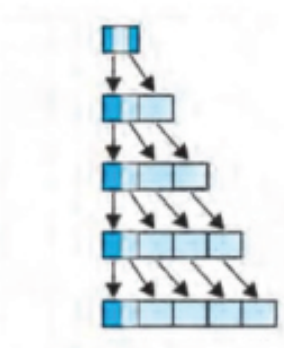


Figure: 15.2 Arithmetic growth.

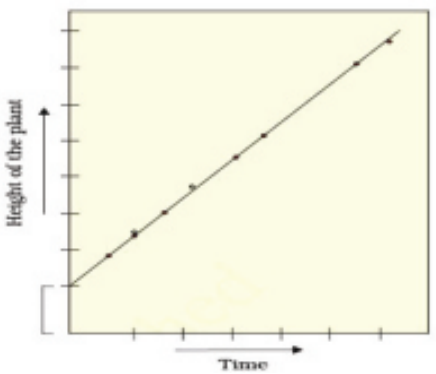


Figure: 15.3 Constant linear growth, a plot of length against time.

→ The type of growth where initial growth is slow is called as lag phase, and increases rapidly thereafter, is called as geometric growth. The growth increases rapidly at an exponential rate, called as the log or exponential phase. Here, both the progeny cells following mitotic cell division retain the ability to divide and continue to do so. However, with limited nutrient supply, the growth slows down leading to a stationary phase. On plotting the parameter of growth against time, we get a sigmoid or S-curve (figure 15.5). Mathematically, the exponential growth can be expressed as:

$W1 = W0ert$

Where, W1 = Final size

Wo = Initial size

r = Relative growth rate

t = Time of growth

e = Base of natural logarithms.

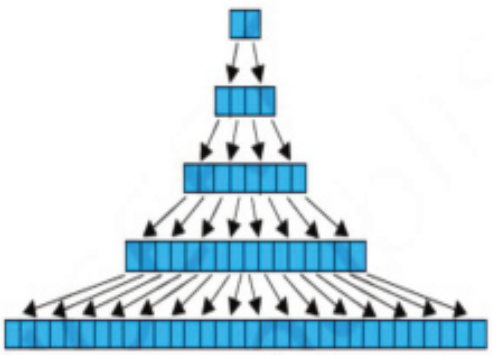


Figure: 15.4 Geometric growth.

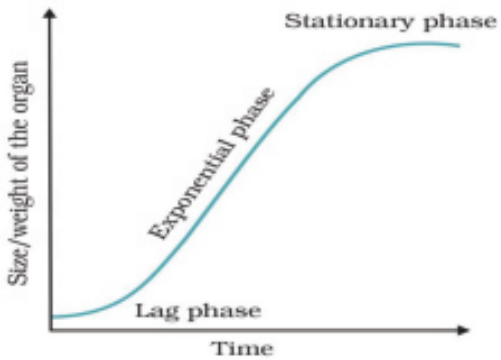


Figure: 15.5 An idealised sigmoid growth curve of typical cells in culture.

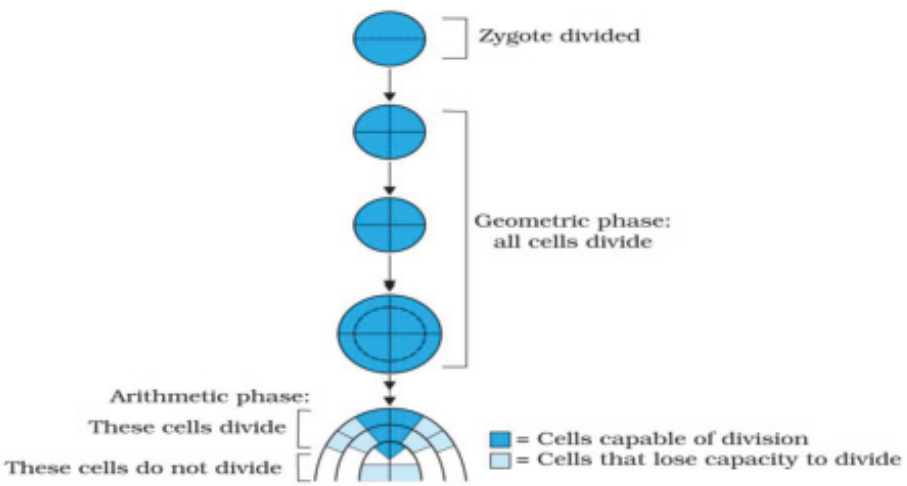


Figure: 15.6 Stages during embryo development showing geometric and arithmetic growth phases.

- ♦ Measurement and comparison of total growth per unit time is called the absolute growth rate.
- ♦ The growth of given system per unit time expressed on a common basis is called relative growth rate.
- ♦ Plants need the following necessary conditions for growth:
- → Protoplasm formation requires water and essential elements like micro and macronutrients.
- → Optimal temperature and other environmental conditions are essential for plant growth.
- ♦ Cells produced by apical meristem become specialized to perform special function. This act of maturation is called differentiation.
- ♦ The living differentiated cells that have lost the ability of division can regain the capacity of division. This phenomenon is called dedifferentiation. Cork cambium and interfascicular cambium for example, can exhibit dedifferentiation.
- ♦ Dedifferentiated cells mature and lose the capacity of cell division again to perform specific functions. This process is called redifferentiation.
- ♦ Development refers to the sequence of events that occur in the life history of cell, organ or organism which includes seed germination, growth, differentiation, growth, differentiation, maturation, flowering, seed formation and senescence.
- ♦ Different structures develop in different phase of growth as well as in response to the environment. The ability to change under the influence of internal or external stimuti is called plasticity. Heterophylly in cotton plant is the example of plasticity.

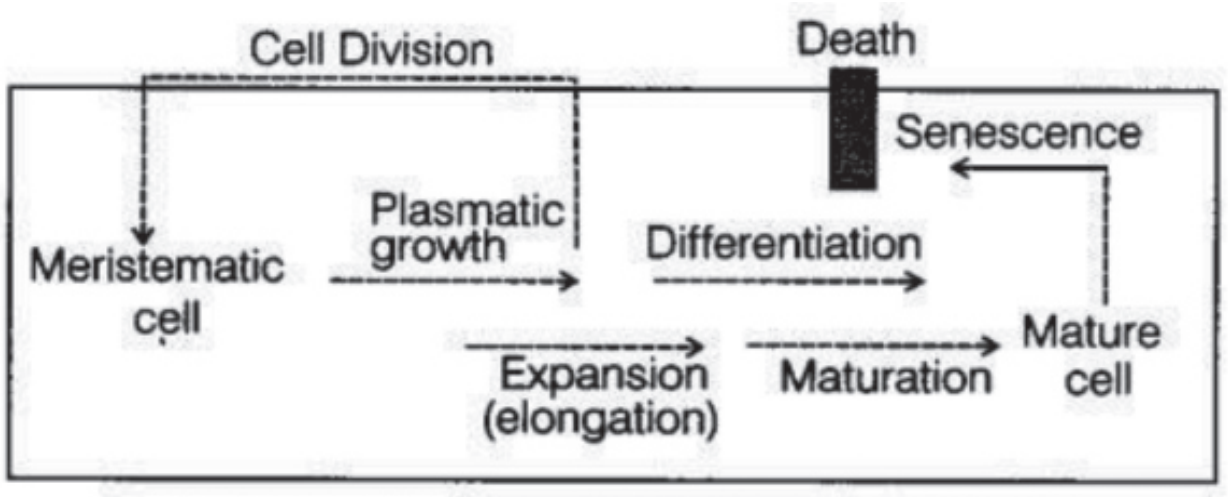
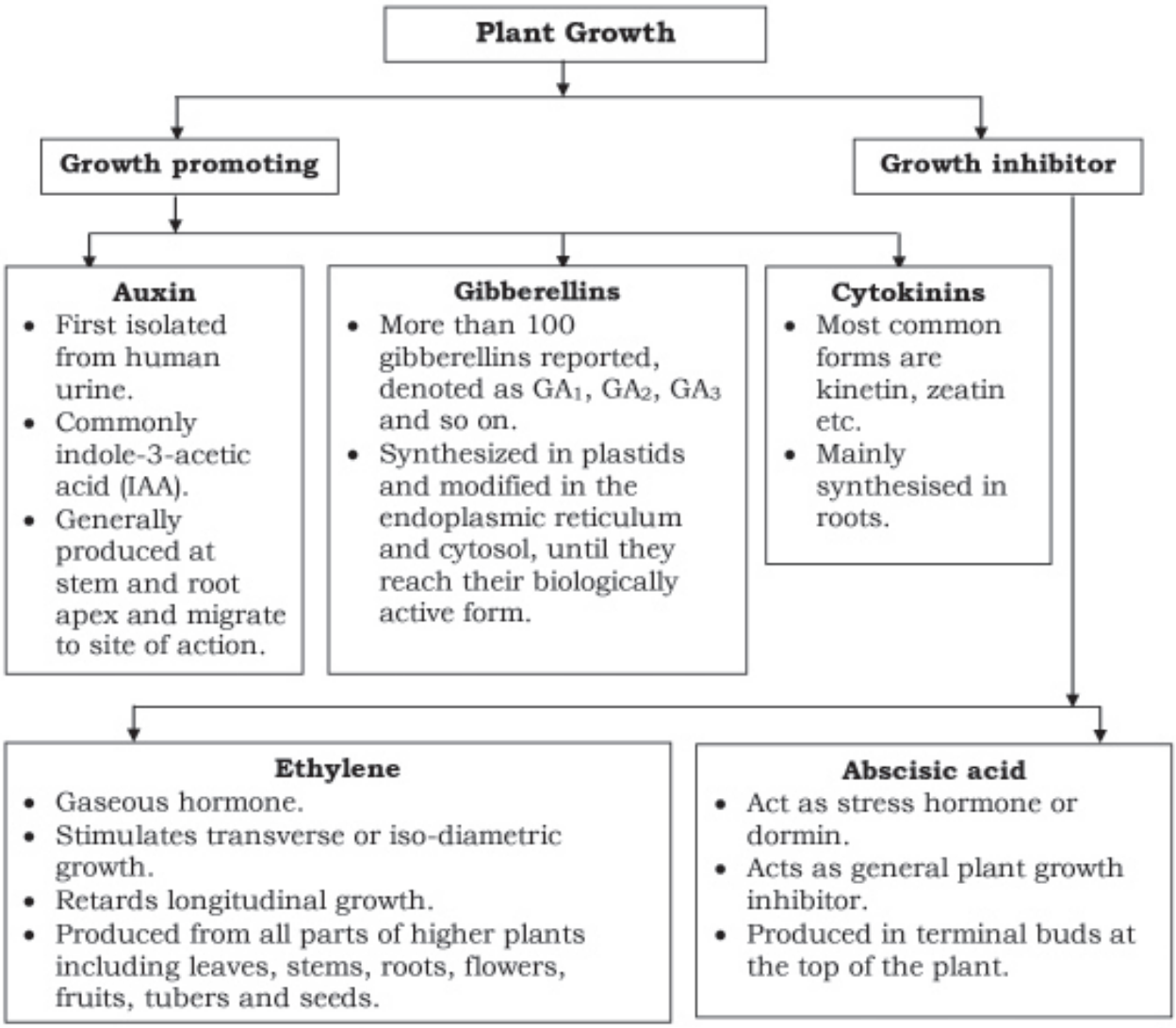


Figure: 15.7 Sequence of the Developmental process in a plant cell.

- ♦ Plant Growth Regulators are simple molecules of diverse chemical composition which may be indole compounds, adenine derivatives or derivatives of carotenoids.



Plant Growth Regulator	Functions
Auxin	Cell enlargement, apical dominance, cell division, inhibition of abscission, induces parthenocarpy.
Gibberellins	Cell elongation, breaking of dormancy, early maturity, seed germination.
Cytokinins	Cell division and cell differentiation, essential for tissue culture, overcome apical dominance, promote nutrient mobilisation.
Ethylene	Inhibition of longitudinal growth, fruit ripening, senescence.
Abscisic acid	Bud dormancy, leaf senescence, seed development and maturation.

♦ The effect of photoperiods or day duration of light hours on the growth and development of plant, especially flowering is called photoperiodism. On the basis of photoperiodic response, flowering plants have been divided into the following categories:

1) Short Day Plants - These plants flower when photoperiod is below a critical period (continuous duration of light which must not be exceeded in short day plants and should always be exceeded in long day plants in order to bring them flower). Example- Xanthium, rice, sugarcane, potato, etc.

2) Long Day Plants - These plants flower when they receive long photoperiod of light, greater than critical period. Example - Radish, barley, lettuce, etc.

3) Day Neutral Plants - These plants can flower throughout the year. Example- Beans, wild kidney beans, etc.

♦ The process of shortening of the vegetative phase and hastening of flowering by cold treatment is called vernalisation. The stimulus of vernalisation is perceived by meristematic cells.

→ Vernalisation helps in shortening of vegetative period of plant and brings about early flowering.

→ It is applicable to temperate plants like wheat, rice, millets, etc.

QUESTION AND ANSWER

A) Objective Questions. **[1 mark]**

I. Choose the most appropriate option from the following:

1. Seed dormancy is triggered by:

   (a) Indole-3-ethanol (b) Abscisic acid (c) Carbon dioxide,

   Ans. (b) Abscisic acid.

2. Tendrils of garden peas coiling around any support signifies:

   (a) Thigmotropism (b) Gravitropism (c) Seismonasty.

   Ans. (a) Thigmotropism.

II. Fill in the blanks :

1. _____ is a plant hormone generally present in the gaseous state.

   Ans. Ethylene.

2. Coconut milk contains a cytokinin called _____, which promotes plant growth.

   Ans. Zeatin.

III. State whether the following statements are true or false:

1. The significance of day length in plants was first shown in barley.

   Ans. False

2. Rapidly dividing tissues synthesizes natural cytokinins.

Ans. True

B) Very Short Answer Type Questions. [1 mark]

1. Name the plant growth regulator present in coconut water?

   Ans. Cytokinin.

2. What is absolute growth rate?

   Ans. Measurement and comparison of total growth per unit time is called absolute growth rate.

3. Name any plant growth regulator which inhibits growth.

   Ans. Abscisic acid.

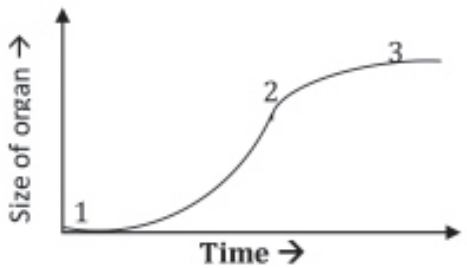
DO IT YOURSELF

A) Short Answer Type Questions. [2 marks]

1. What do you mean by vernalisation? (2)
2. What is arithmetic growth? (2)

B) Short Answer Type Questions. [3 marks]

1. Explain the three different phases of growth. (3)
2. In the given figure of Sigmoid growth curve given below, label segments 1, 2, and 3. (1+1+1)



C) Long Answer Type Questions. [5 marks]

1. What is differentiation? What do you mean by redifferentiation? How is de-differentiation different from differentiation and redifferentiation? (1+1+3)
2. What is photoperiodism? How can you categorise flowering plants on the basis of photoperiodic response? (2+3)
3. Define plant growth regulator. Mention two functions each of auxin and ethylene. (1+2+2)

Teacher's Note

Take care of the following points in the "Do it yourself" section:

- In Q.A.1, give example.
- In Q.A.2, draw the linear graph of arithmetic growth.
- In Q.C.2, give examples of different categories of flowering plants on the basis of photoperiodic response.

UNIT - V
CHAPTER - 16
DIGESTION AND ABSORPTION

IMPORTANT CONCEPTS

- Human digestive system - Formed by the alimentary canal and associated digestive glands.
- Alimentary canal - Formed by mouth, oral cavity, pharynx, oesophagus, stomach, small intestine, large intestine, rectum and anus.

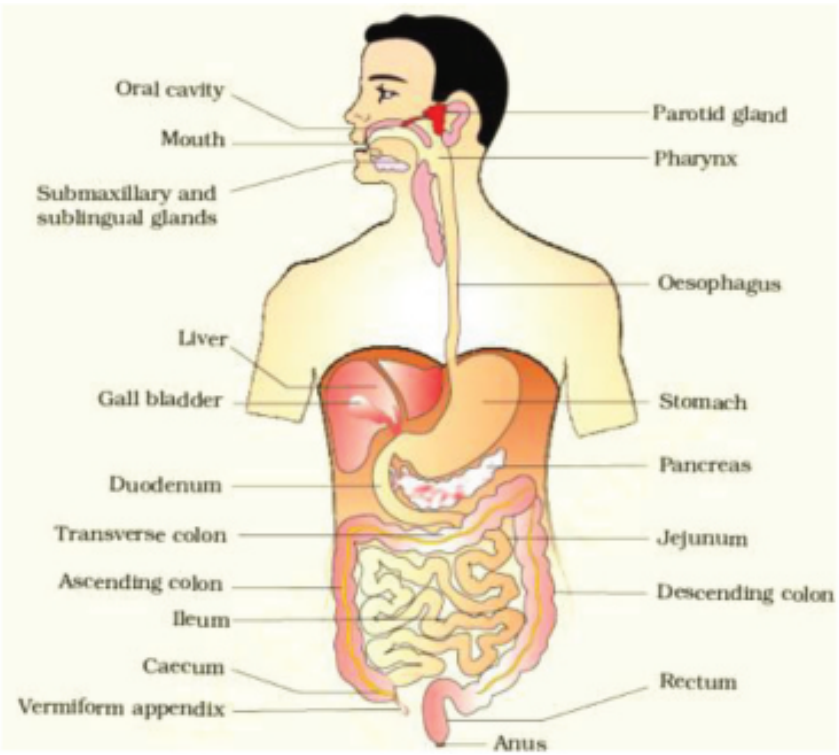


Figure: 16.1 Human digestive system.

- The digestive glands associated with the digestive system are - salivary glands (3 pairs), liver (gall bladder) and pancreas.
- The dentition in human beings are of thecodont, diphyodont and heterodont types. The dental formula in human being is $\frac{2123}{2123}$
- The wall of the alimentary canal starting from the oesophagus to the rectum is made up of four layers - serosa, muscularis, sub-mucosa and mucosa.
- Villi, rugae, goblet cells and associated gastric glands are present in the mucosa.

- Saliva is secreted from the three pairs of salivary glands. These salivary glands are - parotid gland (cheek), sub-maxillary/sub-mandibular gland (lower jaw) and sub-lingual gland (below tongue).
- Liver - It is the largest gland of the human body. The bile juiced secreted by the hepatic cells passes through the hepatic ducts and is stored in the gall bladder. The hepatic duct from the liver along with the duct of gall bladder (cystic duct), together forms the common bile duct.

  The bile duct and the pancreatic duct open together into the duodenum as the common hepatopancreatic duct.

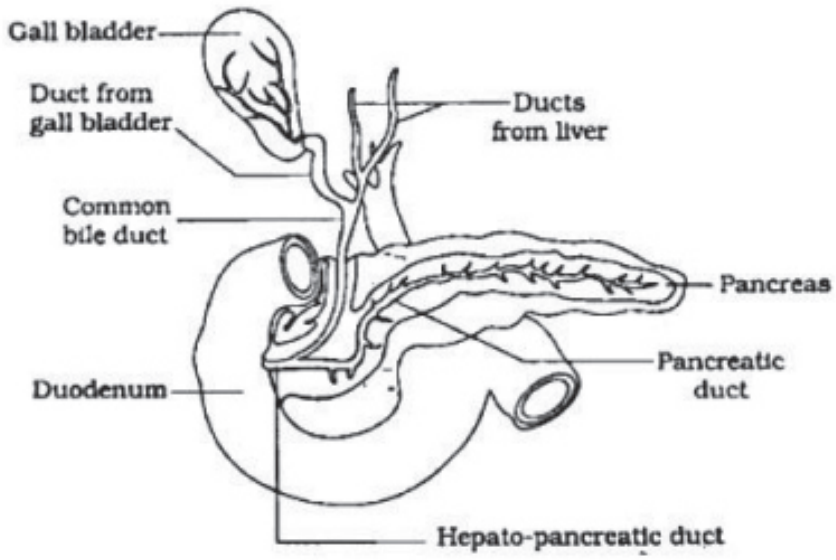


Figure: 16.2 Duct systems of liver, gall bladder and pancreas.

- Pancreas as a compound gland - Exocrine portion of the pancreas secretes pancreatic juice and endocrine portion of pancreas secretes insulin and glucagon hormones.
- Only the starch present in the food can be digested in the buccal cavity. Inside the buccal cavity about 30% of the starch gets digested by the action of the enzyme salivary amylase; the starch is hydrolysed to form a disaccharide namely maltose.

$$\text{Starch} \xrightarrow[P^H\ 6.8]{\text{Sali var y amylase}} \text{Maltose} + \text{Isomaltose} + \text{alpha dextrin.}$$

- Saliva consists of the electrolytes (Na+, K+, Cl, HCO3), salivary amylase and lysozyme.
- The gastric glands present in the mucosa of stomach are having three major types of cells. Those are -

i) Mucus neck cells which secrete mucus.

ii) Peptic or chief cells which secrete the proenzyme pepsinogen.

iii) Parietal or oxyntic cells which secretes HCl and intrinsic factor.

- The peptic juice of stomach consists of HCl. Pepsin, rennin and gastric lipase.

$$\text{Pepsinogen} \xrightarrow{\text{HCl}} \text{Pepsin}.$$

$$\text{Protein} \xrightarrow{\text{Pepsin}} \text{Peptone} + \text{Proteose}.$$

$$\text{Prorenin} \xrightarrow{\text{HCl}} \text{Renin}.$$

- Trypsinogen, chymotrypsinogen, procarboxypeptidase, amylase, and nuclease are present in the pancreatic juice.

$$\text{polysaccharide (Starch)} \xrightarrow{\text{Pancreatic amylase}} \text{Disaccharide}.$$

$$\text{Triglyceride (Fat)} \xrightarrow[\text{Lipase}]{\text{Bile}} \text{Diglyceride} \rightarrow \text{Monoglyceride}.$$

$$\text{Protein Peptone protease} \xrightarrow[\text{Carboxypeptidase}]{\text{Trypsin / chymotrypsin}} \text{Dipeptide}.$$

- Intestinal juice consists of various enzymes like maltase, dipeptidase, lipase, nucleosidase, lactase, sucrase, etc.

$$\text{Dipeptides} \xrightarrow{\text{dipeptidase}} \text{Amino acid}.$$

$$\text{Maltose} \xrightarrow{\text{Maltase}} \text{Glucose} + \text{Glucose}.$$

$$\text{Lactose} \xrightarrow{\text{Lactase}} \text{Glucose} + \text{Galactose}.$$

$$\text{Sucrose} \xrightarrow{\text{Sucrase}} \text{Glucose} + \text{Fructose}.$$

$$\text{Nucleotides} \xrightarrow{\text{Nucleotidase}} \text{Nucleosides} \xrightarrow{\text{Nucleosidase}} \text{Sugar} + \text{Nitrogen bases}.$$

$$\text{Di and monoglycerides} \xrightarrow{\text{Lipase}} \text{Fatty acids} + \text{Glycerol}.$$

- Absorption of food mainly occurs in the mucosa layer of the small intestine. It takes place by passive, active and facilitated transport.
- Some of the glucose, amino acids and electrolytes are transported by the process of simple diffusion. Some substances (glucose and amino acid) are absorbed by the carrier proteins. This mechanism is called as facilitated transport. Active transport occurs against the concentration gradient and hence, requires energy. Some amino acids, monosacchardes (glucose), electrolytes (Na^+) are absorbed into blood by this mechanism.
- Since, fatty acids and glycerol are insoluble, hence they cannot get absorbed into the blood. At first, the fatty acids and glycerol are incorporated into small oil droplets (micelles) and these enter into the mucosa layer of the small intestine. These are re-formed into very small protein coated fat globules (chylomicrons) which are transported into the lymph vessels. These lymph vessels ultimately release the absorbed substances into the blood stream.
- The disorders of the digestive system leads to various diseases in the human beings - Jaundice,

vomiting, diarrhoea, constipation, indigestion.

QUESTION AND ANSWER

A) Objective Questions. **[1 mark]**

Choose the most appropriate option from the following :

1. Compound gland is -

   Liver (b) Salivary glands (c) Pancreas (d) Stomach

   Ans. (c) Pancreas.

2. Hepatopancreatic duct of deuodenum is regulated by -

   (a) Crypts of Lieberkuhn (b) Sphincter of Oddi

   (c) Oxyntic cell (d) Pyloric sphincter

   Ans. (b) Sphincter of Oddi.

3. Name the carbohydrate digestive enzyme which helps in the hydrolysis of starch in the buccal cavity.

   a) Salivary amylase b) Lipase c) Trypsin d) Maltase

   Ans. (a) Salivary amylase.

4. Which of the following plays an important role in digestion of milk products in mammals?

   a) Renin b) Amylase c) Intestinal bacteria d) Peptone

   Ans. (a) Renin.

5. The type of food which gets digested in the stomach is-

   a) Fats b) Proteins c) Sugar d) Starch

   Ans. (b) Proteins.

6. Brunner's gland is situated in -

   a) Stomach b) Gall bladder c) Pancreas d) Small intestine

   Ans. (d) Small intestine.

7. Which of the following is not an element of bile juice?

   a) Bilirubin b) Bile salt c) Phospholiped d) Pepsin

   Ans. (d) Pepsin.

8. HCl is secreted by -

   a) Salivary gland b) Peptic cells c) Oxyntic cell d) Gall bladder

   Ans. (c) Oxyntic cell.

9. Largest gland of the human body is -

   a) Pancreas b) Liver c) Pituitary d) Salivary gland

Ans. (b) Liver.

10. Which of the following statement is incorrect about intestinal villi?

a) Microvilli are present.

b) Increases the surface area for the absorption.

c) Blood capillaries and lymph nodes are present in villi.

d) Only fat digestion occurs here.

Ans. (d) Only fat digestion occurs here.

11. Chose the correct statement from the following:

a) Trypsinogen is an inactive enzyme.

b) Trypsinogen gets secreted from the intestinal mucous layer.

c) Enterokinase is secreted by the pancreas.

d) Trypsin is present in the bile juice.

Ans. (a) Trypsinogen is an inactive enzyme.

12 Which of the following is not a function of liver?

a) Carbohydrate metabolism b) Fat digestion

c) bile secretion d) Secretion of gastrin hormone

Ans. (d) Secretion of gastrin hormone.

II. Fill in the blanks :

1. _____ prevents the entry of food into the wind pipe.

Ans. Epiglottis.

2. The opening of the stomach into the duodenum is guarded by the _____.

Ans. Pyloric sphincter.

3. Sub lingual gland is present below the _____.

Ans. Below the tongue.

4. Chylomicron is formed in _____.

Ans. Small Intestine.

5. The foldings present in the mucus layer of stomach are called as _____.

Ans. Gastric Rugae.

6. Absorbtion of glucose and amino acid takes place by the _____.

Ans. Simple diffusion.

III. Match column A with column B:

1.

Column - A	Column - B
a) Bile salt.	i) Lipase
b) Mucosal cells	ii) Peptic cells
c) Intestinal juice	iii) Goblet cells
d) Proenzyme	iv) Sodium glycocholate.
Ans. (a - iv; b - iii; c - i; d - ii).	

2.

Column - A	Column - B
a) Lysozyme.	i) Digestion of milk protein
b) Gastritis	ii) Pro enzyme
c) Renin	iii) Stomach ulcer
d) Pepsinogen	iv) Kills bacteria
Ans. (a - iv; b - iii; c - i; d - ii).	

3.

Column - A	Column - B
a) Chyme	i) Small intestine
b) Oxyntic cell	ii) Intestinal juice
c) Crypts of Lieberkuhn	iii) Partially digested food
d) Succus entericus	iv) Hydrochloric acid
Ans. (a - iii; b - iv; c - i; d - ii).	

B. Very Short Answer Type Questions. **[1 mark]**

1. What is the dental formula in human beings?

   Ans. $\frac{2\,1\,2\,3}{2\,1\,2\,3}$

2. Which muscle regulates the entry of food inside the stomach?

   Ans. Cardiac sphincter muscle or gastro-oesophagal sphincter.

3. What is the name of the crypts present in between the bases of villi in the intestine?

   Ans. Crypts of Lieberkuhn.

4. Bile is secreted from which gland?

Ans. Liver.

5. Hepato-pancreatic duct opens into which part of the large intestine?

   Ans. Duodenum.

6. Insulin and glucagon is secreted from which gland?

   Ans. Endocrine part of the pancreas.

7. Write the name of the bile pigments?

   Ans. Bilirubin, biliverdin.

8. Secretion of intrinsic factor from the parietal cells of stomach helps in secretion of which vitamin?

   Ans. Vitamin B12.

9. Which part of the alimentary canal absorbs water and simple sugar?

   Ans. Walls of the stomach.

10. What is the mixture called when food gets mixed with the digestive acidic juice present in the stomach?

    Ans. Chyme.

11. Name the type of attachment by which each tooth is embedded in a socket of jaw bone in the human body.

    Ans. Thecodont.

12. Which enzymes are responsible for the breakdown of nucleotides into sugar and nitrogen bases?

    Ans. Nucleotidase and nucleosidase.

13. Name the substance present in saliva that kills bacteria.

    Ans. Lysozyme.

14. Which part of the alimentary canal plays major role in absorption of food?

    Ans. Small intestine.

C. Short Answer Type Questions. **[2 marks]**

The stomach, located in the upper left portion of the abdominal cavity, has three major parts. Name these three parts?

Ans. i) Cardiac portion - Portion where oesophagus opens.

ii) Fundic region - Portion which is filled with air and gas.

iii) Pyloric portion - Portion which opens into the duodenum.

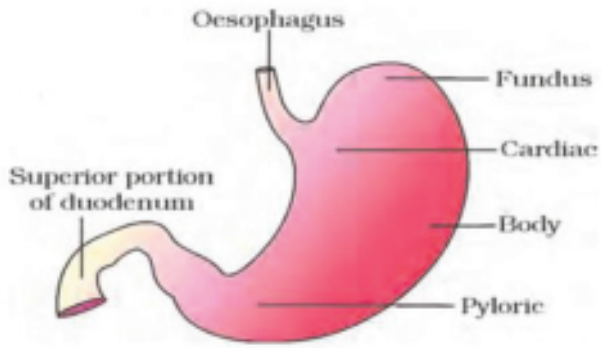


Figure : Anatomical regions of human stomach.

2. Does bile get produced in the gall bladder?

   Ans. Bile does not get produced in the gall bladder, bile gets stored in the gall bladder. Bile is secreted from the liver cells and is transported through the hepatic duct to the gall bladder, where the bile gets stored.

3. How is pepsinogen converted into active form?

   Ans. Pepsinogen is a proenzyme secreted from the peptic cells of the stomach. When the inactive pepsinogen comes in contact with the HCl secreted from the parietal or oxyntic cells of the stomach, it gets converted into pepsin, which is an active protein digestive enzyme. Pepsin converts protein into peptone and proteoses.

   Pepsinogen (inactive) $\xrightarrow{HCl}$ Pepsin (active).

   Protein $\xrightarrow{Pepsin}$ Peptone + proteose.

4. Chose the correct option from the following and write the correct statement.

a) Intestinal mucosal epithelium has goblet cells which secrete mucus/chymotrypsin.

b) Amylase/Lipase helps in the breakdown of fat into di and monoglyceride.

c) Gastric glands present in the mucosal layer of the stomach consist of oxyntic cell/chief cell, from which HCl gets secreted.

d) Saliva consists of starch/protein digestive enzyme.

   Ans. a) Mucus; b) Lipase; c) Oxyntic cell; d) Starch.

5. How does enzyme act on fats in the duodenum?

   Ans. In the duodenum, the enzyme lipase along with the help of bile juice breaks down fats to form diglycerides and monoglycerides. Then, mono and diglycerides are converted to form fatty acid and glycerol by the action of lipase enzyme.

   Fat $\xrightarrow{Lipase}$ Diglyceride $\longrightarrow$ Monoglyceride.

   Di and monoglyceride $\xrightarrow{Lipase}$ Fatty acid + Glycerol.

DO IT YOURSELF

A. Short Answer Type Questions. **[2 marks]**

a. What do you mean by cecum and vermiform appendix? (1+1)

b. Where is goblet cell present? What is its function? (1+1)

c. Which enzyme converts trypsinogen into active trypsin? From which part of the alimentary canal this enzyme is secreted? (1+1)

B. Short Answer Type Questions. **[3 marks]**

1. What are the different parts of the alimentary canal? Name the important digestive glands along with their position in the alimentary canal. (1+2)

2. With the help of a diagram explain how the secretions of pancreas help in digestion. (3)

3. What is the function of gall bladder? What will happen if the gall bladder is removed or stops functioning? (1+2)

4. What are the three major types of cells present in the gastric glands? Write the name of the substances secreted from these glands. (1+2)

5. Name some diseases occurring in human beings because of disorders in the digestive system. What are the different functions of the liver? (1+2)

6. How many pairs of salivary glands are present in the buccal cavity? Mention the names and positions of these glands. (1+2)

7. How does disaccharide and polysaccharide get digested? (3)

8. Write the composition of bile. Write the role of bile in the digestion of fat. (1+2)

C. Long Answer Type Questions. **[5 marks]**

1. Write the major steps of protein digestion which takes places in different parts of the alimentary canal. (5)

2. Write the role of saliva in digestion of starch inside the buccal cavity. Write the different types of teeth present in an adult human being along with the number of those different types of teeth. (3+2)

3. What do you mean by absorption of food? Give a brief description of how fat gets absorbed in the alimentary canal? (1+4)

4. Write the role of hepato-pancreatic duct in digestion of carbohydrate, protein and fat. What is Sphincter of Oddi? (4+1)

Teacher's Note

In the discussed chapter, describe the human digestive system with the help of labelled diagram. Learn the different important parts (pyloric sphincter, goblet cell, Crypts of Lieberkuhn, Sphincter of Oddi, lacteal, Brunner's gland, etc) of the alimentary canal along with their location and function. Digestion of different components of food (starch, protein and fat digestion) should be described with the help of flow diagram and related enzymes involved in the digestion of different components of food.

Refer paragraph 16.2 (Page no. - 263) of text book for answering Q.B.2. In this answer, mention the various transformation (e.g. : Protein $\rightarrow$ Peptone, etc.) processes along with the related enzymes. Refer paragraph 16.2 (Page no. - 263) of text book for answering Q.B.3. Mention the role of bile in digestion of fat.

UNIT - V

CHAPTER - 17

BREATHING AND EXCHANGE OF GASES

IMPORTANT CONCEPTS

- Respiration is a process in which oxygen is used to produce energy releasing CO2 for metabolism of cells.
- The process of exchange of O2 from the atmosphere with CO2 produced by the cells is called breathing.
- Mechanism of breathing vary among different groups of animals depending mainly on their habitats and level of organisation.
- Lower invertebrates exchange O2 with CO2 by simple diffusion over their entire body surface. Insects use a network of tubes (tracheal tubes), aquatic arthropods and molluscs use gills, amphibians use moist skin and mammals use lungs for the exchange of O2 with CO2.
- The main organs of the human respiratory system are the following:

a) Respiratory tract : External nostril, Nasal passage, Internal nostril, Glottis, and Pharynx.

b) Trachea : Larynx, Bronchus, bronchioles.

c) Respiratory organ : Lungs.

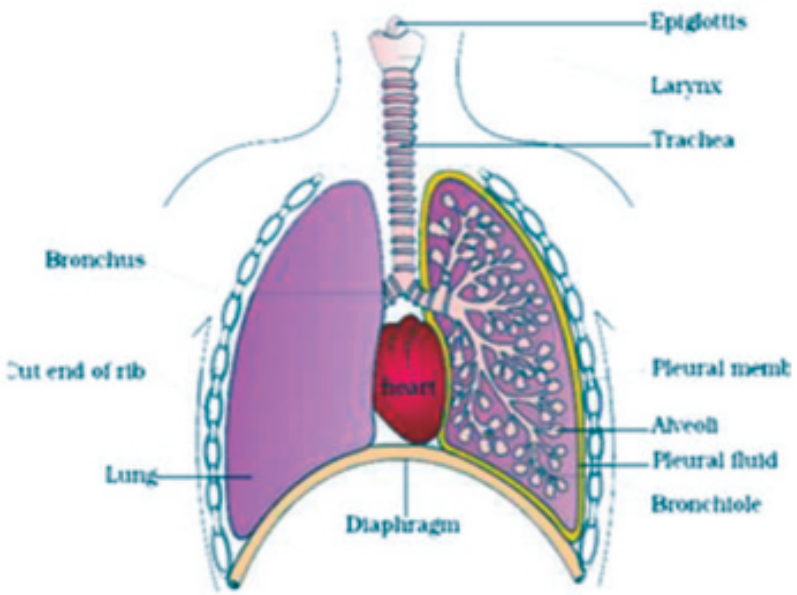


Figure : 17.1 Human Respiratory System.

- Our two lungs are covered by a double layered covering, this covering is called pleura.
- 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 equalises the temperature of this air and our body.
- Exchange part is the site of actual diffusion of O2 and CO2 between blood and atmospheric air.
- The lungs are situated in the thoracic chamber.
- The thoracic chamber is formed dorsally by the vertebral column, ventrally by the sternum, laterally by the ribs and on the lower side by the dome-shaped diaphragm.
- Respiration involves the following steps:

i) Breathing or pulmonary ventilation by which atmospheric air is drawn in and CO2 rich alveolar air is released out.

ii) Diffusion of gases (O2 and CO2) across alveolar membrane.

iii) Transport of gases by the blood.

iv) Diffusion of O2 and CO2 between blood and tissues.

v) Utilization of O2 by the cells for catabolic reactions and resultant release of CO2.

- Breathing involves two stages: inspiration and expiration.
- The diaphragm, external and internal intercostals muscles between the ribs and abdominal muscles are the muscles which help in breathing.

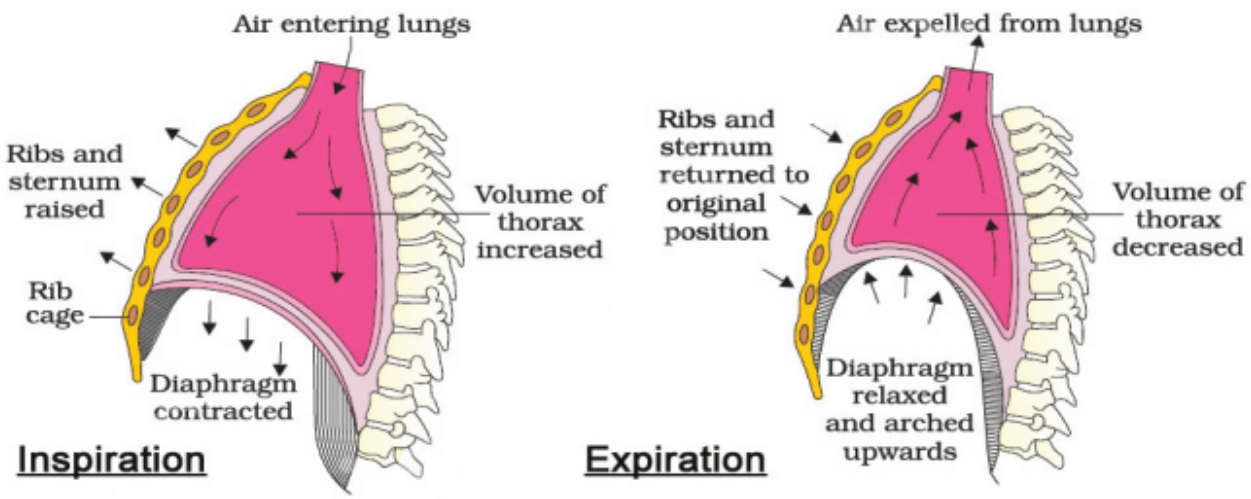


Figure: 17.2 Inspiration and Expiration.

- Respiratory volumes and Capacities:

(a) Tidal Volume (TV) = 500ml.

(b) Inspiratory Reserve Volume (IRV) = 2500-3000ml.

(c) Expiratory Reserve Volume (ERV) = 1000-1100ml.

(d) Residual Volume (RV) = 1100-1200ml.

(e) Inspiratory Capacity (IC = TV +IRV) = 3000-3500ml.

(f) Expiratory Capacity (EC = TV+ERV) = 1500-1600ml.

(g) Functional Residual Capacity (FRC=ERV+RV) = 2500-3000ml.

(h) Vital Capacity (VC=ERV+TV+IRV) = 3100-4800ml.

(i) Total lung Capacity (TLC =RV+ERV+TV+IRV) = 5000-6000ml.

- Exchange of gases occurs between blood and tissues by simple diffusion. The rate of diffusion depends on pressure/concentration gradient, solubility of the gases as well as the thickness of the membranes. These factors influence oxygen transfer from alveoli to deoxygenataed blood; similarly, transfer oxygenated blood to tissues. These factors are helpful in diffusion of CO2 in reverse direction, i.e., transport of CO2 from tissues to alveoli.

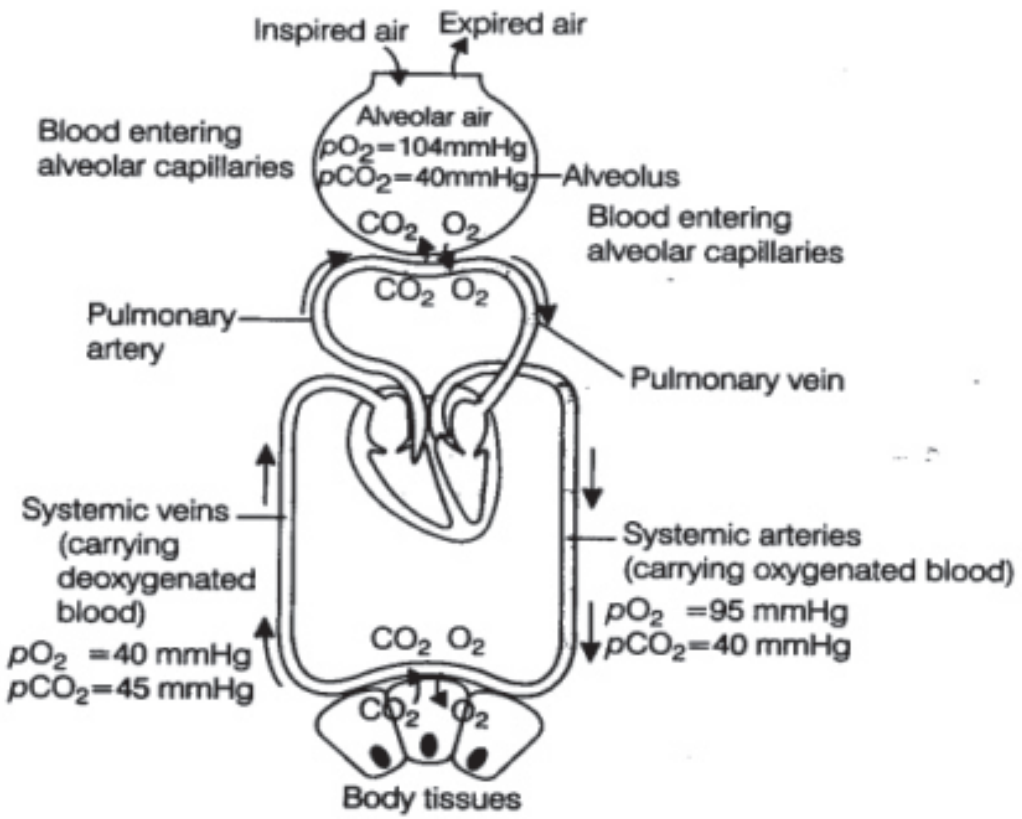


Figure: 17.3 Exchange of gases at the alveolus and the body tissues.

- About 97 percent of O2 is transported by RBCs in the blood. The remaining 3 percent of O2 is carried in a dissolved state through plasma.
- Nearly 20-25 percent of CO2 is transported by RBCs whereas 70 percent of it is carried as bicarbonate and about 7 percent of CO2 is carried in a dissolved state through plasma.
- O2 with combination of haemoglobin forms oxyhaemoglobin. This combination is affected by the partial pressure of O2, CO2 ion concentration of H+ and temperature of the body.
- A sigmoid curve is obtained when percentage saturation of haemoglobin with O2 is plotted against the pO2 which is called the oxygen dissociation curve.

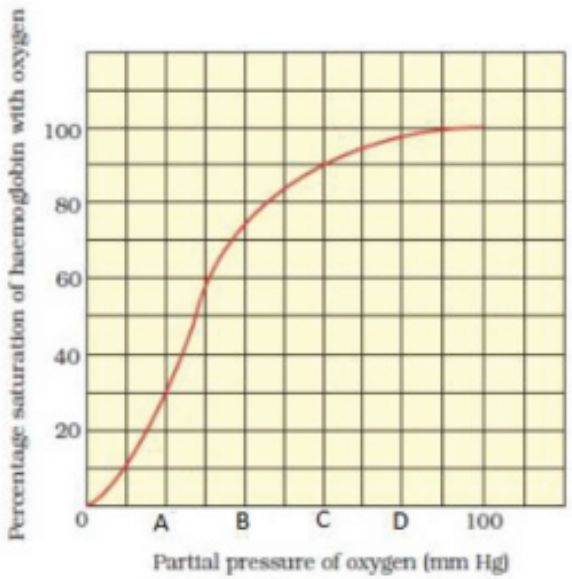


Figure: 17.5 Oxygen dissociation curve.

- In the lung surface, O2 gets associated to haemoglobin and gets dissociated at the tissues.
- Every 100ml of oxygenated blood can deliver around 5ml of O2 to the tissues under normal physiological conditions.
- CO2 is carried by haemoglobin as carbamino-haemoglobin. This binding is related to the partial pressure of CO2 (pCO2) and partial pressure of O2 (pO2).
- Every 100ml of deoxygenated blood releases approximately 4ml of CO2 to the alveoli.
- Nearly 70 percent of CO2 is transported as bicarbonate (HCO_3^-) with the help of the enzyme carbonic anhydrase.
- Respiratory rhythm is maintained by the respiratory centre in the medulla region of brain. A pneumotaxic centre in the pons region of brain and a chemosensitive area in the medulla can alter respiration mechanism.
- For the disorders of respiratory system the following diseases can happen in the human body: Asthama, emphysema fibrosis etc.

QUESTION AND ANSWER

A) Objective Questions. **[1 mark]**

I) Choose the correct answer:

1. Lungs is covered by a double layered lining called -

   (a) Pericardium (b) Pleura (c) Periosteum (d) Perichondrium,

   Ans. (b) Pleura.

2. Insects transport atmospheric air within the body through -

   (a) Gills (b) Moist skin (c) Tracheal tubes (d) Entire body surface.

   Ans. (c) Tracheal tubes.

3. Which of the following actions does not happen during respiration ?

   a) Gaseous exchange in lungs b) Diffusion of gas

   c) Entry of air in the air chamber d) Release of air from the air chamber.

   Ans. (b) Diffusion of gas.

4. The excessive amount of air that a person can take after a forceful inspiration is _____.

   a) Total lung capacity b) Tidal Volume c) Vital capacity d) Inspiratory reserve volume.

   Ans. (d) Inspiratory reserve volume.

5. The factor which affect the binding of O2 and haemoglobin is:

   a) Partial pressure of O2 b) Concentration of H+ ion

   c) Concentration of K+ ion d) Body temperature.

   Ans. (c) Concentration of K+ ion.

6. The part of brain that decreases the time of inspiration is -

   a) Medulla b) Pneumotaxic centre c) Cerebellum d) Spinal cord.

   Ans. (b) Pneumotaxic centre.

7. The instrument by which the volume of air inspired during respiration can be estimated is -

   a) Stethoscope b) Hygrometer c) Sphygmomanometer d) Spirometer.

   Ans. (d) Spirometer.

8. CO2 releases from carbamino-haemoglobin at the time of -

a) The high partial pressure of CO2 and low partial pressure of O2

b) The partial pressure of CO2 and O2 are equal

c) The low partial pressure CO2 and high partial pressure of O2

d) None of the above

Ans. (c) The low partial pressure CO2 and high partial pressure of O2.

9. Which one of the following is occupational respiratory disorder -

   a) Fibrosis b) Asthama c) Emphysema d) Jaundice

   Ans. (a) Fibrosis.

10. _____ of CO2 is transported by blood as bicarbonate.

    a) 20-25 percent b) 7 percent c) 70 percent d) 100 percent.

    Ans. (c) 70 percent.

II) Fill in the blanks:

1. Trachea is divided at the level of _____ thoracic vertebra into a right and left primary bronchi.

   Ans. 5th.

2. On an average, a healthy human breathes _____ times/minute.

   Ans. 12-16.

3. Tidal volume in human body is approx. _____ ml.

   Ans. 500 ml.

4. CO2 is transported as bicarbonate with the help of _____ enzyme.

   Ans. Carbonic anhydrase.

5. The smallest unit of lungs is _____.

   Ans. Alveolus.

III) Match the given column A with column B:

1)

Column A	**Column B**
a) Asthma.	**i) Proliferation of fibrous tissue**
b) Emphysema	**ii) Lacking of O2 in tissue**
c) Fibrosis	**iii) Inflammation of Bronchus and Bronchiole**
d) Hypoxia	**iv) Damage of alveolar wall**
Ans. (a - iii; b - iv; c- i; d - ii).	

2)

Column A	**Column B**
a) Earthworm.	i) Tracheal tubes
b) Aquatic arthropods	ii) Lungs

c) Insects	iii) Gills
d) Birds	iv) Moist skin
Ans. (a - iv; b - iii; c - i; d - ii).	

B) Very short answer type questions. **[1 mark]**

1. How many molecules of O2 can be carried by one molecule of haemoglobin in the human body?

   Ans. 4 molecules.

2. With what kind of epithelium the wall of alveoli is made up of?

   Ans. Thin squamous epithelium.

3. What is tidal volume?

   Ans. Volume of air inspired or expired during a normal respiration is called tidal volume. It is approximately 500 ml.

4. What is Residual Volume?

   Ans. Volume of air remaining in the lungs even after a forcible expiration is called Residual Volume (RV). The average RV is 1100ml to 1200ml.

5. What is Vital Capacity?

   Ans. The maximum volume of air a person can breathe in after a forced expiration is called Vital Capacity (VC). VC=ERV+TV+IRV.

6. What is Pleura?

   Ans. Our lungs are covered with double layered thin clean pleural fluid. This is called Pleura.

7. What is the amount of O2 supplied to tissues through every 100ml of oxygenated blood?

   Ans. 5ml.

8. About 97 percent of O2 is transported by RBC, how is the remaining 3 percent being transported?

   Ans. Remaining 3 percent of O2 is carried in a dissolved state through plasma.

9. Fill in the blanks:

a) Inspiratory Capacity (IC) = _____ + IRV.

b) _____ = TV + ERV.

c) FRC = ERV + _____

   Ans. a) IC = TV + IRV; b) EC = TV + ERV; c) FRC = ERV + RV.

10. Write the Respiratory organs of the following living organisms:

    Earthworm, Bird, Frog, Cockroach.

    Ans. Earthworm- Moist Skin, Bird- Lungs, Frog- Lungs, Moist Skin, Cockroach- Tracheal Tube.

11. How many times does a healthy human breathe on an average?

Ans. 12-16 times/minute.

12. Where is the Respiratory rhythm centre situated?

Ans. In the medulla region of the brain.

C) Short Answer Type Questions. [2 marks]

1) In which form CO2 is transported in the blood?

Ans. i) As carbomino-haemoglobin, 20-25 percent CO2 is transported by RBC.

ii) As bicarbonate, 70 percent CO2 is transported by RBC.

iii) About 7 percent of CO2 is transported as a dissolved state through plasma.

2) Define the following:

a) Functional Residual Capacity (FRC)

b) Asthma

Ans. (a) Functional Residual Capacity: Volume of air that will remain in the lungs after a normal expiration is called Functional Residual Capacity. This includes ERV+RV.

(b) Asthama: It is a disease caused due to inflammation of bronchi and bronchioles leading to muscle contraction in the nasal passage and secretion of mucous causing difficulty in breathing.

3) Emphysema is caused due to smoking. Give reasons.

Ans. Emphysema is a chronic disorder in which alveolar walls are damaged due to which respiratory surface is decreased. Due to cigarette smoking the inflammation of bronchus and bronchioles occurs and alveoli gets damaged. Elastic tissues are replaced by the connective tissue in lungs.

Hence, the respiratory surface decreases because of emphysema. It causes shortness of breath, production of sputum, chronic bronchitis etc.

DO IT YOURSELF

A) Short Answer Type Questions. [2 marks]

1. Name the respiratory muscles that help in respiration? (2)
2. Which factors affect the binding of O2 with haemoglobin? (2)
3. What is pneumotaxic centre? What is its function? (1+1)
4. What is the role of carotid artery and aortic arch? (1+1)

B) Short Answer Type Questions. [3 marks]

1. Define Oxygen dissociation curve. Why is it called sigmoid curve? (1+2)
2. Compared to O2 diffusion rate of CO2 through the diffusion membrane per unit difference in partial is much higher. Why? (3)

3. For completion of respiration process, write the given steps in sequential manner. (3)

(a) Diffusion of gases (O2 and CO2) across alveolar membrane.

(b) Transport of gases by blood.

(c) Utilisation of O2 by the cells for catabolic reactions and resultant release of CO2.

(d) Pulmonary ventilation by which atmospheric air is drawn in and CO2 rich alveolar air is released out.

(e) Diffusion of O2 and CO2 between blood and tissues.

4. Explain the transport of O2 and CO2 between alveoli and tissue with diagram. (3)

C) Long Answer Type Questions. [5 marks]

1. Explain the structure of human lungs with the help of a diagram. (2+3)

2. Explain the mechanism of breathing with the help of a diagram. (2+3)

3. What is respiratory rhythm centre? How is respiratory system controlled? (1+4)

Teacher's Note

In this chapter explain the names, location and functions of the parts of respiratory system. Explain the stages of Respiration, moods of breathing (Inspiration and Expiration), transportation of gas and gaseous substances with the help of diagrams and flow charts. Explain respiratory volume and capacity with a tabular representation. Explain the symptoms and causes of respiratory disorders.

For answering Q.B.2 of '"Do it yourself" section, refer paragraph no.17.3 of textbook.

For answering Q.B.3 of '"Do it yourself" section, refer paragraph no. 17.5 of textbook.

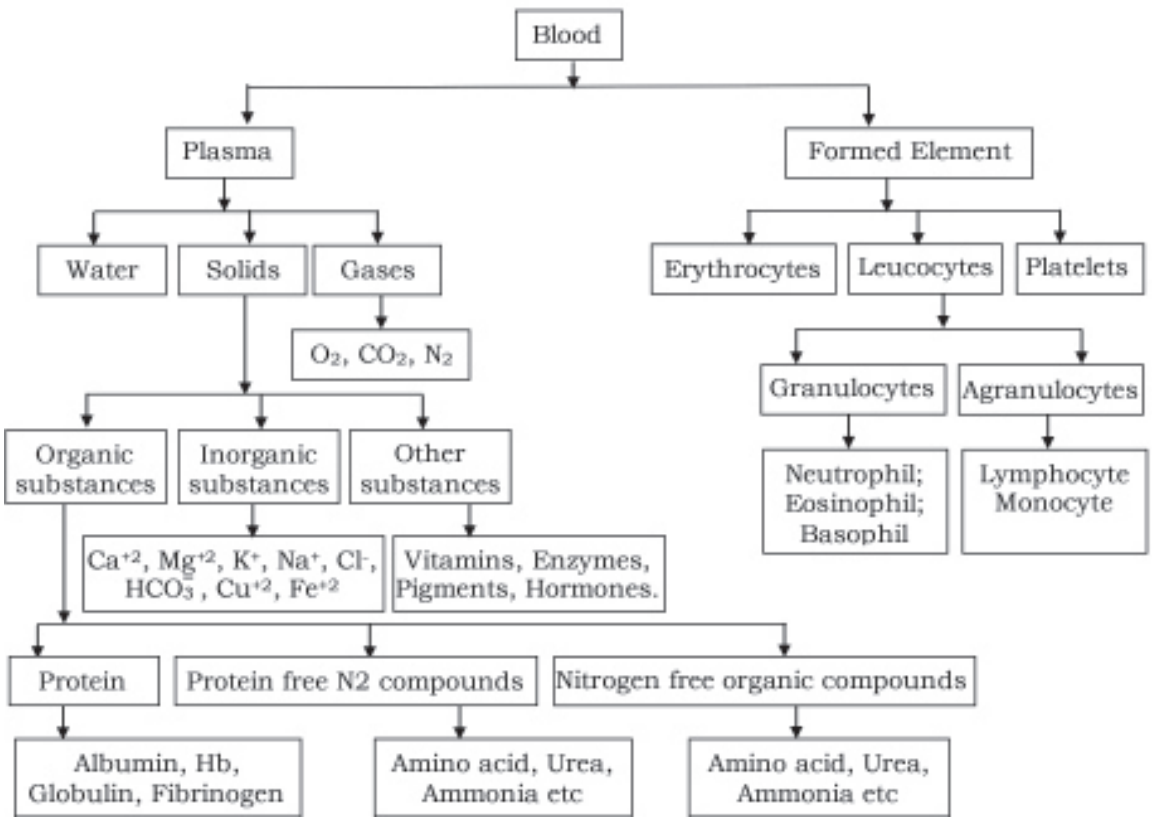
UNIT - V

CHAPTER - 18

BODY FLUIDS AND CIRCULATION

IMPORTANT CONCEPTS

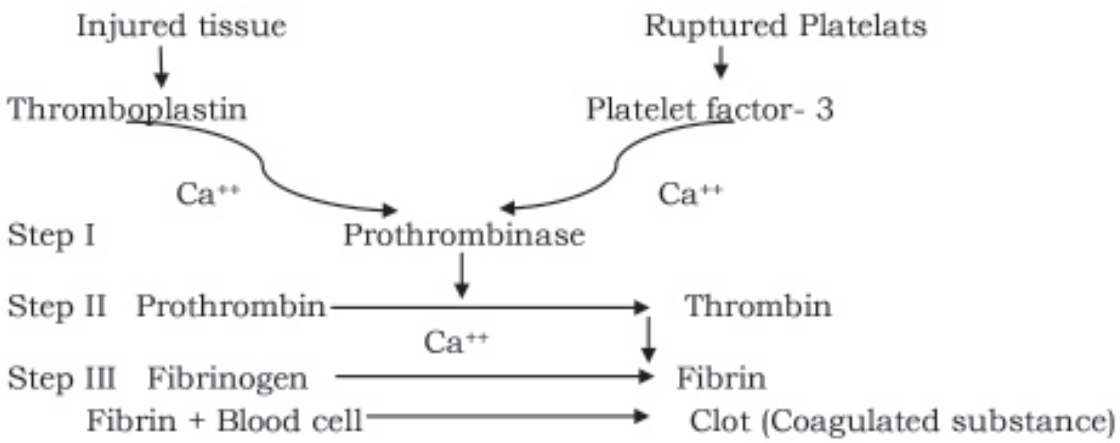
- In all living organisms, all the living cells have to be provided with nutrients, oxygen and other essential substances for the healthy functioning of the tissues. Also, the waste or harmful substances produced have to be removed continuously for the same purpose. Hence, in every living organism, circulatory system has got evolved for such transport to occur.
- Higher organisms including humans, most commonly use blood as the body fluid for the circulation process. Blood is a fluid connective tissue.
- Lymph is another body fluid which helps in the transport of certain substances.
- Blood is special connective tissue consisting of a fluid matrix, plasma and formed elements.
- Plasma is a straw coloured, viscous fluid which constitutes nearly 55% of the blood.
- Erythrocytes, leucocytes and platelets are collectively called formed elements, and they constitute nearly 45% of the blood.



- In human beings, blood has been grouped into different types - A, B, AB, O, based on the presence or absence of two surface antigens on the RBC.

Blood Group	Antigen on RBC	Antibodies in Plasma	Donor's Group
A	B	anti - B	A, O
B	B	anti - A	B, O
AB	A, B	nil	AB, A, B, O
O	nil	anti - A, B	O

- Grouping of blood in human is also done on the basis of the presence or absence Rhesus factor (another antigen) on the surface of RBC.
- The mechanism by which blood coming out from injured part of the body gets coagulated to form a semisolid jelly like substance, is called as coagulation of blood.
- The four major elements needed for blood coagulation are fibrinogen, prothrombin, thromboplastin and Ca++. The mechanism of blood coagulation has been shown below:



- A fluid gets released out of capillaries and is stored in the tissue fluid. And, when this tissue fluid enters into the lymph node, it is called as lymph.
- Lymph helps to develop immunity of the body, and also acts as carrier for nutrients and hormones.
- Two types of circulatory system are present in animal - Open circulatory system and closed circulatory system.
- In open circulatory system, blood pumped by the heart passes through blood vessels into body cavities (sinuses). In closed circulatory system, blood pumped by the heart is always circulated through a closed network of blood vessels.
- Fishes have a 2 - chambered heart with an atrium and a ventricle. The mechanism of single circulation is found in fishes.
- Amphibians and reptiles have a 3 - chambered heart with two atria and a single ventricle. The mechanism of incomplete double circulation is found in amphibians. Mammals have a 4-

chambered heart with two atria and two ventricles. The mechanism of double circulatory system in human is called as double circulation. It consists of a muscular chambered heart, blood and a network of closed branching blood vessels.

- Human heart is four chambered, which has two atria and two ventricles. Section of a human heart have been shown below -

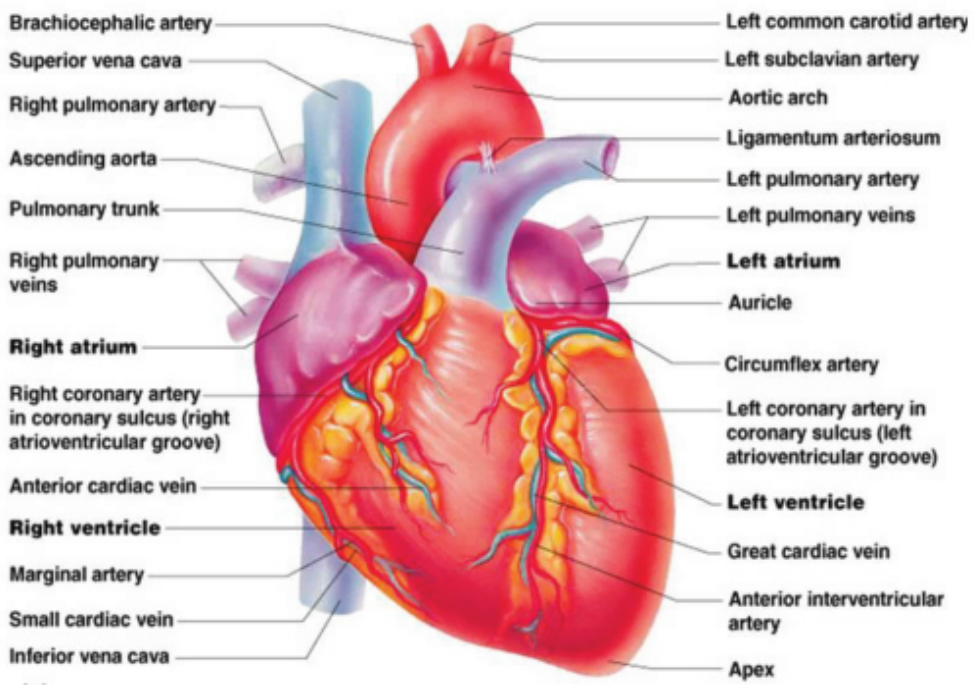
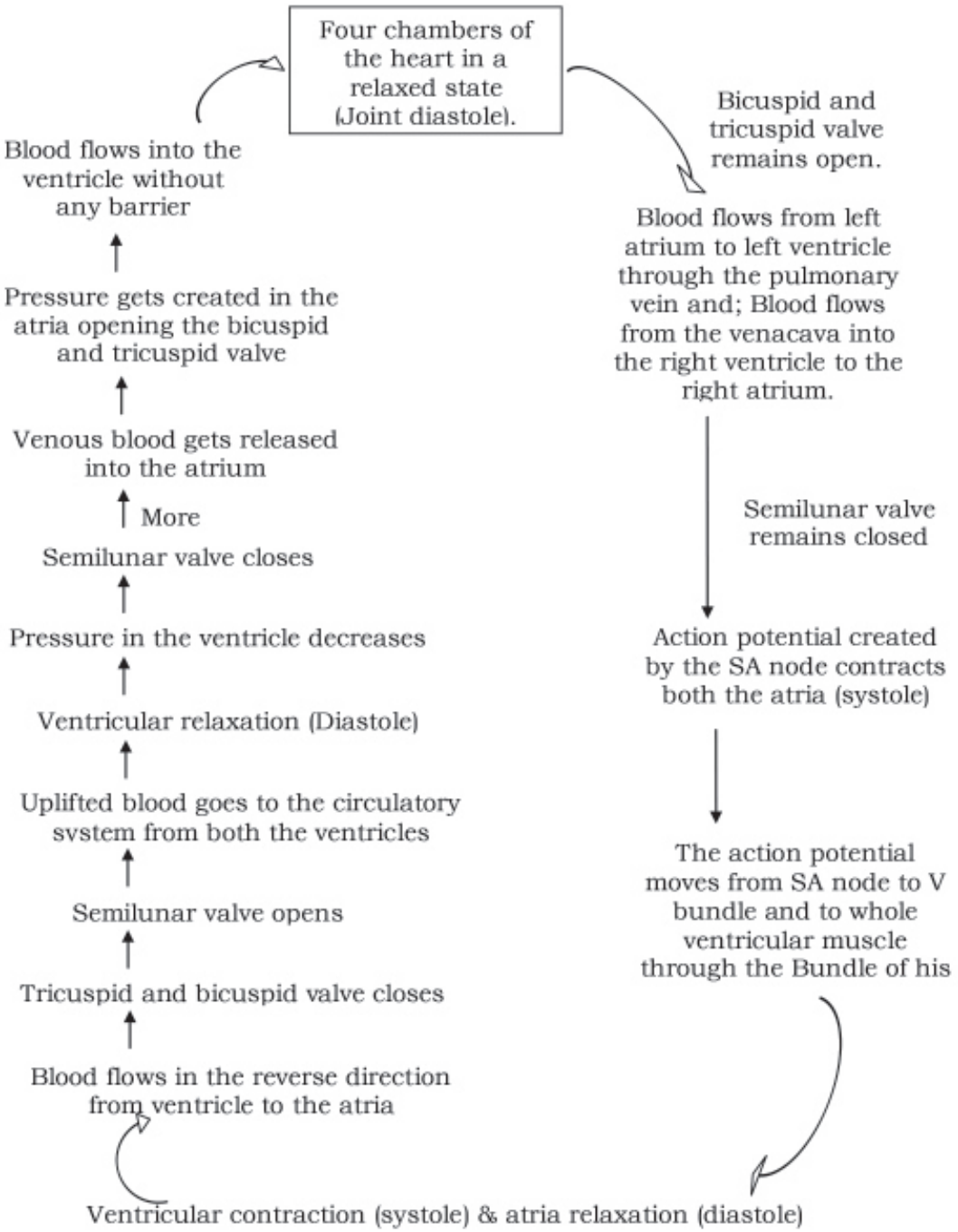


Figure: 18.1 Section of a human heart.

- The opening between the right atrium and right ventricle, and the opening between the left atrium and left ventricle are guarded by the tricuspid valve and the bicuspid value, respectively.
- The opening of the right and the left ventricles into the pulmonary artery and the aorta respectively are provided with the semilunar valves.
- The flow of blood in the heart occurs only in one direction, i.e., from the atria to the ventricles and from the ventricles to the pulmonary artery because of the presence of valves. These valves prevent any backward flow.
- The entire heart is made up of cardiac muscles - sino atrial node (SAN), atrio ventricular node (AVN), purkinje fibres, and bundle of his.
- The SAN can generate the maximum number of action potentials (70-75 per minute), and is responsible for initiating the rhythmic contractile activity of the heart. Hence, SA node is called the pacemaker.
- This sequential event in the heart which is cyclically repeated is called the cardiac cycle. This has been shown with the help of a diagram:



- The heart beats 72 times per minute on an average in a healthy person. The duration of a single cardiac cycle is 0.8 seconds.
- During a cardiac cycle, each ventricle pumps out approximately 70ml of blood which is called stroke volume.
- The volume of blood pumped out by each ventricle per minute is called cardiac output. The stroke volume multiplied by the heart rate gives the cardiac output. On an average, the cardiac

output is 5000ml or 5 litres in a healthy person.

- Electro cardiogram (ECG) is a graphical representation of the electrical activity of the heart during a cardiac cycle. The machine which is used to obtain an electrogram is called electro-cardiograph.

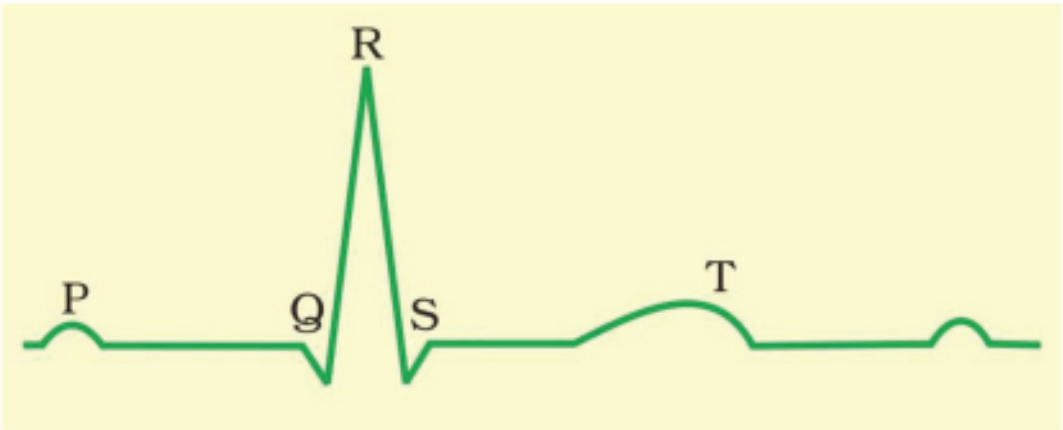


Figure: 18.2 Diagrammatic presentation of a standard ECG.

- In human beings, a complete double circulation occurs, which involves both pulmonary and systemic circulation.
- The pulmonary circulation starts by the pumping of deoxygenated blood by the right ventricle which is carried to the lungs where it is oxygenated and returned to the left atrium. The systemic circulation starts with the pumping of oxygenated blood by the left ventricle to the aorta which is carried to all the body tissues and the deoxygenated blood from there is collected by the viens and returned to the right atrium.
- A blood vascular connection exists between the digestive tract and liver, called as hepatic portal system.
- Coronary circulation - Coronary system of blood vessels is involved in circulation of blood to and from the cardiac musculature.
- The normal activities of heart are auto-regulated. Hence, the heart is called myogenic. The autonomic nervous system (ANS) present in the medulla oblongata, along with adrenal medullary hormones can regulated the cardiac function.
- Coronary Artery Disease (CAD) - Hypertension, coronary artery disease, angina, heart failure.

QUESTION AND ANSWER

A) Objective Questions. **[1 mark]**

I) Choose the most appropriate option from the following:

1. Globulin is a -

(a) Plasma protein (b) Protein (c) Antigen (d) Carbohydrate.

Ans. (a) Plasma protein.

2. Which of the following is not a phagocytic cell?

   (a) Monocyte (b) Neutrophil (c) Basophil (d) Macrophage.

   Ans. (c) Basophil.

3. The average shelf life of an erythrocyte is _____

   a) 120 days b) 180 days c) 150 days d) 200 days.

   Ans. (a) 120 days.

4. Which of the following pairs helps in coagulation of blood?

   a) Heparin and Ca++ b) Ca++ and platelet secretory elements

   c) Oxalate and citrate d) Platelet secretory elements and heparin.

   Ans. (b) Ca++ and platelet secretory elements.

5. Which of the following elements is devoid of nucleus?

   a) Red blood cells b) Neutrophil c) Eosinophils d) Lymphocytes.

   Ans. (a) Red blood cells.

6. Which of the following is responsible for formation of antibodies?

   a) RBC b) T-Lymphocyte c) B-Lymphocyte d) Neutrophil.

   Ans. (c) B-Lymphocyte.

7. Closing of which of the following produces the second heart sound?

   a) Tricuspid valve b) Semilunar valve

   c) Bicuspid valve d) Tricuspid and bicuspid valve.

   Ans. (b) Semilunar valve.

8. Pace maker is _____.

   a) Atrio ventricular node b) Sino atrial node

   c) Purkinji fibre d) Bundle of His.

   Ans. (b) Sino atrial node.

9. What will be the cardia output in a healthy person, if the average heart beat rate is 72 times per minute, and the stroke volume is 70ml?

   a) 360ml b) 3600ml c) 7200ml d) 5040ml.

   Ans. (d) 5040ml.

10. Which of the following organisms processes single circulation?

    a) Amphibians b) Birds c) Fishes d) Humans.

    Ans. (c) Fishes.

11. The protective layer of heart is called as ___

a) Epicardium b) Pericardium c) Pleura d) Myocaridum.

Ans. (b) Pericardium.

12. SA node is located in -

a) Upper part of left atrium, b) Upper part of right atrium,

c) Lower part of left ventricle. d) Lower part of right ventricle.

Ans. (b) Upper part of right atrium.

II) Fill in the blanks:

1. Red blood cells get destroyed in the _____.

Ans. Spleen.

2. The duration of a single cardiac cycle in a healthy human is _____.

Ans. 0.8 seconds.

3. Maximum number of action potentials are created by _____.

Ans. SA node. .

4. Ventricular diastole leads to the opening of _____ value.

Ans. Semilunar value.

5. Hormone secreted from _____ increases the cardiac output.

Ans. Adrenal gland.

6. _____ and monocytes are phagocytic cells.

Ans. Neutrophil.

7. The protein named _____ present in the plasma, plays or important role in coagulation of blood.

Ans. Fibrinogen.

8. _____ is found in amphibians.

Ans. Incomplete double circulation.

B) Very short answer type questions. [1mark]

1. What is the amount of haemoglobin present in the blood of a healthy person?

Ans. 12-16gm of haemoglobin per 100ml of blood is present in a healthy person.

2. Write the name of the blood vascular connection present between the digestive tract and liver?

Ans. Hepatic portal system.

3. What is the basis of ABO blood grouping system?

Ans. ABO blood grouping system is done on the basis of presence or absence of antigen A and antigen B on the surface of RBC.

4. What are the different types of plasma protein present in blood?

   Ans. Albumin, globulin, fibrinogen.

5. What is the total number of RBC present per cubic millimetre of blood?

   Ans. 5-5.5 million.

6. Where is RBC formed in an adult human?

   Ans. Red Bone marrow.

7. From which WBC heparin is secreted?

   Ans. Basophil.

8. Where are platelets formed?

   Ans. Platelets are formed by specialised cells called megakaryocytes present in the bone marrow.

9. In which stage of the cardiac cycle, both the atria and both the ventricles come in relaxation state together?

   Ans. Joint diastole.

10. What does the P - wave signify in ECG?

    Ans. Depolarisation of atrium.

11. What is serum?

    Ans. Plasma devoid of the blood coagulating helping factors is called as serum.

12. How are the lymphocytes helpful for us?

    Ans. Lymphocytes help the body to get immunity.

13. Which enzyme helps in activation of fibrin from inactive fibrinogen?

    Ans. Thrombokinase.

14. What is the location mitral value?

    Ans. The opening between the left atrium and left ventricle.

15. How many action potentials can be created by the SA node every minute?

    Ans. 70-75 action potentials per minute.

16. What is coronary circulation?

    Ans. Circulation of blood to and from heart to heart

C) Short Answer Type Questions. [2 marks]

1) Write the importance of plasma protein present in plasma.

   Ans. The plasma proteins present in plasma are - fibrinogen, globulin and albumin.

Fibrinogen - Helps in blood coagulation.

Globulin - Takes part in immune response of the body.

Albumin - Helps in maintaining the osmotic balance.

2) Why is our heart called as myogenic?

Ans. The normal activities of heart are intrinsically autoregulated by the nodal tissues. Different parts of nodal tissues are SA node, AV Node, Purkinji fibre and Bundle of His. These nodal tissues can create action potential intrinsically, without any external stimulus. Hence, our heart is called myogenic.

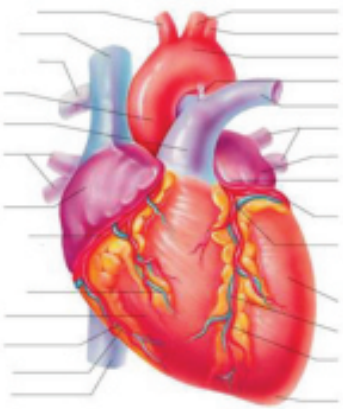
DO IT YOURSELF

A) Short Answer Type Questions. **[2 marks]**

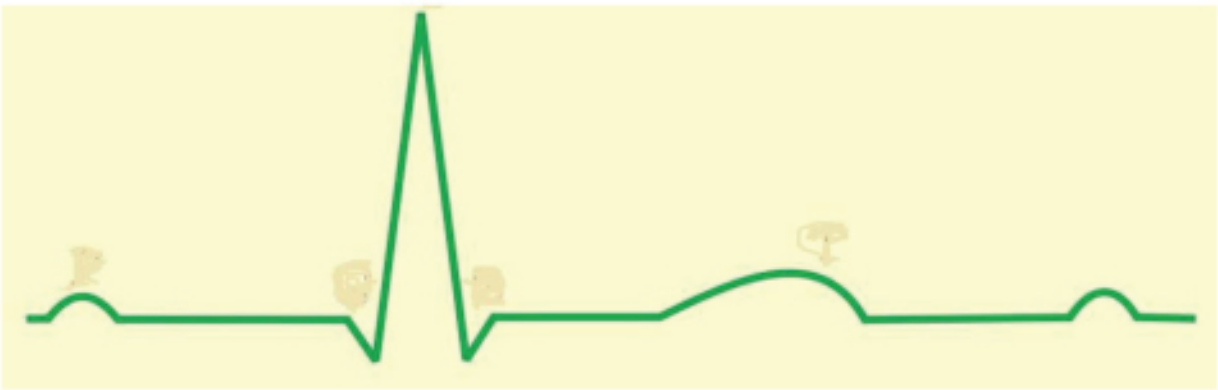
1. What is erythroblastosis fetalis? Why does it occur? (1+1)
2. What is blood coagulation? Name the important elements needed for blood coagulation. (1+1)
3. What is lymph? Write the function(s) of lymph. (1+1)
4. What is the blood flow unidirectional in the heart? (2)
5. What is S.A. Node? Why is it called the pace maker? (1+1)
6. What do you mean by stroke volume and cardiac output? (1+1)
7. Write the functions of neutrophil and basophil. (1+1)
8. What is atherosclerosis? Why does this disease occur? (1+1)

B) Short Answer Type Questions. **[3 marks]**

1. Who are called as universal donors and universal recipients? Write the names of antigen present on the RBC and antibodies present in plasma in their blood. (1+2)
2. Longitudinal section of human heart is given below. Label the different parts of it. (3)



3. An electrocardiogram is shown below. Label the different waves of this electrocardiogram and indicate these waves signify. (2+1)



P- ? Q- ? R- ? S- ? T- ?

4. Write the differences between the following:

a. Open circulation and closed circulation. (1)

b. S.A. node and A.V. node. (1)

c. Bicuspid value and Tricuspid value. (1)

5. Write short notes on:

a) Hypertension (1)

b) Angina pectoris (1)

c) Heart failure (1)

C) Long Answer Type Questions. [5 marks]

1. What is pulmonary circulation and systemic circulation? Write the events of cardiac cycle in brief. (2+3)

2. Write the name of different valves present in human heart along with their locations. Write the role of nervous system in functioning of heart in brief. (2+3)

Teacher's Note

In the discussed chapter, describe the different components of blood and different blood grouping systems in tabular form. Describe the structure of human heart with labelled diagram. Use flow diagram to describe the phases of blood coagulation, cardiac cycle, blood circulation in the human body and blood flow in the human heart.

While answering Q.A.1, refer paragraph 18.1.3.2 (Page no. - 281) of the textbook. While answering Q.A.4, refer paragraph 18.3.1 (Page no. - 283, 284). Short notes given in Q.B.5 should be answered by mentioning the symptoms and causes of the diseases. Refer paragraph 18.5 (Page no. - 287) of textbook while answering Q.C.2.

UNIT - V

CHAPTER - 19

EXCRETORY PRODUCTS AND THEIR ELIMINATION

IMPORTANT CONCEPTS

- The process of elimination of water soluble contaminants produced by metabolism in animals is called excretion.
- The major nitrogenous wastes excreted by animals are - ammonia, Uria and Uric Acid.
- Animals those excrete ammonia are called ammonotelic animals e.g. - Bone fish, aquatic amphibians.
- Animals those excrete uric acid are called uricotelic animals e.g. - Reptiles, birds, land snail and insects.

Animals	Excretory organ
Flat worm	Protonephrida
Amphioxus	Protonephridia
Earthworm	Nephridia
Cockroach	Malpighian Tubule
Prawn	Antennal or green gland

- Human excretory system consists of a pair of kidneys, a pair of ureters, a urinary bladder and a urethra.

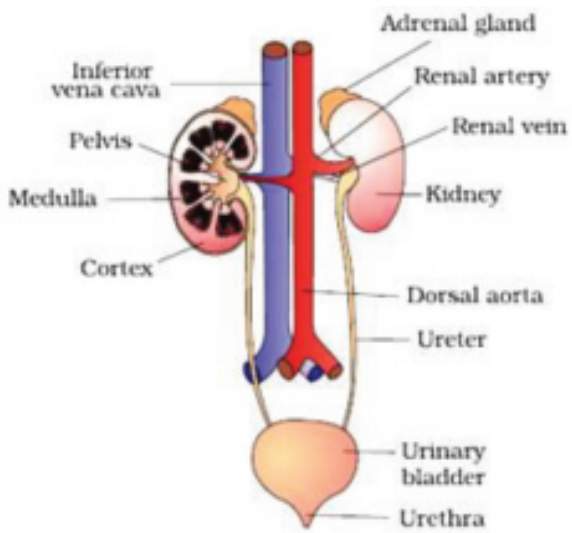


Figure: 19.1 Human Excretory System.

- 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 120-170g. Towards the centre of the inner concave surface of the kidney is a notch through which ureter, blood vessels and nerves enter, called hilum.

  Inside the kidney, there are two zones -

  (a) Outer cortex (b) Inner medulla.

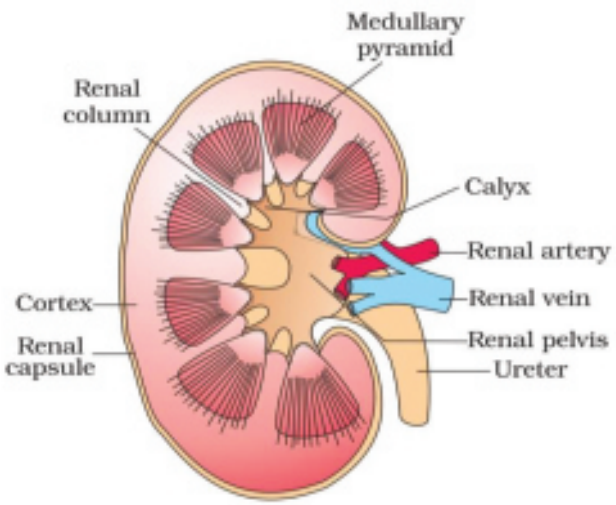


Figure: 19.2 Longitudinal Section (Diagrammatic) of a Kidney.

- The structural and functional unit of kidney is nephron.
- Parts of a nephron are the malpighian corpuscle and the renal tubule.
- The malpighian corpuscle has two parts -

(i) Bowman's capsule

(ii) Glomerulus

- The parts of the renal tubule are

i) Proximal convoluted tubule

ii) Henle's loop

iii) Distal convoluted tubule

iv) Collecting duct

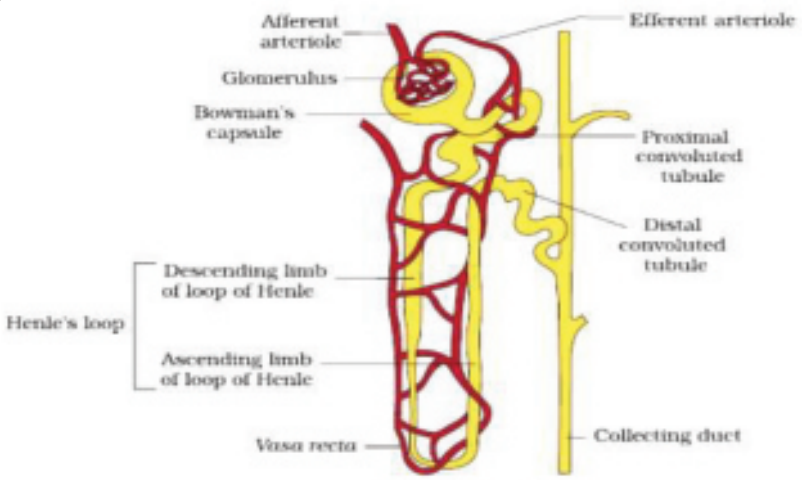


Figure: 19.3 A diagrammatic representation of a nephron showing blood vessels, duct and tubule.

- Major functions of Kidney:

  i) Maintaining water balance.

  ii) Removal of nitrogenous waste.

- Major functions of nephron:

  i) Ultra filtration occurs in the glomerulus.

  ii) Reabsorption, secretion and production of new substances occurs in the renal tubule.

- There are two types of nephron:

  a) Cortical nephron (The size of Henle's loop is very small)

  b) Juxta medullary nephrons (The size of Henle's loop is very long)

- Urine formation involves three main processes namely -

  a) Glomerular filtration

  b) Reabsorption

  c) Secretion

- On an average, 1100-1200ml of blood is filtered by the kidneys per minute which constitute roughly 1/5th of the blood pumped out by each ventricle of the heart in a minute.
- 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. Therefore, it is considered as a process of ultra filtration.
- The amount of the filtrate formed by the kidneys per minutes is called glomerular filtration rate (GFR). GFR in a healthy individual is approximately 125ml/minute, i.e., 180 litres per day.
- Juxta glomerular apparatus (JGA) is a special sensitive region formed by cellular modifications in the distal convoluted tubule and the afferent arteriole at the point of their contact.
- A comparison of the volume of the filtrate formed per day (180 litres per day), suggest that nearly 99 percent of the filtrate has to be reabsorbed by the renal tubules. This process is called reabsorption.
- Substances like glucose, amino acids, Na+ etc., in the filtrate are reabsorbed by active transport whereas the nitrogenous wastes are absorbed by passive transport.
- Reabsorption of water occurs passively in the initial segments of the renal tubule.
- During urine formation, the tubular cells secrete substances like H+, K+ and ammonia into the filtrate which helps in the maintenance of ionic and acid-base balance of body fluids.
- **Function of the tubules :**

a) Proximal convoluted tubule (PCT): Nearly all of the essential nutrients, and 70-80 percent of electrolytes and water are reabsorbed by this segment. Secretion of hydrogen ions, ammonia, potassium ions into the filtrate and absorption of HCO_3 from it helps to maintain the pH and ionic balance of the body.

b) Henle's loop: 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 permeable to electrolytes. Therefore, as the concentrated filtrate passes upward, it gets diluted due to the passage of electrolytes to the medullary fluid.

c) Distal convoluted tubule (DCT): Reabsorption of Na+, water, HCO3 and secretion of hydrogen ions, potassium ions and NH3 takes place in this segment to maintain the pH and sodium-potassium balance in the blood.

d) Collecting duct: Large amounts of water could be reabsorbed from this region to produce a concentrated urine. It also plays a role in the maintenance of pH and ionic balance of blood by the secretion of H+, K+ and urea.

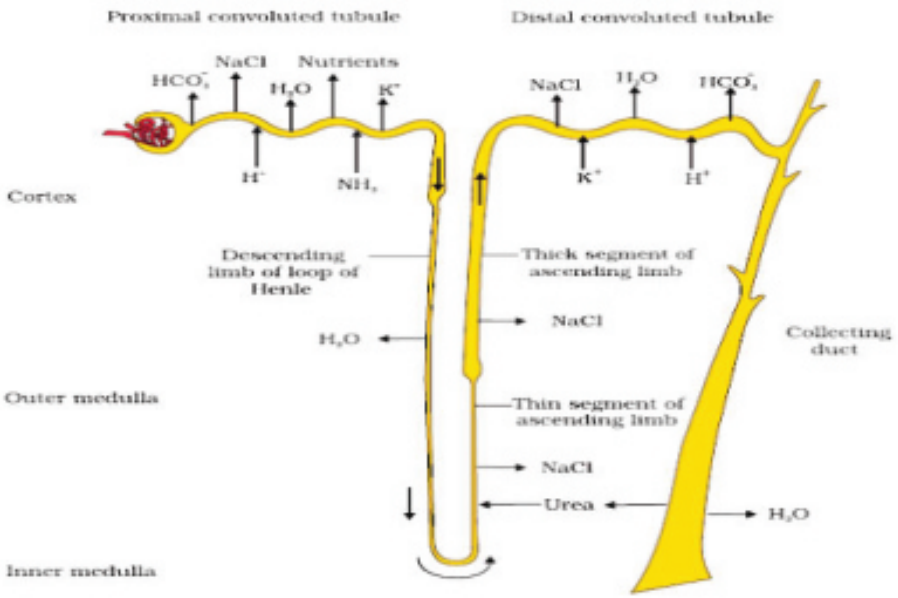


Figure: 19.4 Reabsorption and secretion of major substances at different parts of the nephron (Arrow indicate direction of movement of materials).

♦ Mechanism of concentration of the filtrate:

The Henle's loop and vasa recta plays a significant role in producing a concentrated urine. The proximity between the Henle's loop and vasa recta, as well as the counter current mechanism in them helps in maintaining an increase in 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.

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 the vasa recta. Similarly, small amount of urea enters the thin segment of the ascending limb of Henle's loop which is transported back to the intertitium by the collecting tubule. This process is called counter current mechanism.

The concentration gradient created by counter current mechanism occurring in the medulla, helps in an easy passage of water from the collecting tubule thereby concentrating the filtrate

(urine). This is an important process for storing water in the body.

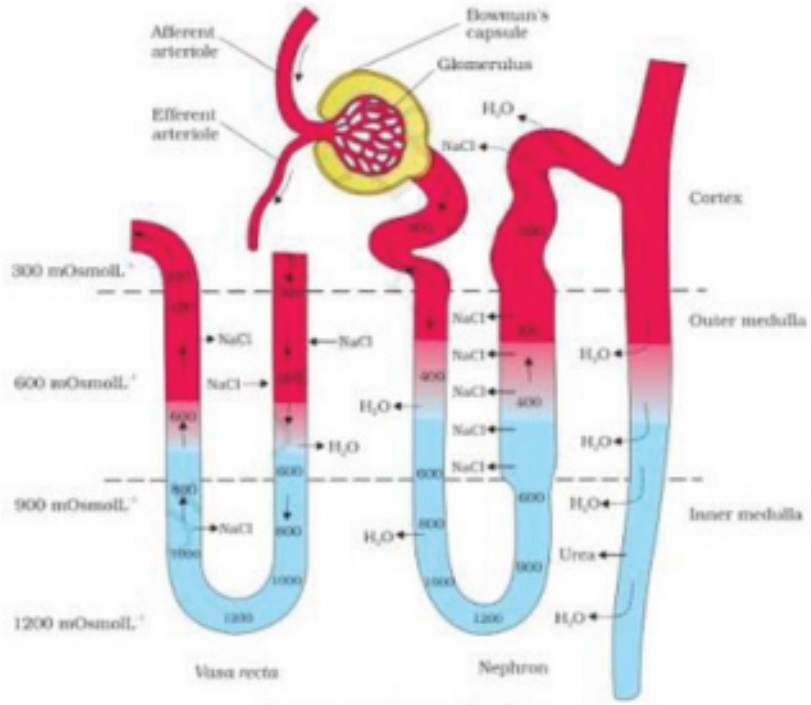


Figure: 19.5 Diagrammatic representation of a nephron and vasa recta showing counter current mechanisms.

- Regulation of kidney Function:

i) An excessive loss of fluid from the body can activate the osmoreceptors which stimulate the hypothalamus to release antidiuretic hormone (ADH) or vasopressin from the neurohypophysis. ADH facilitates water reabsorption from the renal tubule. An increase in body fluid volume can switch off the osmoreceptors and suppress the ADH release to complete the feedback.

ii) ADH causes an increase in blood pressure by its constrictory effects on blood vessels. This causes an increase in the glomerular blood flow and thereby the GFR.

iii) The JGA plays a complex regulatory role. A fall in glomerular blood flow/pressure can decrease the GFR. As a result, it can activate the Juxta Glomerular cells (JG cells) to release renin. Renin converts angiotensinogen in blood to angiotensin I and further to angiotensin II. Angiotensin II, being a powerful vasoconstrictor, increases the glomerular blood pressure and thereby GFR. This complex mechanism is generally known as the Renin-Angiotensin mechanism.

iv) An increase in blood flow towards the atria of the heart can cause the release of Atrial Natriuretic Factor (ANF). ANF can cause vasodilation (dilation of blood vessels) and thereby decrease the blood pressure. ANF mechanism, therefore acts as a check on the renin-angiotensin mechanism.

- An adult human excretes, on an average, 1 to 1.5 litres of urine per day.
- Other than the kidneys, lungs, liver and skin also help in the elimination of excretory wastes.

Our lungs remove large amount of CO2. Liver secretes bilirubin, biliverdin, cholesterol, degraded steroid hormones, vitamins and drugs. The sweat glands eliminate NaCl, small amounts of urea, lactic acid in the form of sweat and sebaceous glands eliminate sterols, hydrocarbons and waxes through sebum.

QUESTION AND ANSWER

A) Objective Questions **[1 mark]**

I) Choose the most appropriate option from the following:

1. Which of the following substance excreted by the animals is least toxic?

   a) Urea (b) Uric acid (c) Ammonia (d) CO2

   Ans. (b) Uric acid.

2. In which part of kidney, renal pyramids are found?

   a) Pelvis (b) Medulla (c) Cortex (d) Hilum

   Ans. (b) Medulla.

3. Podocyte cells are found -

a) In the walls of Henle's loop

b) In the walls of blood vessels of Glomerulus

c) In the walls of Bowman's capsule

d) In the walls of Vasa recta

   Ans. (c) In the walls of Bowman's capsule

4. The average pH of urine in human is -

   a) 4.0 b) 6.0 c) 9.0 d) 7.5

   Ans. (b) 6.0

5. Which statement is incorrect?

a) Birds and land snails are uricotelic animal.

b) Mammals and frog are ureotelic animal.

c) Aquatic amphibians and aquatic insects are ammonotelic animal.

d) Birds and reptiles are ureotelic animal.

   Ans. d) Birds and reptiles are ureotelic animal.

6. The amount of blood filtrated through two kidneys per minute is -

   a) 1500ml b) 1200ml c) 800ml d) 4200ml.

   Ans. (b) 1200ml.

7. Which of the following is an antidiuretic hormone?
   a) Oxitocin b) Vasopressin c) Adrenaline d) Calcitonin.
   Ans. (b) Vasopressin.
8. Atrial Natriuretic Factor (ANF) is secreted by -
   a) Hypothalamus b) Kidneys c) Heart d) Liver.
   Ans. (c) Heart.
9. The average (approx.) amount of urea excreted from the body is -
   a) 100gm b) 2-3gm c) 50-60gm d) 25-30gm.
   Ans. (d) 25-30gm.
10. Which of the following is not a constituent of dialysing fluid?
   a) NaCl b) Calcium c) Glucose d) Nitrogenous waste.
   Ans. (d) Nitrogenous waste.
11. Concentrated urine is formed from the filtrate by the process of -

a) Reabsorption by PCT

b) Reabsorption by Collecting tubule

c) Reabsorption by DCT

d) Counter current mechanism of Henle's loop

Ans. d) Counter current mechanism of Henle's loop

12. Which of the following statements is incorrect?

a) Renin converts angiotensinogen to Angiotensin I and Angiotensin II.

b) Aldosterone causes reabsorption of Na+ and water from the distal parts of the tubule.

c) ANF can cause vasodilation.

d) ADH removes water from the body.

Ans. d) ADH removes water from the body.

II) Fill in the blanks :

1. The structural and functional unit of human kidneys are _____.
   Ans. Nephron.
2. Malpighian corpuscle is present in the _____ region of the Kidneys.
   Ans. Cortex.
3. The _____ glands are located in the upper part of human kidney.
   Ans. Adrenal.

4. Nearly all of the essential and 70-80 percent of electrolytes and water are reabsorbed by the _____ of the renal tubule.

   Ans. Proximal Convoluted Tubule (PCT).

5. The reason for the formation of stones in the kidneys is the formation of _____

   Ans. Oxalate crystals.

III) Match the column A with column B:

1)

Column A	**Column B**
a) Protonephridia	i) Prawn
b) Nephridia	ii) Cockroach
c) Malpighian tubules	iii) Earthworm
d) Green glands	iv) Flatworms
Ans. (a-iv; b-iii; c-ii, d-i)	

2)

Column - A	**Column - B**
a) Glycosuria	i) Accumulation of urea in blood
b) Uremia	ii) Ketone bodies in urine
c) Ketonuria	iii) Presence of glucose in urine
d) Renal calculi	iv) Oxalate salts formed within the kidney
Ans. (a-iii; b-i; c-ii, d-iv)	

B) Very short answer type questions. **[2 marks]**

1. What is osmoregulation?

   Ans. The process by which organisms can maintain the balance of water and various ions in their bodies is called osmoregulation.

2. What do you mean by columns of Bertini?

   Ans. The cortex extends in between the medullary pyramids as renal columns called columns of Bertini.

3. What is the GFR in a healthy person?

   Ans. GFR in a healthy individual is approximately 125ml/minute i.e., 180 litres per day.

4. From which part of the kidney does rennin get secreted?

   Ans. Renin is secreted from the juxta glomerular cells of the kidneys.

5. From which part of the body does ADH get secreted?

Ans. ADH is secreted from the neurohypophysis of hypothalamus.

6. Sweat produced from sweat glands is made up of which ingredients?

Ans. NaCl, small amounts of urea, lactic acid, etc.

7. What is Glomerulonephritis?

Ans. Inflammation of glomeruli of kidney.

C) Short Answer Type Questions. [2 marks]

1) What is glomerular filtration? Why it is called ultra filtration?

Ans. The first step in urine formation is the filtration of blood, which is carried out by the glomerulus and is called glomerular filtration. Blood is filtered so finely through the filtration membranes, that almost all the constituents of the plasma except the proteins pass onto the lumen of the Bowman's capsule. That is why it is called as a process of Ultra filtration.

2) What is Renin? What is its function?

Ans. A fall in GFR can activate the juxta glomerular cells to release an enzyme, called renin.

Renin converts angiotensinogen in blood to angiotensin I and further to angiotensin II. Angiotensin II, being a powerful vasoconstrictor, increases the glomerular blood pressure and thereby GFR.

3) What is that difference between glycosuria and ketonuria? What is the role of sebaceous gland in excretion?

Ans. Refer paragraph no. - 19.6 (Page no. - 298) of the textbook.

4) Active and passive absorption of which substances occurs from the filtrate of the glomeruli?

Ans. Refer paragraph no. -19.2 (Page no. - 294) of the textbook.

5) From which part of the body ANF gets secreted?

Ans. Refer paragraph no. -19.5 (Page no. - 297) of the textbook.

D) Short Answer Type Questions. [3 marks]

1) The composition of glomerular filtrate and urine are not same. Explain.

Ans. The composition of glomerular filtrate and urine are not same. Large amount of water, urea, uric acid, creatinine, amino acid, glucose, sodium, potassium, vitamin etc. remains dissolved in the glomerular filtrate.

The urine is a transparent light yellow coloured watery fluid which is formed from the glomerular filtrate after rigorous reabsorption and secretion. It constitutes about 95% water and 5% of other organic and inorganic substances.

Organic substances in the urine includes nitrogen, urea, creatine, ammonia, uric acid, oxalic acid, vitamins, hormones and enzymes.

Whereas inorganic substance in urine includes chlorides, phosphate, sulphate, potassium, sodium,

calcium, magnesium, iodine, arsenic and lead. Glucose is not found in urine normally. Hence, composition of glomerular filtrate and urine is different.

2) Aquatic animals are usually ammonotelic but terrestrial animals are not. Explain.

Ans. The process of excreting ammonia is ammonotelism. Many bony fishes, aquatic amphibians and aquatic insects are ammonotelic in nature. Since ammonia is readily soluble, it is generally excreted by diffusion across body surfaces or through gill surfaces (in fish) as ammonium ions.

As ammonia is the most toxic form, it requires large amount of water for its elimination. This process of excretion is suitable for aquatic organisms because they are in constant access to water.

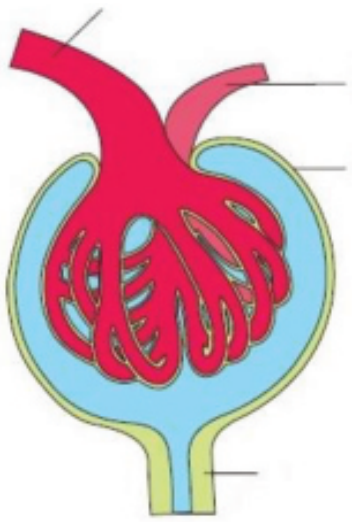
In the need of terrestrial adaptation, the production of lesser toxic nitrogenous wastes like urea and uric acid for conservation of water. Mammals, many terrestrial amphibians and marine fishes mainly excrete urea and are called ureotelic animals.

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 and are called uricotelic animals. Conversion of ammonia to uric acid and its elimination requires less water, thus it is very essential for terrestrial forms that do not have constant water supply.

DO IT YOURSELF

A) Short Answer Type Questions. **[2 marks]**

1. Level the different parts of the diagram is given below. (2)



2. Name the excretory product excreted by each of the following excretory organs: (2)

   i) Kidney ii) Lungs iii) Liver iv) Skin

3. Write the full form of the following: (2)

   i) ANF ii) ADH iii) GFR iv) DCT

B) Short Answer Type Questions. **[3 marks]**

1. What is counter current mechanism? What is its role in urine formation? (1+2)
2. What is the role of rennin angiotensin mechanism in regulating the function of kidneys? (3)
3. What is the role of different hormones in reabsorption of glomerular filtrate? (3)

C) Long Answer Type Questions. **[5 marks]**

1. Explain the mechanism of concentration of the filtrate or urine formation with the help of diagram. (5)
2. Explain reabsortion and secretion of major substances at different parts of the nephron with the help of diagram. (3+2)
3. Describe the structure of a human kidney with the help of a labelled diagram. (3+2)

Teacher's Note

In this chapter, explain structure, location and function of human excretory system (kidney and nephron) with the help of diagrams. Counter current mechanism and its role in urine formation (Q.B.1 of 'Do it yourself' section) are explained in paragraph no. - 19.4 (Page no. - 296, 297) of textbook. Refer paragraph no. - 19.5 (page-297) of textbook for Q.B.2 and Q.B.3 of 'Do it yourself' section. Refer paragraph no. 19.3 (page - 294, 295) of textbook for Q.C.2 of Long-answer type questions and explain it with the help of diagram.

The following topics may be explained with the help of flow diagram: Function of renal tubule in urine formation, mechanism of concentration of filtrate and regulation of kidney function.

UNIT - V

CHAPTER - 20

LOCOMOTION AND MOVEMENT

IMPORTANT CONCEPTS

- All living organisms move their body in two ways:

a) When one part of the body performs, but whole body remains fixed in a certain place, is called movement.

b) Some of the movements result in a change of place or location. Such voluntary movement is called locomotion.

- Movement of cilia, flagella in many organisms, movement of limbs, jaws, eyelids, tongues etc are examples of locomotion.
- Walking, running, climbing, flying, swimming are all some forms of locomotory movements.
- Methods of locomotion performed by animals vary with their habitats and the demands of the situation. Locomotion generally occurs for search of food, shelter, mating, suitable breeding grounds, favourable climatic conditions or to escape from enemies/predators.
- Cells of the human body exhibit three main types of movements:

(a) Amoeboid movement - Movement of Macrophage and leucocytes cells.

(b) Ciliary movement - Removing of dust particles (inhaled from atmospheric air) from the trachea and the passage of ova through the female reproductive tract is facilitated by ciliary movement.

(c) Muscular movement - Movement of jaws, tongues.

- About 40-50 percent of the body weight of a human adult is contributed by Muscles.
- Properties of muscle - excitability, contractility, extensibility and elasticity.
- Based on their location, three types of muscles are identified - (i) Skeletal, (ii) Visceral and (iii) Cardiac.
- Skeletal muscles - closely associated with the skeletal components of the body. They are called striated muscles or voluntary muscles. These 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 alimentary canal, reproductive tract, etc. These muscles help in the transportation of food through the digestive tract and gametes through the genital tract. These muscles are smooth muscles or involuntary muscles.
- Cardiac Muscles - located in the muscles of the heart. These muscles are striated and involuntary in nature.

- Each organised skeletal muscle in our body is made up of a number of muscle bundles or fascicles held together. Each fascicles contain a number of muscle fibres. Each muscles fibre is lined by the plasma membrane called sarcolemma.

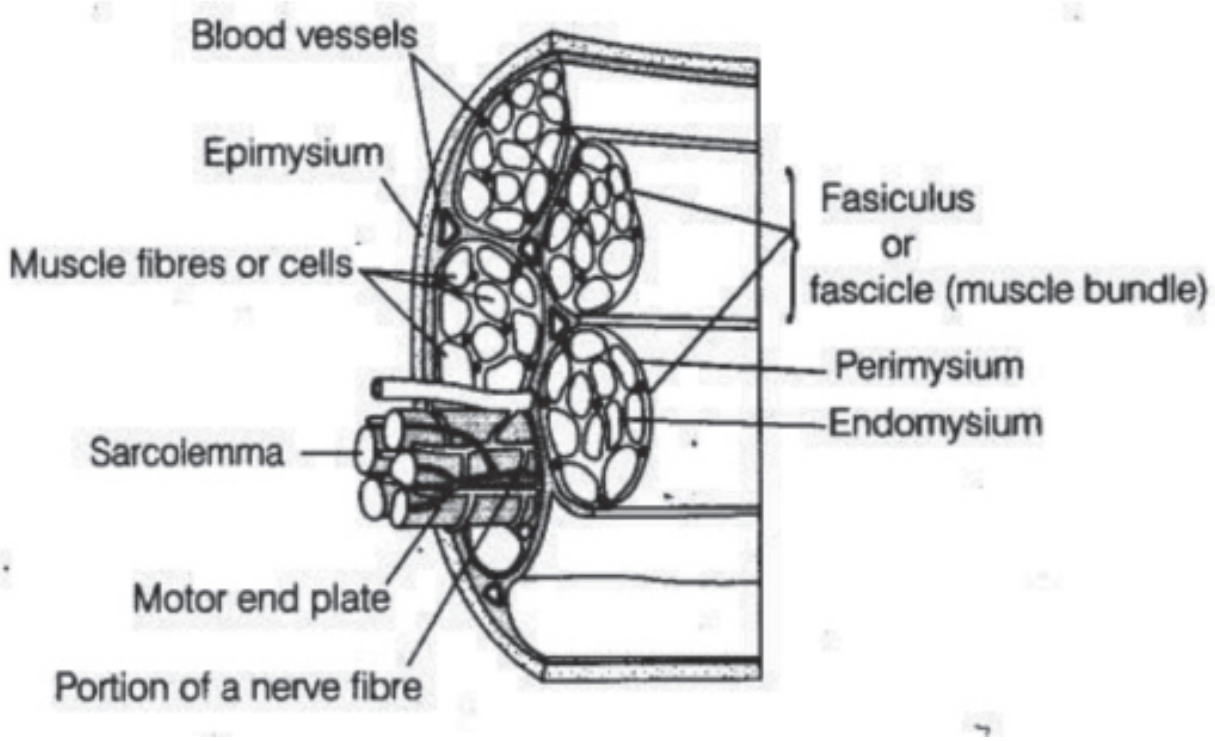


Figure: 20.1 Diagrammatic representation of cross sectional view of a muscle showing muscle bundles and muscle fibres.

- In the sarcoplasm of muscle fibre, there is the presence of a large number of parallelly arranged filaments. These are called myofilaments or myofibrils.

  Each myofibril has alternate dark and light bands on it due to the distribution pattern of two important proteins. The light bands contain Actin and is called I -band or Isotropic. The dark bands contain Myosin and is called A - band or Anisotropic.

- Sarcomere - The functional unit of contraction and is called sarcomere.

- Structure of contractile proteins - Each actin (thin) filament is made of two 'F' (filamentous) actins consisting of 'G' (Globular) actin. Two filaments of tropomyosin runs close to the 'F' actins throughout its length. Troponin protein is located on tropomyosin.

  Each myosin filament (thick filament) constitutes monomeric proteins called meromyosins. Each meromyosin has two important parts - a globular head with a short arm and a tail. The head and short arm projects outwards at regular distance and angle from each other from the surface of a polymerised myosin filament is known as cross arm. The globular head is an active ATPase enzyme and has binding sites for ATP and active sites for actin.

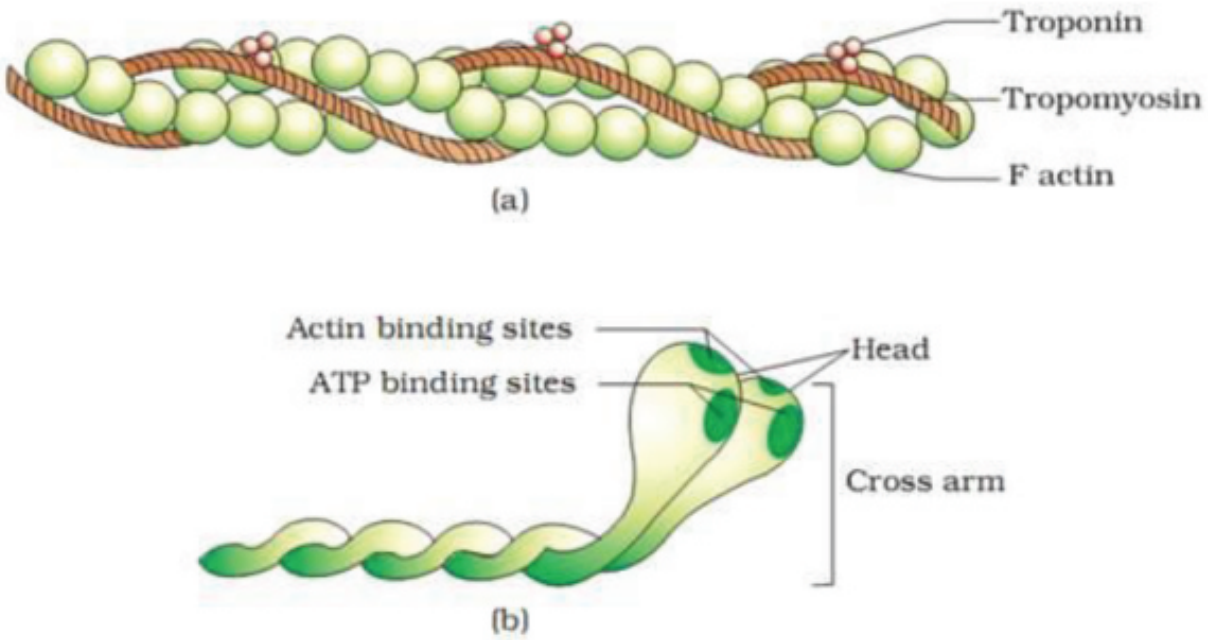


Figure: 20.2 (a) An Actin Filament. (b) Myosin monomer (Meromyosin)

- Mechanism of muscle contraction - Mechanism of muscles contraction is best explained by the sliding filament theory. This theory states that contraction of a muscle fibre takes place by the sliding of the thin filaments over thick filaments.

The steps of this process are -

(i) A motor neuron carries signal to the muscle fibre which generates an action potential in it. This causes the release of Ca++ from sarcoplasmic reticulum.

(ii) Ca^{++} binds with troponin present in actin filament removes the masking of active sites for myosin.

(iii) Utilising the energy from ATP hydrolysis, the myosin head now binds to the exposed active sites of actin to form a cross bridge.

(iv) This cross bridge pulls the attached actin filaments towards the centre of A - band. This results in pulling the Z - line (attached to these actins) inwards thereby causing shortening of the sarcomere.

(v) Ca^{++} then returns to sarcoplasmic reticulum, which inactivates the action. Cross bridges are broken and the muscles relax.

The ATP is hydrolysed by myosin head and the cycle of cross bridge formation and breakage is repeated causing further sliding. As a result, sliding again takes place in muscle filament.

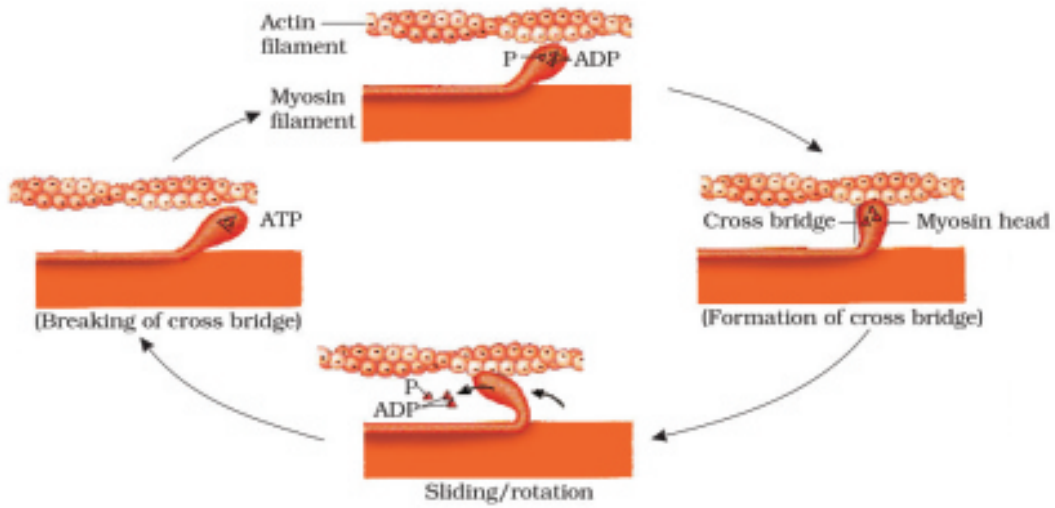


Figure: 20.3 Stages in cross bridge formation, rotation of head and breaking of cross bridge.

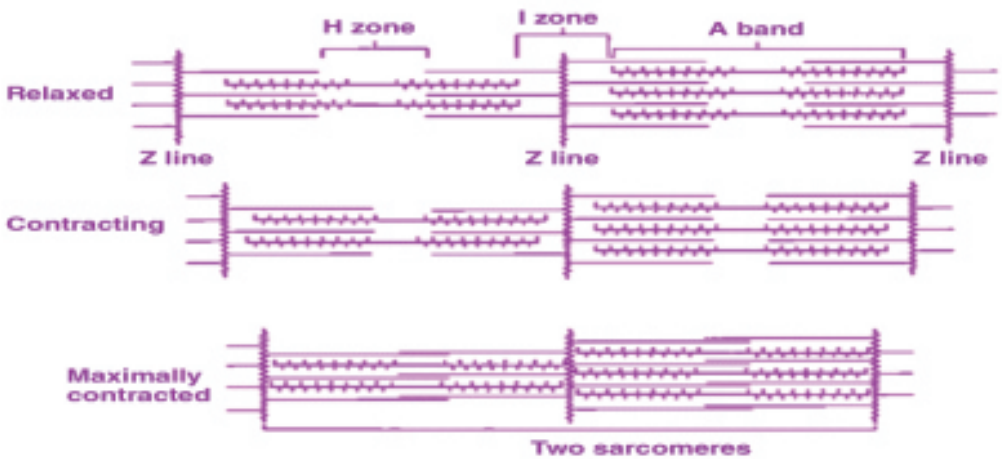


Figure: 20.4 Sliding filament theory of muscle contraction (movement of the thin filaments and the relative size of the I band and H Zones).

- Repeated activation of the muscles can lead to accumulation of lactic acid due to anaerobic breakdown of glycogen in them, causing fatigue.
- Based on the amount of red coloured myoglobin pigment in muscles, muscles are primarily classified as red and white fibres.
- Bones and cartilages constitutes the skeletal system.
- Due to the presence of calcium salts bones have a very hard matrix and for chondroitin salts, cartilages have slightly pliable matrix.

- The skeletal system is made up of 206 bones and a few cartilages.
- The skeletal system is divided into two important parts - the axial and appendicular skeleton.
- Axial skeleton - the skull, vertebral column, sternum and ribs together constitutes the axial skeleton.
- The skull - Eight (08) cranial bones and Fourteen (14) facial bones together make the skull. There are 22 bones in total.

  Malleus, incus and stapes are three Ear ossicles – present here.

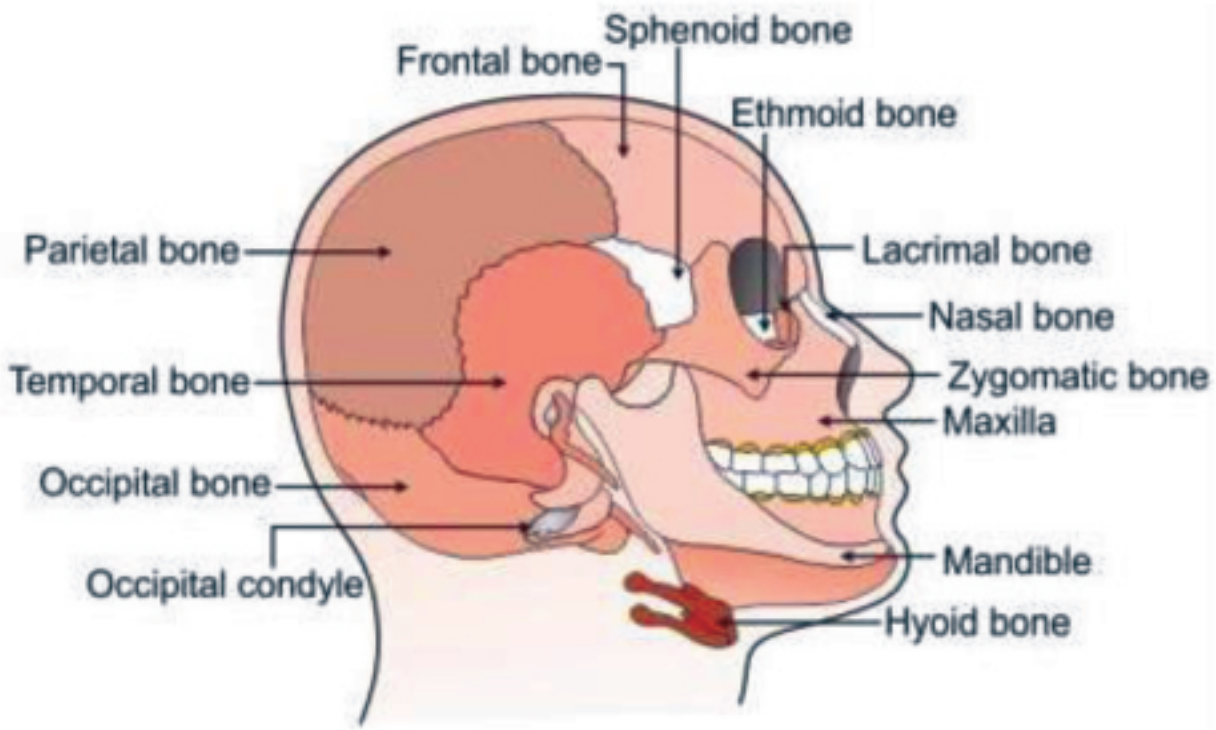


Figure: 20.5 Diagrammatic view of human skull.

- Vertebral Column - It is formed by 26 serially arranged units called vertebrae. This is differentiated into cervical (7), thoracic (12), lumber (5), sacral (1-fused) and coccygeal (1-fused) regions starting from the skull.
- Sternum is a flat bone on the ventral midline of thorax.
- There are 12 pairs of ribs in the human body. First seven pairs of ribs are called true ribs. They are attached to the thoracic vertebrae and ventrally connected to the sternum with the help of hyaline cartilage. The 8th, 9th and 10th pairs of ribs do not articulate directly with the sternum but join the 7th rib with the help of hyaline cartilage. These are called vertebrochondral or false ribs. The 11th and 12th ribs are not connected ventrally and therefore are called floating ribs.
- Thoracic vertebrae, ribs and sternum together forms the rib cage.

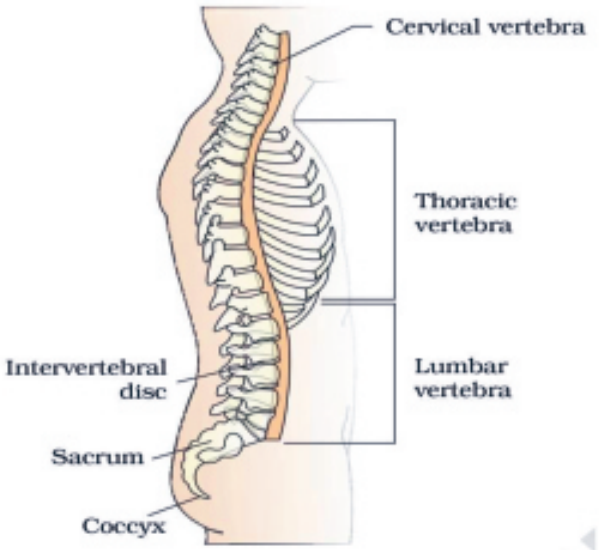


Figure: 20.6 Vertebral column (Right lateral view).

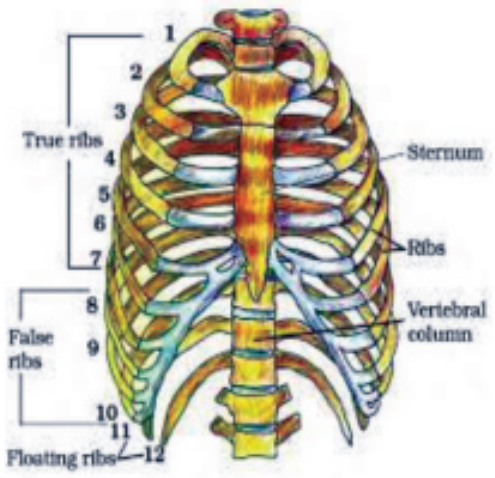


Figure: 20.7 Ribs and Ribcage.

- Limb bones along with their girdles constitute the appendicular skeleton. Each limb is made up of 30 bones.
- The bones of hand (fore limb) are humerus, radius, ulna, carpals (8 in number), metacarpals (6 in number) and phalanges (14 in number).
- The bones of legs (hind limb) are femur, tibia, fibula, tarsals (7), metatarsals (5) and phalanges (14). A cup shaped bone called patella covers the knee ventrally (knee cap).
- Pectoral and pelvic girdle bones help in the articulation of the upper and lower limbs respectively with the axial skeleton.

  Each girdle is formed of two halves. Pectoral girdle consists of a clavicle and a scapula. Pelvic girdle consists of two bones. Each coxal bone is formed by ilium, ischium and pubis.

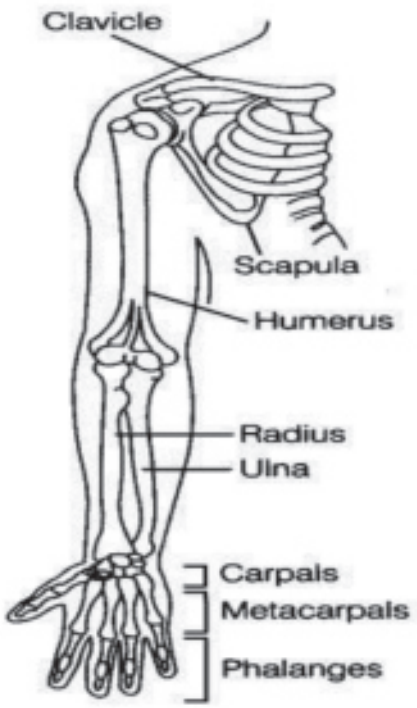


Figure: 20.8 Right pectoral girdle and upper arm (frontal view).

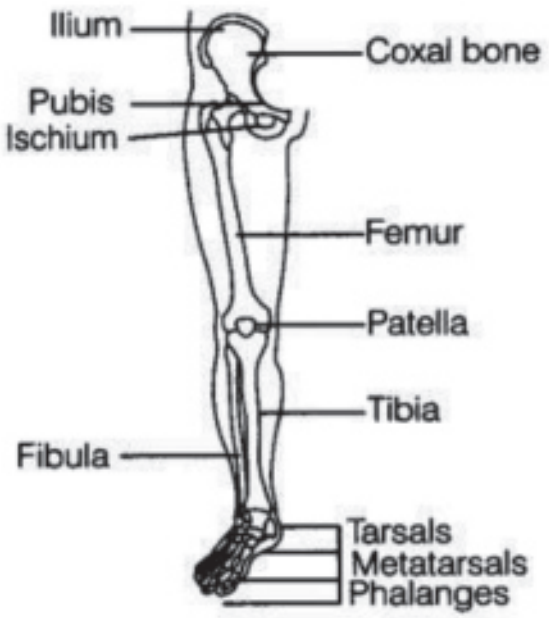


Figure: 20.9 Right pelvic girdle and lower limb bones (frontal view).

- Points of contact between bones, or between bones and cartilages are called joints. Joints have been classified into three major structural forms - fibrous, cartilaginous and synovial.

Fibrous joints do not allow any movement, cartilaginous joints help in limited movement. Synovial joints help in locomotion and different types of movement.

- Disorder of muscle and skeletal system leads to the following diseases: myasthenia gravis muscular dystrophy, tetany, arthritis, osteoporosis, gout.

QUESTION AND ANSWER

A) Objective Type Questions. **[1 mark]**

I) Choose the correct option:

1. Bone which is connected with rib is

   (a) Scapula (b) Sternum (c) Clavicle (d) Ilium.

   Ans. (b) Sternum.

2. ATPase enzyme is present in

   (a) Actinoids (b) Troponin (c) Myosin (d) Actin.

   Ans. (c) Myosin.

3. Which of the following is a proper sequence?

a) Cervical - Lumbar - Thoracic - Sacral.

b) Cervical - Thoracic - Sacral - Lumbar - Coccygeal.

c) Cervical - Sacral - Thoracic - Lumbar - Coccygeal,

d) Cervical - Thoracic - Lumbar - Sacral - Coccygeal.

   Ans. (d) Cervical - Thoracic - Lumbar - Sacral - Coccygeal.

4. The elbow joint is a kind of

   a) Saddle joint b) Ball and socket joint c) Pivot joint d) Hinge joint

   Ans. (d) Hinge joint.

5. Macrophage and leucocytes show

   a) Ciliary movement b) Flagella movement

   c) Amoeboid movement d) Muscular movement

   Ans. (c) Amoeboid movement.

6. Which one of the following is not a disease caused due to the disorders of bone system?

   a) Arthritis b) Osteoporosis c) Rickets d) Atherosclerosis

   Ans. (d) Atherosclerosis.

7. Which of the following accumulates to make the muscles fatigued or inactive?

   a) Lactic acid b) Glycogen c) Creatine phosphate d) CO2

   Ans. (a) Lactic acid.

8. Edge of the two bones are connected by

   a) Muscle b) Tendon c) Cartilage d) Ligament

   Ans. (b) Tendon.

9. Each muscle fibre is covered by

   a) Perimysium b) Endomysium c) Sarcomere d) Epimysium

   Ans. (c) Sarcomere.

10. Humerus bones are present in

    a) Hand b) Leg c) Lower jaw d) Thigh.

    Ans. (a) Hand.

11. Which one of the following happens during muscle contraction?

a) O2 is released due to the reduction of ATP

b) Z lines come close to each other

c) Myosin filament slides upon actin

d) Muscle fibre expands

   Ans. (b) Z lines comes close to each other.

12. Striated and involuntary muscle are found in

a) Muscles of alimentary canal

b) Cardiac muscles

c) Muscles linked with movement

d) Muscles of eye

   Ans. (b) Cardiac muscle.

II) Match the column A with column B:

	Column A	**Column B**
a)	Sternum	i) Synovial
b)	Glenoid Cavity	ii) Vertebrae
c)	Cartilaginous joint	iii) Pectoral girdle
d)	Ball and socket joint	iv) Flat bones
	Ans. (a - iv; b - iii; c - ii; d - i)	

B) Very short answer type questions. [1mark].

1. Where is ball and socket joint present?

   Ans. Ball and socket joint is present between humerus and pectoral girdle.

2. How do the joints move without any sound and pain?

   Ans. Joints move without any sound and pain because of the presence of synovial fluid.

3. Which tissue gets affected due to myasthenia gravis?

   Ans. Weariness, weakness and inactiveness of muscles is called myasthenia gravis. This disease occurs due to the disorder affecting neuromuscular junction.

4. Name the three main bones of our forelimbs.

   Ans. Humerus, radius and ulna.

5. What is the difference between matrix of bones and cartilage?

   Ans. Matrix of bones becomes strong due to presence of calcium salt. Cartilage becomes flexible due to presence of chondroitin salt.

6. What is cranium?

   Ans. The bones that form a protective external covering of the brain is called cranium.

7. What is fascia?

   Ans. A number of muscle bundles or fascicles are held together by a common collagenous connective tissue layer, which is called fascia.

C) Short Answer Type Questions. [2 marks]

1) What types of movement are found in the tissues?

   Ans. Three types of movement are found in the tissues of human body.

a. Amoeboid movement - Macrophages and leucocytes in blood exhibit amoeboid movement. Amoeboid movement is found in the cytoskeletal elements.

b. Ciliary Movement - The coordinated movements of cilia in the trachea help in removing dust particles and some of the foreign substances inhaled along with atmospheric air. Passage of ova through the female reproductive tract is facilitated by the ciliary movement.

c. Muscular Movement - Movement of our limbs, jaws, tongue etc. require muscular movement.

2) What is the source of energy for muscle contraction?

   Ans. ATP (Adenosine Triphosphate) is the source of energy for muscle contraction. The head of each myosin molecule contains an enzyme called myosin ATPase.

   In the presence of this enzyme along with Ca^{++} and Mg^{++} ions, the ATP molecule breaks down into ADP and inorganic phosphate, thus releasing energy in the head of myosin.

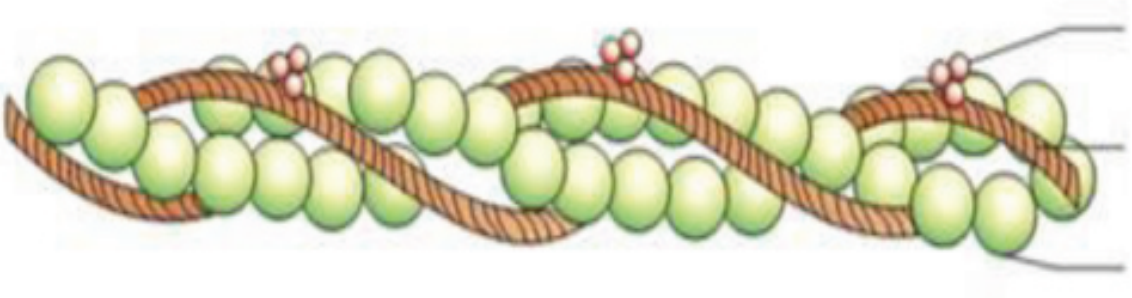
   ATP ' ADP + Pi + Energy

   Energy from ATP causes energised myosin to cross bringe and bind with actin and in this way muscle contraction is initiated.

DO IT YOURSELF

A) Short Answer Type Questions. **[2 marks]**

1. Label the different parts of the given diagram: (2)



2. Name the bones of forelimb (hand) and hind limb (legs). (1+1)
3. What are called joints? How many types of joints are there in human body? (1+1)

B) Short Answer Type Questions. **[3 marks]**

1. Write short notes on the following: (1+1+1)

   (a) Sternum (b) Floating Ribs (c) Osteoporosis.

2. Pectoral and pelvic girdle are made up of which bones? (3)
3. What is synovial joint? Name the different types of synovial joints along with example. (1+2)

C) Long Answer Type Questions. **[5 marks]**

1. Explain the sliding filament theory of muscle contraction with neat diagram. (2+3)
2. What is sarcomere? Draw a labelled diagram of the sarcomere. What is the role of Ca++ in muscle contraction? (1+2+2)

Teacher's Note

Discuss Comparative explanation of the location and characteristics of 3 types of muscle explained in this chapter. Discuss the muscle contraction theory (Answer of Long answer type no.1) with a flow chart. Make a table of different bones present in the skeletal system mentioning their names and number. Explain the structure of myofibril and sarcomere with diagrams.

UNIT - V

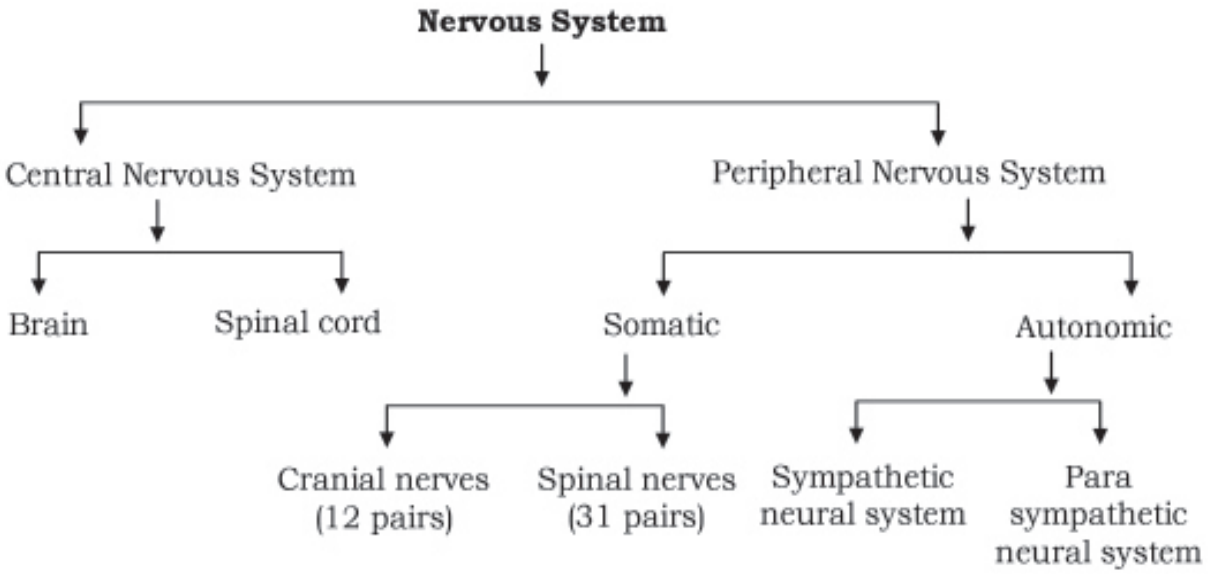
CHAPTER - 21

NEURAL CONTROL AND COORDINATION

IMPORTANT CONCEPTS

- Coordination is the process through which two or more organs interact and complement the functions of one another.
- In our body, the neural system and the endocrine system jointly coordinate and integrate all the activities of the organs.
- Neuron is the structural and functional unit of the nervous system.
- In humans, the nervous system has been divided into 2 parts:

  1) Central Nervous system (CNS) 2) Peripheral Nervous system (PNS)
- Central nervous system - Includes the brain and spinal cord. It is the site of information processing and control.
- Peripheral nervous system - comprises of all the nerves of the body associated with the CNS.



- A neuron is composed of three major parts namely - cell body, dendrites and axon.
- Depending on the number of dendrites and axons, the neurons are divided into three parts - a) Multipolar neuron, b) Bipolar neuron, c) Unipolar neuron.
- There are two types of axons - myelinated and non-myelinated.

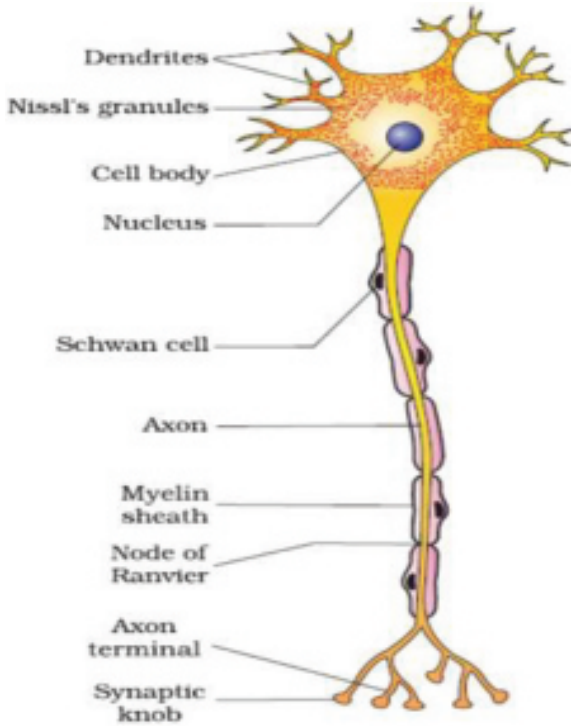


Figure: 21.1 Structure of a neuron.

- Generation and conduction of nerve impulse:

  In resting phase, the axonal membrane is more permeable to potassium ions (K+) and nearly impermeable to sodium ions (Na+), and is also impermeable to negatively charged proteins present in the axoplasm. As a result, the axoplasm inside the axon contains high concentration of K+ and negatively charged proteins and low concentration of Na+. In contrast, the fluid outside the axon contains a low concentration of K+, a high concentration of Na+. Hence, a concentration gradient is formed across the resting membrane, which is maintained by the active transport of ions by the sodium-potassium pumps. This pump transport 3 Na+ outwards for 2K+ into the cell.

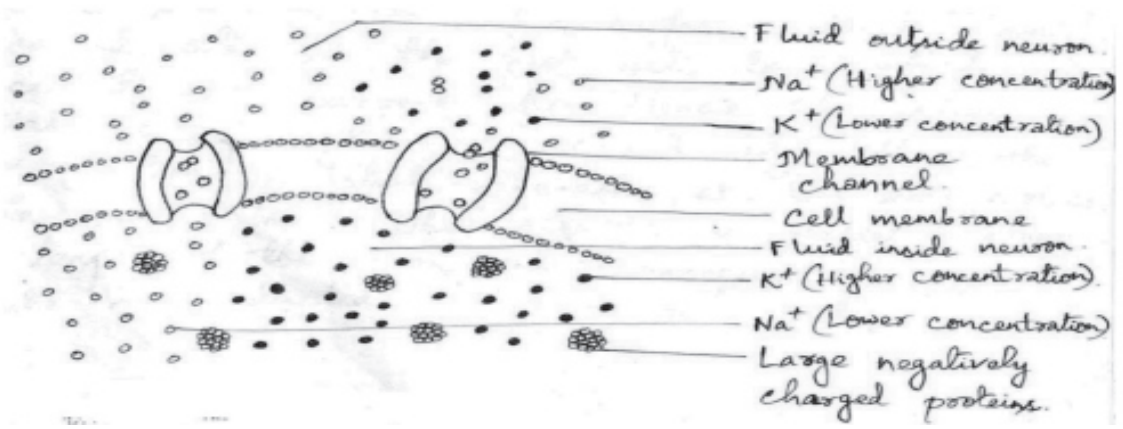


Figure: 21.2 Movement of ions causing polarisation of axon membrane.

As a result, the outer surface of the axonal membrane possesses a positive charge while its inner surface becomes negatively charged. This state is called as polarised state. The electrical potential difference across the resting plasma membrane is called as the resting potential.

When a stimulus is applied at a site on the polarised membrane, the membrane in this site becomes freely permeable to Na+, leading to a rapid influx of Na+ followed by the reversal of the polarity (depolarised state) at that site, i.e., the outer surface of the membrane becomes negatively charged and the inner side becomes positively charged. The electrical potential difference across the plasma membrane is called the action potential or nerve impulse.

In the second site (immediately ahead of the first site where action potential is created), the axon membrane has a positive charge on the outer surface and a negative charge on its inner surface. As a result, a current flows on the inner surface from the first site to the second site. On the outer surface, current flows from the second site to the first site to complete the circuit of current flow. Hence, the action potential is generated at second site. Thus, the impulse (action potential) generated at the first site arrives at the second site. This sequence is repeated along the length of the axon and consequently the impulse is conducted.

- Synapse - A nerve impulse is transmitted from one neuron to another through junctions called synapses.

  A synapse is formed by the membrane of a pre-synaptic and a post-synaptic neuron.

  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 which are involved in the transmission of impulses through the synapses, are called as neurotransmitters.

- Transmission of impulses - 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.

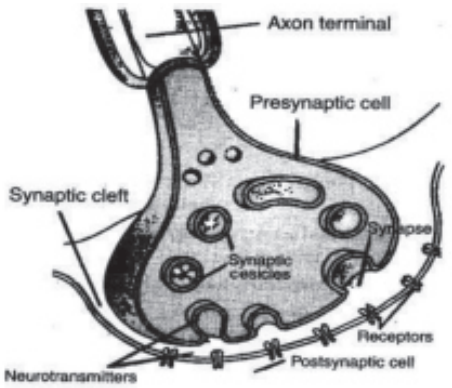
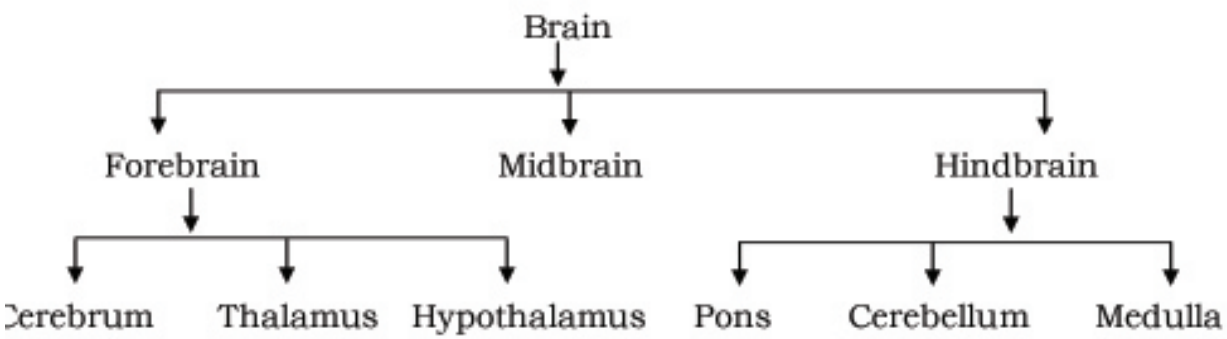


Figure: 21.3 Axon terminal and synapse.

- The brain is the central information processing organ of our body, and acts as the command and control system.
- The brain can be divided into three major parts:

  (i) Forebrain (ii) Midbrain (iii) Hindbrain.



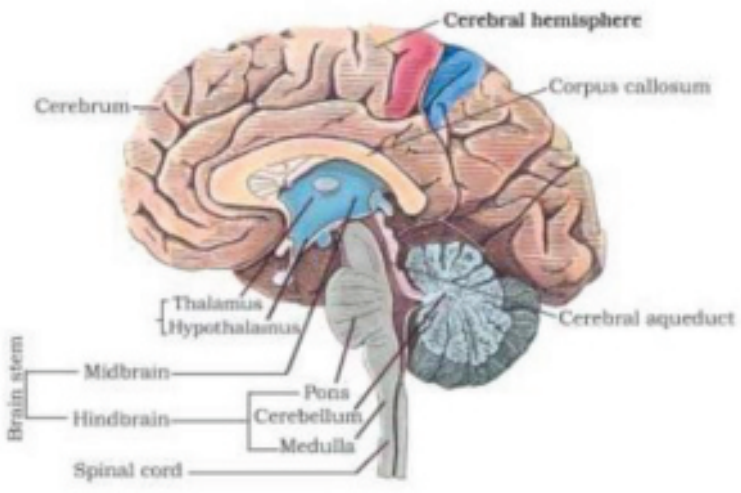


Figure: 21.4 Sagittal section of the human brain.

- Cerebrum is divided into two hemispheres - (a) Left cerebral hemisphere and (b) Right cerebral hemisphere. These hemispheres are connected by a tract of nerve fibres called corpus callosum.
- The layer of cells which covers the cerebral hemisphere is called cerebral cortex.
- Thalamus - Cerebrum wraps around a structure called thalamus. It is the major coordinating centre for sensory and motor signalling.
- Hypothalamus- It is another important part of the brain which lies at the base of the thalamus.

  It contains a number of centres which control body temperature, urge for eating and drinking.
- Limbic system - The inner parts of cerebral hemispheres and a group of associated deep structures like amygdala, hippocampus, etc., forms a complex structure called the limbic system. It is involved in the regulation of sexual behaviour, expression of emotional reactions and motivation.

- Midbrain - It is located between hypothalamus and pons. A canal called the cerebral aqueduct passes through the midbrain.
- Hindbrain - Comprises of pons, cerebellum and medulla. Medulla is connected with the spinal cord.
- Reflex action - Any sudden rapid autonomic involuntary reaction that occurs in the animal body in response to any sensory stimulus is called as reflex action.

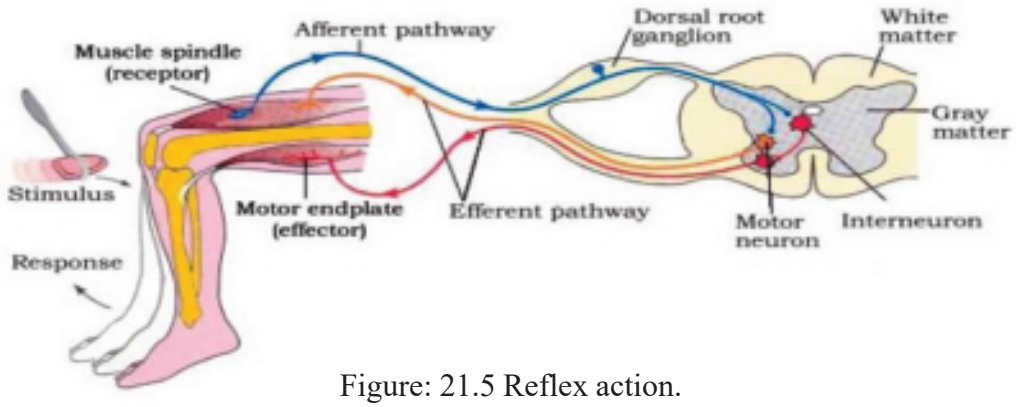


Figure: 21.5 Reflex action.

- Eye - The wall of the eye ball is composed of three layers. The external layer is called sclera. The middle layer, choroid forms the iris which is visible coloured portion of the eye. The inner layer is retina.
- Retina - Contains three layers of cells - ganglion cells, bipolar cells, and photoreceptor cells.

  There are two types of photoreceptor cells - rod cells and cone cells. Rod cells help to see objects in twilight. Cone cells help to see objects in daylight and also to identify different colours of objects.
- The optic nerves leave the eye and the retinal blood vessels enter it at a point medial to and slightly above the posterior pole of the eye ball. Photoreceptor cells are not present in that region and hence it is called the blind spot.

  The space between the cornea and the lens is called the aqueous chamber and contains a thin watery fluid called aqueous humor. The space between the retina and the lens is called the vitreous chamber and is filled with a transported gel called vitreous humor.

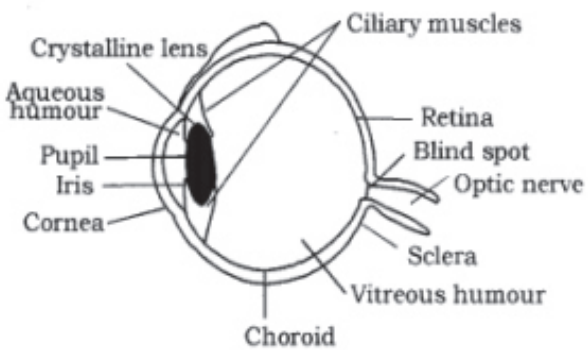


Figure: 21.6 Parts of an eye.

- Mechanism of vision:

(i) The light rays in visible wavelength focussed on the retina through the cornea and lens generate nerve impulses in the rod cells and cone cells.

(ii) Light induces dissociation of the retinal from opsin.

(iii) The structure of the opsin protein changes, resulting into the change in membrane permeability.

(iv) Potential differences are generated in the photoreceptor cells.

(v) This produces a signal that generates action potentials in the ganglion cells through the bipolar cells.

(vi) These action potentials are transmitted by the optic nerves to the visual cortex area of the brain.

(vii) The neural impulses are analysed in the visual cortex, and then image is formed on the retina are recognised based on earlier memory and experience.

- Ear - The ears perform the function of hearing and maintenance of body balance in the human body. The ear can be divided into three major sections - outer ear, middle ear and inner ear.

  The outer ear consists of the pinna and external auditory meatus. The middle ear contains three ossicles - malleus, incus and stapes. The middle ear cavity is connected with the pharynx through a tube called eustachian tube.

  The fluid filled inner ear is called labyrinth. The coiled portion of the labyrinth is called cochlea. The organ of corti is a structure located on the basilar membrane (forming cochlea) which contains hair cells that act as auditory receptors. The inner ear contains a complex system called vestibular apparatus which is composed of three semi - circular canals and the otolith (saccule and utricle).

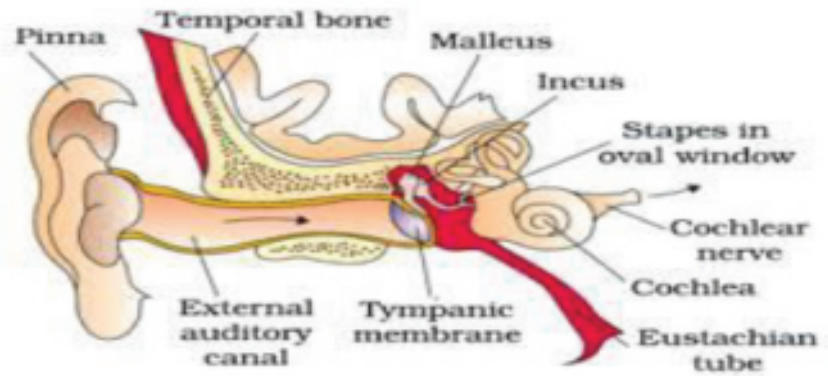


Figure: 21.7 Human ear.

- Mechanism of hearing -

(i) The external ear receives sound waves and directs them to the ear drum.

(ii) The ear drum vibrates in response to the sound waves and these vibrations are transmitted through the ear ossicles (malleus, incus and stapes) to the oval window.

(iii) The vibrations are passed onto the fluid of the cochlea, where they generate waves in the lymphs.

(iv) The waves in the lymph induce a ripple in the basilar membrane.

(v) These movements of the basilar membrane bend the hair cells, pressing them against the tectorial membrane which results into generation of nerve impulses in the associated afferent neurons.

(vi) These impulses are transmitted by the afferent fibres via auditory nerves to the auditory cortex of the brain.

(vii) The impulses get analysed and the sound is recognised.

QUESTION AND ANSWER

A) Objective Questions. **[1 mark]**

I) Choose the most appropriate option from the following:

1. The chemicals released in the nerve impulse because of the nerve impulse is

   (a) Hormone (b) Cerebrospinal fluid (c) Neurotransmitter (d) Lymph

   Ans. (c) Neurotransmitter.

2. The inner side of the axon membrane remains negatively changed during the resting state. This is maintained by which of the following ions?

   (a) Na+ and K+ ions (b) CO3-2 and Cl- ions

   (c) Ca++ and Mg++ ions (d) Ca+4 and Cl- ions

   Ans. (a) Na+ and K+ ions.

3. _____ maintains the balance between the functioning of different parts of the body.

   a) Nervous system b) Circulatory system

   c) Endocrine system d) Both (a) and (c) are correct

   Ans. (d) Both (a) and (c) are correct.

4. Which of the following maintains the resting state in the axon membrane?

   a) Hormone b) Neurotransmitter c) Na+ and K+ ions d) None of these

   Ans. (c) Na+ and K+ ions.

5. Corpus callosum connects

   a) Two hemispheres of the cerebrum b) Medulla and cerebellum

   c) Two hemispheres of the cerebellum d) Pons and cerebellum

   Ans. (a) Two hemispheres of the cerebrum.

6. The expression of the emotions is controlled by which part of the brain?

   a) Cerebral cortex b) Cerebellum c) Limbic system d) Medulla

   Ans. (c) Limbic system.

7. Rhodopsin contains which of the following vitamins?

   a) Vit - A b) Vit - B c) Vit - C d) Vit - D

   Ans. (a) Vit - A.

8. The part of the inner ear which takes part in the process of hearing is _____.

   a) Cochlea b) Semi-circular cana c) Utricle d) Macula

   Ans. (a) Cochlea.

9. Organ of corti is present in _____.

   a) Outer ear b) Middle ear c) Semi-circular canal d) Cochlea

   Ans. (d) Cochlea.

10. Bipolar neuron is present in _____.

    a) Cerebrum b) Retina c) Embryo d) None of these

    Ans. (a) Retina.

II) Fill in the blanks:

1. The junction between two neurons is called _____.

   Ans. Synapse.

2. _____ is the auditory receptor of the ear.

   Ans. Organ of corti.

3. Human brain is covered by _____.

   Ans. Meninges.

4. Synpathetic nerve is a part of _____ nervous system.

   Ans. Autonomous.

5. The granular bodies present on the cell bodies of the neuron are called _____.

   Ans. Nissl granules.

B) Very short answer type questions. [1mark]

1. Which cells of the retina help to identify colours of objects?

   Ans. Cone cells.

2. Arrange and write the correct sequential order for receiving and flowing of sound waves from the following :

   A) Afferent neurons of cochlea b) Pinna c) Ear drum d) Stapes e) Ear Canal f) Incus g) Malleus

   Ans. b) Pinna' e) Ear Canal c) Ear drum' g) Malleus ' f) Incus ' d) Stapes ' a) Afferent neurons of cochlea.

3. Which part of the brain acts as the centre for controlling hunger?

   Ans. Hypothalamus.

4. Which part of the ear maintains the balance of the body posture?

   Ans. Vestibular apparatus of the inner ear.

5. Unmyelinated nerve fibre is found in which nervous system(s)?

   Ans. Autonomic and somatic nervous system.

6. What is cerebral cortex?

   Ans. The cellular layer which covers the cerebral hemisphere of the cerebrum, is called as the cerebral cortex.

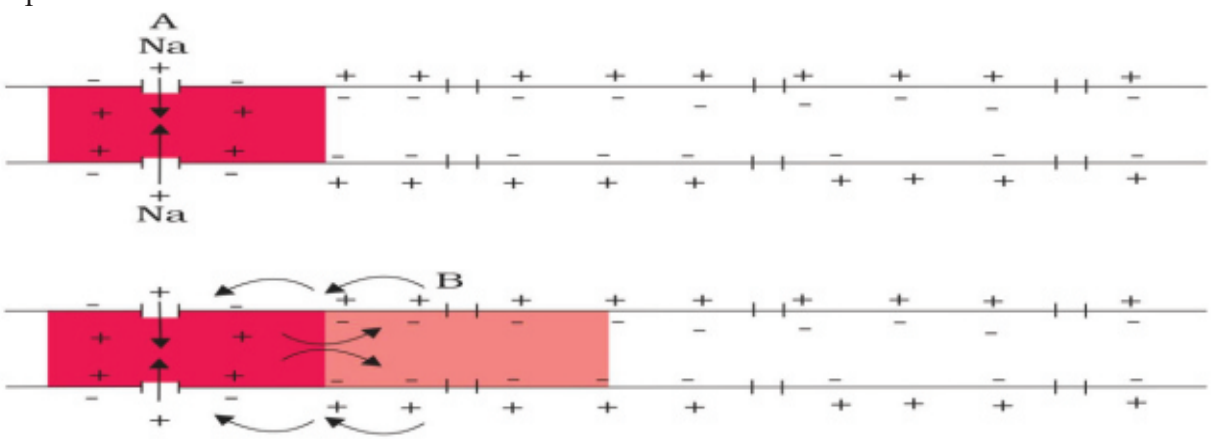
7. What is eustachian tube?

   Ans. The tube which connects the middle ear cavity with the nasopharynx, is called as Eustachian tube.

C) Short Answer Type Questions. **[2 marks]**

1) What is the role of Na+ ion in the creation of action potential?

   Ans. The charge in permeability of Na+ ions through the polarized membrane is responsible for the creation of action potential. When the nerve gets stimulated, then sodium gate opens at the place of stimulation resulting in the increase of the permeability of Na+ ions across the membrane. Fast movement of Na+ ions occur inside the membrane. As soon as the Na+ ions enter the membrane, the potential difference across the membrane decreases. This state is called as depolarisation. This electric potential difference across the cell membrane is called as action potential.



(Fig. : Passing of Nerve impulse (In A and B)

2) Which part of our body helps to maintain the balance in our body?

   Ans. Cerebellum situated in the hind brain and vestibular apparatus situated in the inner ear helps to maintain the balance in our body. The flocculonodular lobe of the cerebellum along with the vestibular apparatus (of ear) controls the body posture and balance in our body.

Whenever the body gets disbalanced or displaced, the crista and maculae hair cells of inner ear gets stimulated. This stimulation is caused by the movement of endolymph and otolith. This stimulus reaches the medulla oblongata of the brain through the auditory nerves. The signal is sent from the brain to different muscles. The contraction of the muscles maintains the balance in the body.

3) What are afferent and efferent nerves?

Ans. Refer paragraph 21.2 of page no. - 316 of textbook.

4) How many types of nerve cells are there depending on the number of dendrons and axons? Write the name and location of each of these types of nerve cells.

Ans. Refer paragraph 21.3 of page no. - 316 & 317 of textbook.

5) What is neurotransmitter? What is its function?

Ans. Refer paragraph 21.3.2 of page no. - 319 of text book.

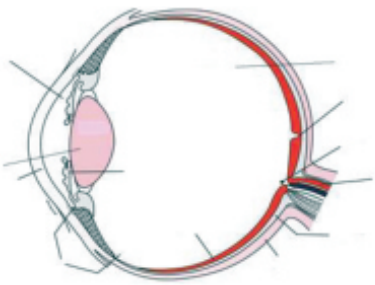
6) What is limbic system? What is its function?

Ans. Refer paragraph 21.4.1 of page no. - 321 of textbook.

DO IT YOURSELF

A) Short Answer Type Questions. **[2 marks]**

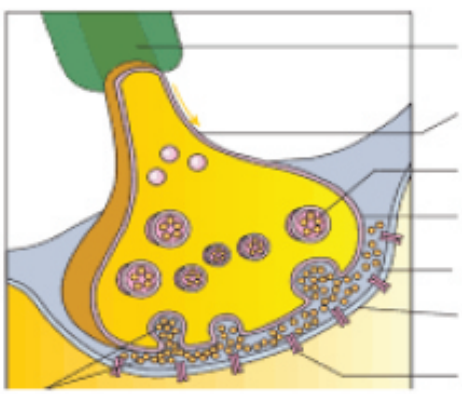
1. Label the different parts of the given diagram. (2)



2. What is somatic nervous system and autonomic nervous system? (1+1)

B) Short Answer Type Questions. **[3 marks]**

1. What is synapse? Label the different parts of the given diagram of the synapse. (1+2)



2. What is neuron? Draw the diagram of a neuron and label its different parts. (1+2)

C) Long Answer Type Questions. [5 marks]

1. Describe the structure of forebrain, midbrain and hind brain in human body. (5)
2. Describe the structure of middle ear and inner ear with the help of labelled diagrams. (5)

Teacher's Note

In the topics discussed in this chapter, describe the structure, location and function of neuron, brain, eyes and ear with the help of labelled diagrams.

Generation of nerve impulse and conduction of nerve impulse through cells, production of action potential has been given in para no. - 21.3.1 of page no. - 317 and summary of this chapter in the textbook. Synapse and the process of transmission of nerve impulse through synapse has been discussed along with diagram in para no. - 21.3.2 of page no. - 319 of the textbook

UNIT - V

CHAPTER - 22

CHEMICAL COORDINATION AND INTEGRATION

IMPORTANT CONCEPTS

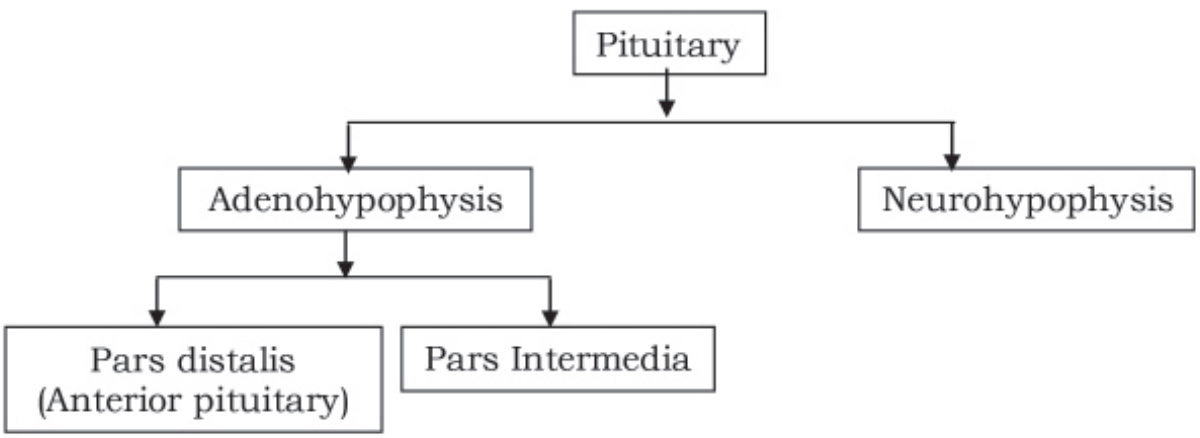
- The neural system and the endocrine system jointly coordinate and regulate the physiological functions in the body.
- Endocrine glands lack ducts and thus are called ductless glands. Secretions of these glands are called hormones.
- Hormones are one kind of non nutrient chemicals that are produced in trace amounts act as intercellular messengers.
- The endocrine glands present in our body are pituitary, pineal, thyroid, adrenal, pancreas, parathyroid, thymus and gonads.
- Besides the endocrine glands the organs of our body that secrete hormones are - liver, kidney, heart and gastrointestinal tract.
- Hypothalamus - Basal part of diencephalon of forebrain. The neurosecretory cells of it produce hormones. These hormones regulate the synthesis and secretion of pituitary hormones.
- Hypothalamus produces two types of hormones:

(i) Releasing hormones - Stimulates secretion of pituitary hormones.

(ii) Inhibiting hormones - Inhibits secretions of pituitary hormones.

- Pituitary glands - It is located in a bony cavity called sella turcica in the base of the brain and is attached to hypothalamus through a stalk.

  The parts of pituitary are:



♦ The hormones secreted pituitary are:

(a) Pars distalis (Anterior pituitary) - Growth Hormones (GH), Prolactin, thyroid stimulating hormone (TSH), adrenocorticotrophic hormone (ACTH), luteinizing hormone (LH) and follicle stimulating hormone (FSH).

(b) Pars intermedia - Melanocyte stimulating hormone (MSH).

(c) Pars nervosa (Posterior pituitary) - Oxytocin, vasopressin (these two hormones are synthesised by the hypothalamus and are transported axonally to neurohypophysis.

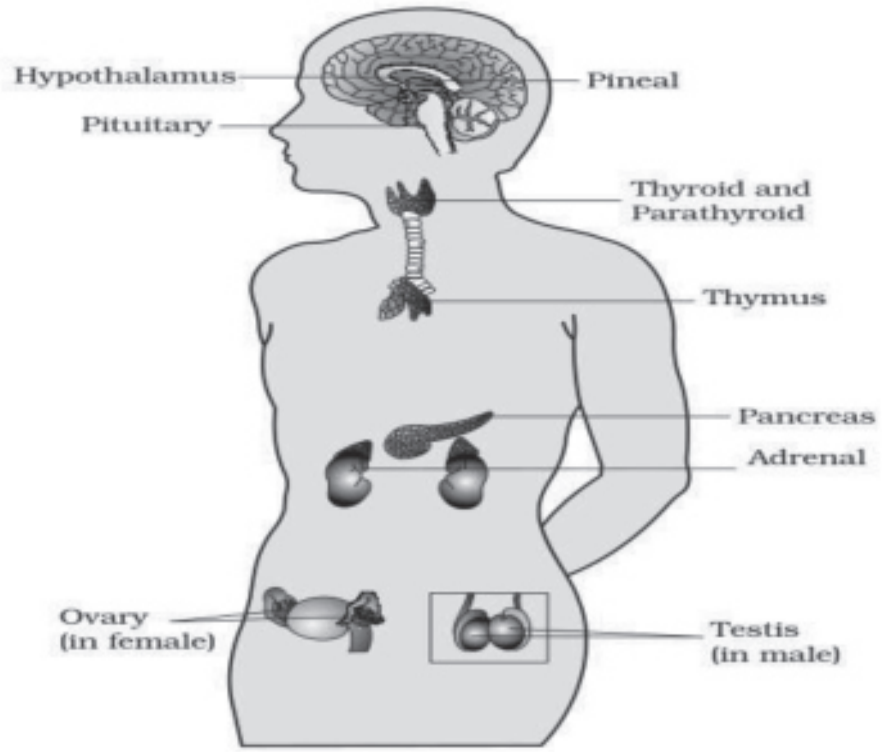


Figure: 22.1 Location of Endocrine Glands.

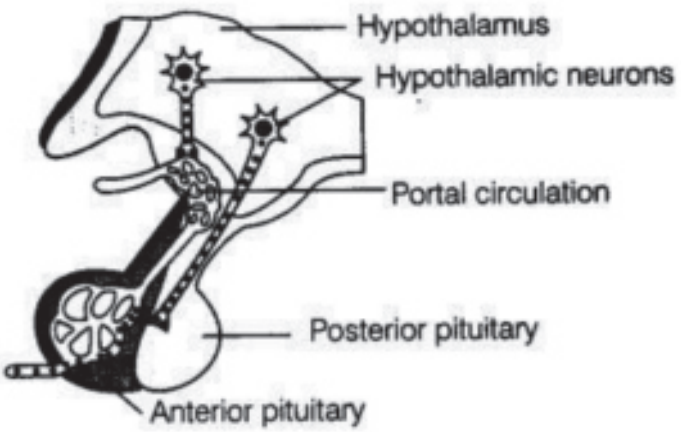


Figure: 22.2 Diagrammatic representation of Pituitary and its relationship with hypothalamus.

- Growth hormone - Over secretion results in gigantism and low secretion results in dwarfism. Over secretion occurs in the adults.
- Prolactin - Regulates the growth of the mammary gland and formation of milk in them.
- TSH - Stimulates the synthesis and secretion of thyroid hormones from the thyroid gland.
- ACTH - ACTH stimulates the synthesis and secretion of steroid hormones called glucocorticoids from the adrenal cortex.
- LH and FSH - Stimulates gonadal activity and hence are called gonadotrophins.
- In males - LH stimulates the synthesis and secretion of androgen hormone from testis. FSH and androgens regulate spermatogenesis.
- In Females - LH induces ovulation of fully mature follicles (graafian follicles) and maintains the corpus luteum, formed from the remnants of the graafian follicles after ovulation. FSH stimulates growth and development of the ovarian follicles.
- MSH - Regulates the pigmentation of the skin.
- Oxytocin - Stimulates a vigorous contraction of uterus at the time of child birth and milk ejection from the mammary gland.
- Vasopressin - Stimulates resorption of water and electrolytes by the distal tubules of kidney. Hence, this hormone is called anti diuretic hormone (ADH).

  ADH - The synthesis and secretion of ADH reduces the water storage capacity of kidney. This condition is called diabetes insipidus.

  The Pineal Gland - Melatonin hormone gets secreted from Pineal Gland. It helps in maintaining the normal rhythms of sleep-wake cycle, body temperature of our body.

  Thyroid Gland - The follicular cells synthesize 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 diet results in hypothyroidism and enlargement of the thyroid gland, this is called goitre. Hypothyroidism during pregnancy causes defective development and maturation of the growing baby leading to stunted growth. This is called cretinism. This results in mental retardation, deaf and mutism in children.

  Due to cancer of the thyroid glands, the rate of synthesis and secretion of the thyroid hormone increases to abnormal high levels. This condition is called hyperthyroidism. Exophthalmic goitre is a special type of hyperthyroidism. This disease is also called graves.

  Thyrocalcitonin (TCT) regulates the calcium level in blood.
- Para thyroid Gland - Four parathyroid glands are present on the back side of the thyroid gland. Peptide hormone secreted by parathyroid gland is called parathyroid hormone (PTH). PTH is a hypercalcemic hormone. It increases the Ca^{2+} levels in blood.
- Thymus - Secretes thymosins, differentiates cell mediated immunity provider lymphocytes. It produces antibodies.

- Adrenal Gland - Our body has one pair of adrenal glands, one at the anterior part of each kidney. The centrally located tissue in this gland is called adrenal medulla and outside this lies adrenal cortex.
- Adrenal Medulla - Secretes two hormones - (a) adrenaline or (b) noradrenaline or norepinephrine.

Adrenaline and noradrenaline are rapidly secreted in response to stress of any kind and during emergency situations and are called emergency hormones or hormones of fight.

- Adrenal Cortex - The hormones that adrenal cortex secretes are called corticoids. For example -

(i) Glucocorticoids are involved in carbohydrate metabolism (e.g. - cortisol).

(ii) Mineralocorticoids regulates the balance of water and electrolytes in our body. (e.g. - Aldosterone).

- Pancreas - Pancreas is a composite gland. It acts as both exocrine and endocrine gland.

  The endocrine pancreas consists of 'Islets of Langerhans'. The two main types of cells in the Islets of Langerhans are called - ? and ? cells. The ? cells secrete glucagon and ? cells secrete insulin.

  Glucagon acts upon the liver cells (hepatocyte) and stimulates the process of glycogenolysis and gluconeogenesis. As a result, glucose level increases in blood. This condition is called hyperglycemia. Thus, glucagon is a hyperglycaemic hormone.

  Insulin enhances cellular glucose uptake and utilisation. As a result, decreases the glucose level in blood which is called hypoglycaemia. Insulin stimulates conversion of glucose to glycogen. (glycogenesis)

  Insulin and glucagon - these two hormones jointly maintain the homeostasis of glucose in blood. Prolonged hyperglycemia leads to a complex disorders called diabetes mellitus.

- Testis - Testis is composed of seminiferous tubules and interstitial tissue. The Leydig cells or interstitial cells are present in the intertubular spaces. The hormones produced by these cells are called androgens. Testosterone is the main androgen hormone.

  Androgens regulate the development, maturation and functions of the male accessory sex organs. These hormones stimulate the spermatogenesis.

- Ovary - Ovary produces two steroid hormones called estrogen and progesterone. Ovary is composed of ovarian follicles and stromal tissue. The estrogen is synthesised and secreted by the growing ovarian follicles. After ovulation, the ruptured follicles is converted to corpus luteum. This corpus luteum secretes progesterone.
- The atrial wall of the heart secretes atrial natriuretic factor (ANF) which decreases blood pressure.
- The juxtaglomerular cells of kidney produce erythropoietin which stimulates erythropoiesis (formation of RBC).
- In different parts of gastro intestinal tracts, four hormones are secreted - gastrin, secretin, cholecystokinin (CCK) and gastric inhibitory peptide (GIP).
- The hormones that act on the tissue or cell gets attached to the receptor present in the cell

membrane or receptor present inside the cell. Each receptor is specific to one hormone only and hence receptors are specific. As a result, hormone-receptor complex is formed and certain biochemical changes occur. Thus, hormones regulate the metabolic and physiological functions of cells.

- Hormone is divided into the following kinds based on its chemical nature -

  (a) Peptide hormone (b) Steroid hormone (c) Iodothyronines
  (d) Hormones derived from amino acid.

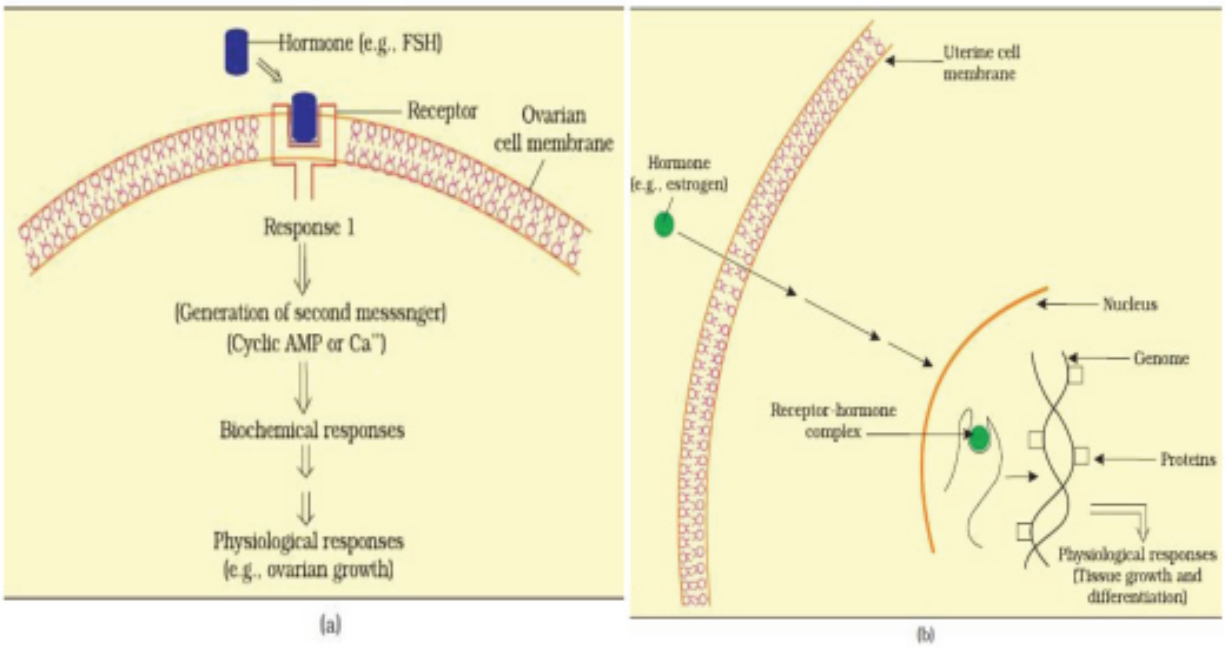


Figure: 22.3 Diagrammatic representation of mechanism of hormone action:
(a) Protein hormone (b) Steroid hormone.

QUESTION AND ANSWER

A) Objective Questions. **[1 mark]**

I) Choose the most appropriate option from the following:

1. Which of the following hormones is not secreted from anterior pituitary?

   (a) GH (b) FSH (c) Oxytocin (d) ACTH

   Ans. (c) Oxytocin.

2. The steroid that is responsible for balance of water and electrolytes in our body is _____.

   (a) Insulin (b) Melatonin (c) Testosterone (d) Aldosterone

   Ans. (d) Aldosterone

3. Which part of the brain effects the endocrine gland?
   a) Medulla b) Hypothalamus c) Cerebellum d) Cerebrum
   Ans. (b) Hypothalamus.
4. The second messenger in the function of protein hormone is _____.
   a) Cyclic AMP b) Insulin c) T3 d) Gastrin
   Ans. (a) Cyclic AMP.
5. The hormone produced by leyding cells are _____.
   a) Androgen b) Estrogen c) Aldosterone d) Gonadotropin
   Ans. (a) Androgen.
6. _____ is secreted from pars intermedia.
   a) Oxytocin b) MSH c) FSH d) Vasopressin
   Ans. (b) MSH.
7. Corpus Luteum secretes _____.
   a) Prolactin b) Progesterone c) Aldosterone d) Testosterone
   Ans. (b) Progesterone.
8. Cortisol gets secreted from _____.
   a) Pancreas b) Thyroid c) Adrenal d) Thymus
   Ans. (c) Adrenal.
9. Which of the following hormones help in ovulation?
   a) LH b) FSH c) Progesterone d) Estrogen
   Ans. (b) FSH.
10. Prolactin acts upon _____.
    a) Mammary gland b) Pancreas c) Liver d) Bones
    Ans. (a) Mammary glands.

II) Fill in the blanks:

1. Acromegaly occurs due to the excessive secretion of _____ hormone.
   Ans. Growth Hormone.
2. Cretinism caused during the pregnancy period occurs due to _____.
   Ans. Hypothyroidism.
3. Thyrocalcitonin gets secreted from _____.
   Ans. Thyroid.

4. The main Glucocorticoids in human body is _____.

   Ans. Cortisol.

5. _____ functions as both endocrine and exocrine glands.

   Ans. Pancreas.

6. Two hormones that are secreted from ovary are _____ and _____.

   Ans. Estrogen and progesterone.

III) Match the column A with column B:

1.

Column A	Column B
(a) Pineal	(i) Epinephrine
(b) Thyroid	(ii) Melatonin
(c) Ovary	(iii) Estrogen
(d) Adrenal Medulla	(iv) Tetraiodo thyronine
Ans. a - ii; b - iv; c - iii; d - i.	

2.

Column A	Column B
(a) Epinephrine	(i) Growth of muscle
(b) Testosterone	(ii) Reduces blood pressure
(c) Glucagon	(iii) Break down of Glycogen
(d) ANF	(iv) Increases heart beat
Ans. a - iv; b - i; c - iii; d - ii.	

B) Very short answer type question. **[1 mark]**

1. Which hormone helps in cell-mediated immunity?

   Ans. Thymosin.

2. Which hormone controls sleep-wake cycle?

   Ans. Melatonin.

3. Name 2 hormones secreted from thyroid gland.

   Ans. Tetraiodothyronine or thyroxine (T4) and Triiodothyronine (T3).

4. Which hormones are gonadotrophins?

   Ans. LH and FSH.

5. Which hormone controls the calcium level in blood?

Ans. Thyrocalcitonin.

6. Which are called emergency hormones?

   Ans. Adrenaline and noradrenaline are rapidly secreted in response to stress of any kind and during emergency situations and are called emergency hormones.

7. Give example of mineralocorticoids.

   Ans. Aldosterone.

8. Where is erythropoietin produced?

   Ans. In glomerulus cells in kidney.

9. Give examples of two steroid hormones.

   Ans. Cortisol, Testosterone.

10. Which hormones are secreted from the endocrine cells present in the digestive canal?

    Ans. Gastrin, secretin, cholecystokinin (CCK) and gastric inhibitory peptide (GIP).

C) Short Answer Type Questions. **[2 marks]**

1) Which endocrine gland secretes calcitonin? What is the role of this hormone?

   Ans. Calcitonin, which is a protein hormone, gets secreted from thyroid gland. This controls the level of calcium in blood.

2) What is the role of LH in male and female reproductive system?

   Ans. In males, LH stimulates the synthesis and secretion of hormone called androgen. Androgens regulate spermatogenesis.

   In females LH induces ovulation of fully mature follicles and maintains the corpus luteum formed from the remnants of the ovarian follicles.

3) What is the effect of hypothyroidism in the development and maturation of the growing child (during pregnancy)?

   Ans. Hypothyroidism causes defective development and maturation of the growing baby leading to stunted growth, which is called as cretinism. Child becomes mentally retarded, less intelligent, abnormal skinned and deaf and mute, etc.

DO IT YOURSELF

A) Short Answer Type Questions. **[2 marks]**

1. How does protein hormone function as second messenger? (2)
2. What is erythropoiesis? Which hormone activates it? (2)
3. Write full forms of the any four of the following: (2)

   GH, PRL, TSH, ACTH, MSH, FSH, ADH, TCT, PTH, ANF, CCK, GIF.

B) Short Answer Type Questions. **[3 marks]**

1. Differentiate between hypothyroidism and hyperthyroidism. (3)
2. Hypothalamus produces both releasing hormones and inhibiting hormones. Discuss this dual work of Hypothalamus. (1½+1½)
3. What are the roles of Insulin and Glucagon in controlling the equilibrium of glucose in blood? (1½+1½)

C) Long Answer Type Questions. **[5 marks]**

1. Write the hormones secreted from Anterior pituitary. Write the role of each in maintaining the physiological functions of the body? (2+3)
2. What is catecholamine? What are glucocorticoids and mineralocorticoid? Write the functions of glucocorticoids and mineralocorticoid. (1+2+2)
3. Write the functions of protein hormone and steroid hormone with a flow chart. (2½+2½)

Teacher's Note

Among the topics discussed in this chapter make a table of the hormones secreted from endocrine glands explaining their name, source and function. Explain the function of protein hormone as a secondary messenger with a flow chart. Role of hypothalamus is explained in the paragraph no. 22.2.1 of textbook. The Role of glucagon and insulin for maintaining the glucose level in blood is explained in the paragraph no. 22.2.8 of textbook. Explain the role of the hormones secreted from anterior pituitary with the help of a table while answering Q.C.1 of "Do it Youself" section). Role of glucocorticoid and mineralocorticoid is explained in the paragraph no. 22.2.7 of textbook.

BIOLOGY

Class-XI

Sample Question Paper - 1

Max. Marks - 70. **Time - 3 Hours.**

General Instructions:

1. **All questions are compulsory.**
2. **This question paper consists of section A, B, C and D. Section A contains 5 questions of one mark each. Section B contains 7 questions of 2 marks each. Section C contains 12 questions of 3 marks each and section D contains 3 questions of 5 marks each.**
3. **There is no overall choice in the paper. However, there is an internal choice in one question of 2 marks weightage, one question of 3 marks weightage and all the three questions of 5 marks weightage.**
4. **Wherever necessary, the diagrams drawn should be neat and properly labelled.**

Section - A

(1x5=5)

1. Which scientist discovered binomial classification? (1)
2. Write the full form of PPLO. What is the other name of it? (1)
3. Water circulatory system is the characteristic of which groups of animals -
   (a) Porifera (b) Ctenophora (c) Echinodermata (d) Chordata.
4. Write the floral formula of Fabaceae family. (1)
5. Which bacteria produces nitrate from nitrite - (1)
   (a) Nitrosomonas (b) Clostridium (c) Nitrobacter (d) Pseudomonas

Section - B

(2x7=14)

6. Write the difference between G1 and G2 of cell - cycle. (2)
7. Write the functions of the following: (2)
   (a) Elaioplast (b) Centriole (c) Mesosome (d) Lysosome.
8. Why is ATP called energy currency? (2)
9. All vertebrates are chordates but all chordates are not vertebrates. Explain. (2)
10. What are C3 and C4 plants. Give examples. (2)
11. What are the important functions of Boron and Copper in plants? (2)
    OR
    What are the micro elements? Write deficiency symptoms of any two micro elements.

12. Which gland secretss saliva? Write a function of this gland. (1+1)

Section - C

(3x12=36)

13. Differentiate between monocotyledons and dicotyledons. (3)
14. Draw a labelled diagram of the digestive system of cockroach. (3)
15. Write the characteristics of eukaryotic cells. Give an example of eukaryotic cell. (2+1=3)
16. What are glycosidic, peptide and phosphodiester bond? (3)
17. Mention one importance of each of the following in the growth of plants - Auxin, gibberellins and abscisic acid. (1+1+1)
18. Write 3 characteristics of Annelida and Arthropoda. (1½+1½=3)
19. What is R.Q. (Respiratory Quotient)? Write the significance of RQ. (1+1)
20. Write the characteristics of bryophyta and pteridophyta. Give examples. (1½+1½=3)
21. Draw a labelled diagram of stomata. Write its two functions. (2+1=3)
22. What are the bones of thoracic chamber? Mention the number of ribs present in thoracic chamber. (1+2=3)
23. Define the following - (1+1+1=3)

    (i) Aestivation (ii) Placentation (iii) Actinomorphic

    OR

    What is Inflorescence? Differentiate between racemose and cymose. (1+2=3)
24. Why is bile very important in digestion although there is no digestive enzyme in the bile? Write the names of different type digestive juices. (2+1=3)

Section - D

(5x3=15)

25. What is cell cycle? Explain the interphase stage of cell cycle with a neat diagram. (1+4=5)

    OR

    Explain structure of the following with labelled diagrams -

    (a) Nucleus (b) Centrosome. (2½+2½=5)
26. What is glycolysis? Where does this process occur? Write the stages of glycolysis. (1+1+3=5)

    OR

    Represent the complete Kreb's cycle with a flow chart. Why is the Kreb's cycle called as citric acid cycle? (1+4=5)
27. Which family is recognised as lily family? Write the floral formula and floral diagram of this type of plant. Write 2 economic importance of this type of plant.

    OR (1+2+2=5)

    What is vascular tissue system? Explain various types of vascular bundle with diagrams. (1+4=5)

BIOLOGY

Class-XI

Sample Question Paper - 2

Max. Marks - 70. **Time - 3 Hours.**

General Instructions:

1. **All questions are compulsory.**
2. **This question paper consists of section A, B, C and D. Section A contains 5 questions of one mark each, Section B contains 7 questions of two marks each, Section C contains 12 questions of three marks each and section D contains 3 questions of five marks each.**
3. **There is no overall choice in the paper. However, there is an internal choice in one question of 2 marks weightage, one question of 3 marks weightage and all the three questions of 5 marks weightage.**
4. **Wherever necessary, the diagrams drawn should be neat and properly labelled.**

Section - A

(1x5=5)

1. Choose the correct option from the following: (1)
   Segmentation in the body is first observed in which of the following:
   a) Platyhelminthes b) Aschelminthes c) Annelida d) Arthropoda
2. Vexillary aestivation is seen in _____ plants. (1)
   a) Hibiscus b) Cassia c) Pea d) Calotropis
3. Find the odd one out: (1)
   RBC, WBC, Platelets, Cartilages.
4. State whether the following statement is true or false, and correct it if necessary: (1)
   Nitrogen as a nutrient element, is highly immobile in plants.
5. What is meristem?

Section - B

(2x7=14)

6. What do you mean by taxonomy and systematics? (2)
7. What is co-factor? Write its importance. (1+1)
8. Name two cell organelles which are surrounded by a double membrane. Write their functions. (1+1)
9. Draw the diagram of an ideal leaf and label its different parts. (2)
10. Write the difference between guttation and transpiration. (2)
11. Write the location of goblet cells. Write its function. (1+1)

12. What is the importance of plasma-protein present in plasma? (2)

OR

Name the hormones secreted from the anterior pituitary gland.

Section - C

(3x12=36)

13. What are bulliform cells? What are its functions? (1+2)
14. Differentiate between cardiac muscle and striated muscle. (3)
15. What is diatomaceous earth? Write its uses. (1+2)
16. What is heterospory? Give two examples of such plants which show heterospory. Briefly comment on the significance of heterospory. (1+1+1)

OR

Compare the main characteristic features of chordates and non - chordates.

17. Draw the diagram of a dorsiventral leaf and label its different parts. (1+2)
18. What is centromere? Draw the different types of chromosomes based on the location of the centromere. (1+2)
19. Define the following:

Glycosidic bond, peptide bond, phosphodiester bond. (1+1+1)

20. Differentiate between mitosis and meiosis. (3)
21. What is water potential? Discuss the factors which affect the water potential. (1+2)
22. What is oxygen dissociation curve? Why is it called as sigmoid curve? (1+2)
23. What are the main steps of aerobic respiration? Where does it occur? (3)
24. What is synovial joint? Write the name of different types of synovial joint and give one examples for each. (1+2)

Section - D

(5x3=15)

25. Describe the steps of mitosis. Why is it called as equational division? (4+1)

OR

What is parthenocarpic fruit? Draw the labelled diagram of the lateral section of a maize seed. Write two differences between racemose and cymose inflorescence. (1+2+2)

26. What is Calvin cycle? Describe the different steps of Calvin cycle. (1+4)

OR

What is glycolysis? Write the steps of glycolysis in brief. (1+4)

27. Describe the structure of human ear with the help of a labelled diagram. [3+2(Diagram)]

OR

Describe the reabsorption and secretion of major substances at different parts of nephron with the help of a labelled diagram. [3+2(diagram)]

BIOLOGY

Class-XI

Sample Question Paper - 3

Max. Marks - 70. **Time - 3 Hours.**

General Instructions:

1. **All questions are compulsory.**
2. **This question paper consists of section A, B, C and D. Section A contains 5 questions of one mark each, Section B contains 7 questions of two marks each, Section C contains 12 questions of three marks each and section D contains 3 questions of five marks each.**
3. **There is no overall choice in the paper. However, there is an internal choice in one question of 2 marks weightage, one question of 3 marks weightage and all the three questions of 5 marks weightage.**
4. **Wherever necessary, the diagrams drawn should be neat and properly labelled.**

Section - A

(1x5=5)

1. What does ICZN stand for? (1)
2. Iodine turns starch into blue black. Why? (1)
3. What is 'endarch' arrangement? (1)
4. What is facilitated diffusion? (1)
5. Name the regions of brain, which constitute 'brain stem'. (1)

Section - B

(2x7=14)

6. What is metagenesis? Give an example of an animal which shows metagenesis. (1+1)
7. Give any four important characteristics of mycoplasma. (2)
8. The spread of living pteridophytes is limited and restricted to narrow geographical regions. Why? (2)
9. What are exocrine glands? Name the secretions of any two exocrine glands. (2)
10. Name the two types of lymphocytes and write one difference between the two. (1+1)
11. A frog's tadpole becomes ammonotelic, while the adult frog becomes ureotelic. Why? (2)
12. Ovaries produce two groups of steroid hormones called estrogen and progesterone. Mention at least two functions of each of these two hormones in human females. (1+1)

    OR

    Mention the three types of joints found in human body. Which of these plays a significant role in locomotion? (1+1)

Section - C

(3x12=36)

13. (a) Differentiate between the racemose and cymose inflorescence. (b) What is phyllotaxy? Name the type of phyllotaxy found in (i) Mustard (ii) Alstoma and (iii) Calotropis (1+1+1)
14. Give atleast three points of difference between spring wood and autumn wood. (3)
15. Draw a diagram of alimentary canal of cockroach and label any six parts in it. (3)
16. Name the scientists who proposed cell theory. Also list its main postulates. (1+2)
17. Enlist the different types of amino acids based on the number of carboxyl and amino groups in them. Also give one example of each of these amino acids. (1½+1½)

    OR

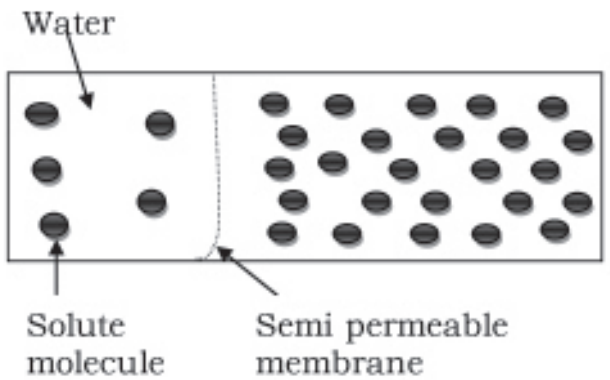
    Explain a glycosidic, peptide and a phosphodiester bond. (1+1+1)
18. Describe the stages of cell cycle during the interphase preceding mitosis, in brief. (3)
19. Study the given figure in which two chambers, A and B, containing solutions are separated by a semi-permeable membrane. (½+½+½+½+½+½)

a) Solution of which chamber has a lower water potential?

b) Solution of which chamber has a lower solute potential?

c) In which direction will osmosis occur?

d) Which solution has a higher solution potential?



e) At equilibrium which chamber will have lower water potential?

f) If one chamber has a ? of -2000 k Pa and the other -1000 k Pa, which is the chamber that has the higher ?

20. Discuss "the respiratory pathway is an amphibolic pathway". (3)
21. What would be expected to happen if: (1+1+1)

(a) GA3 is applied to rice seedling.

(b) A rotten fruit gets mixed with unripe fruits.

(c) You forget to add cytokinin to the culture medium.

22. Name any three enzymes secreted by pancreas. Specify the substrate and product of each. (1+2)
23. Describe the role of haemoglobin in the transport of respiratory gases.

    OR (3)

Explain how the counter current mechanism contributes to concentrate urine in human kidney. (3)

24. Explain the nitrogen cycle in brief. (3)

Section - D

(5x3=15)

25. Name the scientist who proposed the fluid mosaic model about the structure of plasma membrane. Describe the structure of plasma membrane according to this model. (1+4)

    OR

    Why meiosis is called as reduction division? Describe the key events of prophase-I of meiosis-I cell division. Write the significance of meiosis cell division. (1+3+1)

26. Name the CO_2 acceptor involved in mesophyll cells of C_4 plants. Describe the glucose synthesis process in these plants.

    OR (4+1)

    Explain the major steps involved in kerb's cycle. Why is this cycle called citric acid cycle? (4+1)

27. Describe the sequence of events which occur in the cardiac cycle in human. Where and how are the sounds 'lub' and 'dub' produced in the heart during this cycle? (4+1)

    OR

    Briefly describe the mechanism of the following hormones: a) Protein hormones, b) Steroid hormone. (2½+2½)