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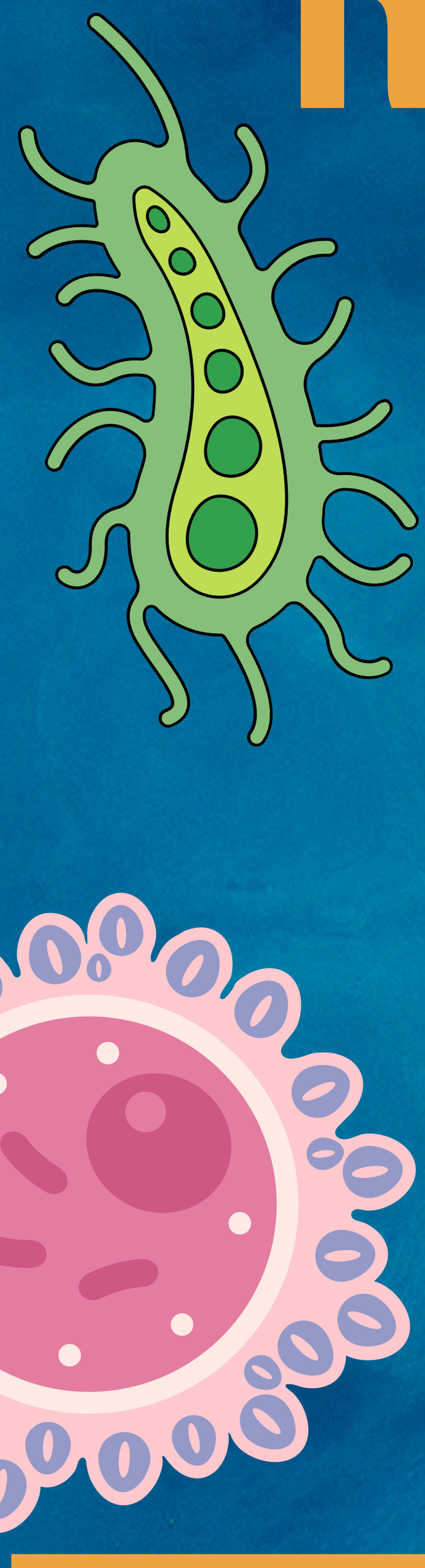
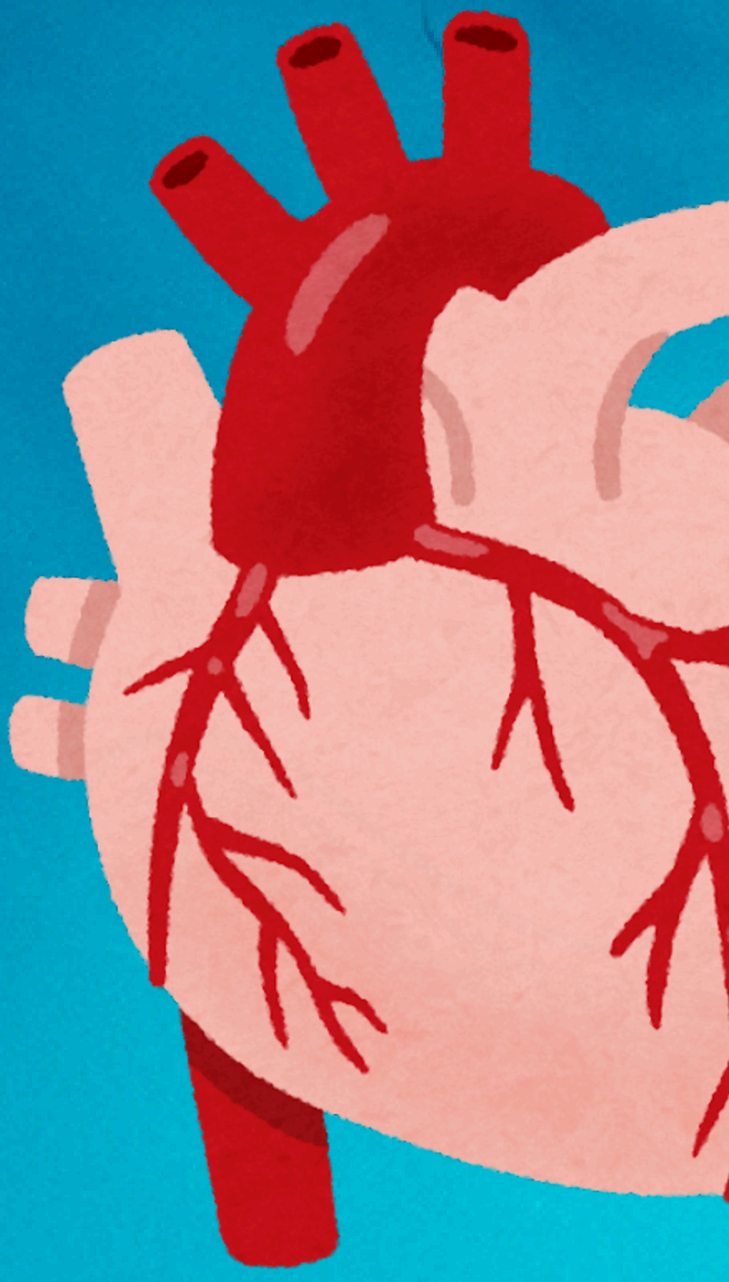
BIOLOGY

REVISION

CLASS 11





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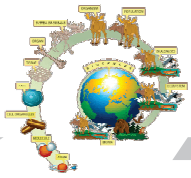
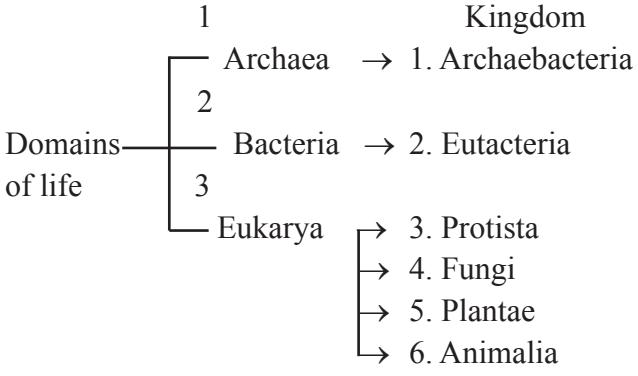


Chapter - 1

The Living World

Points to Remember

1. Organism (Microorganism, plant and animals) who posseses life is living.
2. Life is a complex organisation expressing itself through chemical reactions and exhibit characteristics of living organisms.
3. **Characteristics of Living Organisms :** Growth, reproduction, metabolism, cellular organisation, consciousness (ability to sense environment), self-replicating and self regulation.
   - Reproduction and growth are NOT defining properties.
   - Metabolism, cellular organisation and consciousness are defining properties.
   - Living organisms are self-replicating, evolving, self-regulating and interactive systems capable of responding to external stimuli.
4. **Biodiversity :** Term used to refer to the variety of microorganisms, plant and animals on earth.
5. **Need for classification :** To organise the vast number of microorganisms, plants and animals into categories that could be named, remembered, studied and understood.
6. **Three Domains of Life** : Proposed by Carl Woese in 1990 who also proposed the six kingdom classification for living organisms. The three Domains of life are Archaea, Bacteria and Eukarya.



7. **Taxonomy :** Study of principles and procedures of identification, nomenclature and classification.
8. **Systematics :** It deals with classification of organisms based on their diversities and relationships among them. Term was proposed by Carolus Linnaeus who wrote *'Systema Naturae'*.
9. **Concept of Species :** All the members that can interbreed among themselves and can produce fertile offsprings are the members of same species. This is the biological concept of species proposed by Mayr.
10. **Taxa :** Each category (*i.e.,* unit) of classification is called as a taxon.
11. **Taxonomic Hierarchy :** Classification of organisms in a defnite sequence of taxon or category or rank in a desending order.
    Kingdom → Phylum /Division → Class → Order → Family → Genus → Species.
12. **Binomial Nomenclature :** Given by Carolus Linnaeus. Each scientific name has two components-Generic name + Specific epithet.
13. **ICBN :** International Code for Botanical Nomenclature (for giving scientific name to plants.)
14. **ICZN :** International Code of Zoological Nomenclature (for giving scientific name to animals.)
15. **Rule for Nomenclature :**
    - Latinised names are used.
    - First word is genus, second word is species name.
    - Printed in italics; if handwritten then underlined separately.
    - First word starts with capital letter while species name written in small letter.
16. - **Scientific names of some organisms :**

Man	—	*Homo sapiens*
Housefly	—	*Musca domestica*
Mango	—	*Mangifera indica*
Wheat	—	*Triticum aestivum*

17. Taxonomical Aids are the tools for study of taxonomy.
18. Museums in educational institutes (school and colleges) have collection of skeletons of animals, stuffed and preserved specimens of organisms for study and reference.
19. Zoological Parks (Places where wild animals are kept in protected environment under human care) Example : National Zoological Park, Delhi.
20. **Herbarium :** Store house of dried, pressed and preserved plant specimen on sheets, kept systematically according to a widely accepted system of classification, for future use.

21. **Botanical Garden :** Collection of living plants for reference.

    Example : Royal Batanical garden Kew (England), National Botanical Research Institute (Lucknow), Indian Botanical Garden Howrah.

22. **Keys :** (Used for indentification of plants and animals on the basis of similarities and dissimilarities.)

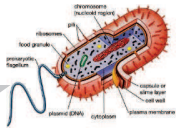
23. **Couplet :** are the two alternate characteristic statement used in key to identify organisation.

24. Each Statement of the key is called a *lead*.

25. • Flora (Index to plant species found in a particular area.

26. • Manuals (Provide information for identification of name of species in an area.)

27. • Mongoraphs (Contain information on any one taxon.)



Chapter - 2

Biological

Classification

Points to Remember

Systems of Classification :

- Earliest classification was given by Aristotle. Divided plants into herbs, shrubs and trees.

  Animals into those with red blood and those who do not have it.

- **Two kingdom classification :** Given by Carolous Linneaeus–Kingdom–plantae and kingdom–Animalia.
- **Five kingdom classification :** By R.H. Whittaker, Monera, Protista, Fungi, Plantae and Animalia are the five kingdoms.
- The main criteria for classification of organisms into five kingdoms include cell structure, thallus organisation, mode of nutrition, reproduction and phylogenetic relationships.

Kingdom Monera :

- Has bacteria as sole members.
- Bacteria can have shapes like : Coccus (spherical), Bacillus (rod-shaped), Vibrium (comma shaped) and spirillum (spiral shaped).
- Bacteria found almost everywhere and can be Photosynthetic autotrophs, Chemosynthetic autotrophs or Heterotrophs.

Bacteria → **Archaebacteria**, **Eubacteria**

- Halophiles (salt-loving)
- Thermoacidophiles (in hot springs)
- Methanogens (in marsh and in gut of ruminant animals. Produce methane gas.)
- Photosynthetic autotrophs like Cyanobacteria (Blue-green algae BGA). Some like *Anabaena* and *Nostoc* have specialized cells called heterocysts for nitrogen fixation.
- *Algae bloom* is rich growth of blue green algae over the surface of polluted water bodies.
- Algae bloom releases neurotoxins, deplete oxygen and makes water unfit for use.
- **Chemosynthetic autotrophs :** Oxidise various inorganic substances like nitrates/nitrites, ammonia and use released energy for their ATP proudction. They helps in nutrients recycling of N, P, Fe and S.
- **Heterotophic bacteria :** Decomposers help in making curd, production of antibiotic, N_2 fixation, casuse disesaes like cholera, typhoid, tetanus and citrus canker.

Mycoplasmas : Completely lack cell wall. Smallest living cells. Can survive without oxygen. Pathogenic in animals and plants.

Kingdom PROTISTA

(Comprises of all single celled eukaryotes)

- Forms a link between plants, animals and fungi.

(i) **Chrysophytes** (Has diatoms and golden algae/desmids)

Fresh water/marine, photosynthetic, microscopic plankton.

- Chief producers in Ocean.
- Cell walls have silica which makes it indestructible and cell walls overlap to fit together like a soap box.
- Their accumulation forms 'Diatomaceous Earth" (gritty soil)
- Used in polishing, filtration of oils and syrups.

(ii) **Dinoflagellates :**

- Marine, photosynthetic, cell wall has stiff cellulose plates.
- Two flagella–one longitudinal and other transverse in a furrow between wall plates.
- **Example :** *Gonyaulax multiples rapdily, make sea appear red (red tides) and produce toxins to kill marine animals.*

(iii) **Euglenoids :**

- Found in stagnant fresh water.

  Have protein rich layer 'pellicle' which makes body flexible.
- Photosynthetic in presence of sunlight but become heterotrophs if they do not get sunlight. (Mixotrophic nutrition)
- **Example :** *Euglena*

(iv) **Slime Moulds :**

- Saprophytic protists
- Under suitable conditions form an aggregates called plasmodium, grows on decaying twigs and leaves.
- During unfavourable conditions, plasmodium differentiates and forms fruiting bodies bearing spores at their tips.
- Spores have true walls which are extremely resistant and survive for many years and dispersed by air currents.

(v) **Protozoans :** Are heterotrops and live as parasites. Have four major groups.

Amoeboid : Catch prey using pseudopodia, *e.g., Amoeba. Entamoeba* are parasite.

Flagellated : Have one or more flagella. Cause disease like Sleeping Sickness *e.g., trypanosoma.*

Ciliated : Have clilia to move food into gullet and help in locomotion. *e.g., Paramoecium.*

Sporozoans : Have infective spore like stage in life cycle, *e.g.,* Plasmodium which causes malaria.

Kingdom Fungi

1. Heterotrophic organisms
2. Non chlorpohyllous hyphae
3. Network of hyphae called mycelium
4. Hyphae which have multinucleated cytoplasm are called coenocytic hyphae
5. Cell wall of chitin and polysaccharides
6. Cosmopolitan. Grow in warm and humid places.
7. Saprophytic, parasitic, symbiotic (Lichen and Mycorrhiza) *e.g.,* ***Puccinia,*** (wheat rust disease), ***Penicillium,*** Yeast (unicellular fungus).
8. Reproduction can take place by vegetative means fragmentation, fission and budding. Asexual reproduction by spores–conidia, sporangiospores or zoospores. Sexual reproduction by Oospores, ascospores and basidiospores–produced in fruiting bodies.
9. **Sexual cycle involves 3 steps :**
   (i) Plasmogamy (fusion of Protoplasms.)
   (ii) Karyogamy (fusion of two nuclei.)
   (iii) Meiosis in zygote resulting in haploid spores.
10. Dikaryophase is a condition of having dikaryon in an intervening dikaryotic stage (n + n *i.e.,* two nuclei per cell) between plasmogamy and karyogamy in fungi like ascomycetes and basidiomycetes.

Classes of Fungi

(i) Phycomycetes :

- grow on decaying wood or as obligate parasites on plants
- Mycelium aseptate and coenocytic
- Spores produced endogenously in sporangium.
- Asexual reproduction by Zoospores or Aplanospores
- Zygospores are formed by the fusion of gametes.

  e.g., ***Rhizopus, Albugo, Mucor***

(ii) Ascomycetes :

- also known as 'sac fungi'
- Are saprophytic, decomposers, parasitic or coprophilous (growing on dung).
- Mycelium branched and septate
- Asexual spores are called conidia produced exogenously on the conidiophores.

  Sexual spores are called ascospores produced endogenously in ascus, produced inside fruiting body called Ascocarp.

  e.g., ***Aspergillus, Neurospora, Saccharomyces (Unicellular fungi), Claviceps, morels, truffles***

(iii) Basidiomycetes :

- Mycelium septate and branched.
- Generally asexual spores are not found.
- Vegetative reproduction by fragmentation.
- Sexual reproduction by fusion of vegetative or somatic cells to form basidium produced in basidiocarp.
- Basidium produces four basidiospores exogenously after meiosis.

  e.g., ***Agaricus, Ustilago, Puccinia***

(iv) Deuteromycetes :

- Called as 'Fungi Imperfecti' as sexual form (perfect stage) is not known for them.
- Once sexual form is discovered the member is moved to Ascomycetes or Basidiomycetes.
- Mycelium is septate and branched.
- Are saprophytic parasitic or decomposers.

  e.g., ***Alternaria, Colletotrichum, Trichoderma.***

Viruses :

- They did not find a place in biological classification.
- Not truly living.

- Non-cellular organisms which take over the machinery of host cell on entering it and become living but as such they have inert crystalline structure appear non-living. So, difficult to call them living or non-living.
- Virus means venom or poisonous fluid. Pastuer gave the term 'virus'.
- D.J. Ivanowsky found out that certain microbes caused Tobacco Mosaic Disease in tobacco plant.
- M.W. Beijerinek called fluid as 'Contagium vivum fluidum' as extracts of infected plants of tobacco could cause infection in healthy plants.
- W.M. Stanely showed viruses could be crystallized to form crystals of protein which are inert outside their specific host.
- Viruses are obligate parasites.

Structure of Virus :

- It is a nucleoprotein made up of protein coat called Capsid. Capsid is made up of capsomeres arranged in helical or polyhedral-geometric forms. Have either DNA or RNA as genetic material which may be single or double stranded.
- Usually plant viruses have single stranded RNA; bacteriophages have double stranded DNA and animal viruses have single or double stranded RNA or double stranded DNA.

Diseases caused in humans :

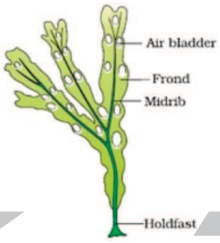
Mumps, Small pox, herpes, influenza and AIDS etc. In plants, symptoms can be mosaic formation, leaf rolling and curling, yellowing and vein clearing, dwarfing and stunted growth.

Viroids :

- Infectious agent, free RNA (lack protein coat)
- RNA has low molecular weight.
- Causes potato spindle tuber disease.
- Discovered by T.O. Diener.

Lichens :

- Symbiotic association between algal component (Phycobiont) and fungal component (mycobiont). Algae provides food. Fungi provides shelter and absorb nutrients and water for alga.
- Good pollution indicators as they do not grow in polluted areas.



Chapter - 3

Plant Kingdom

Points to Remember

Classification :

- **Artificial System of Classification**
  - By Carolus Linnaeus, based on androecium structure and vegetative characters.
- **Natural System of Classification**
  - Based on natural affinities among organisms
  - Included external as well as *internal features*
  - By Geroge Bentham and J.D. Hooker
- **Phylogenetic System of Classfication**
  - Based on evolutionary relationships between the various organisms
  - By Engler and Prantl
  - Later on By Hutchinson

Numerical Taxonomy :

- Carried out using computers
- Based on all observable characteristics
- Data processed after assigning number and codes to all the characters.

  Advantages : Each character gets equal importance and a number of characters can be considered.

Cytotaxonomy :

- Based on *cytological informations.*
- Gives importance to chromosome number, structure and behaviour.

Chemotaxonomy :

- Based on Chemical constitutents of the plants.

Algae :

- Chlorophyll bearing, simple, thalloid, autotrophic and largely aquatic organisms.

Importance of Algae :

- Help in carbon dioxide fixation by carrying out photosynthesis and have immense economic importance.
- At least half of the total carbon dioxide fixation on earth carried out by them.
- Increases dissolved oxygen level in their environment.
- Many species like ***Laminaria, Sargassum, Porphyra*** etc. are used as food.
- ***Agar*** obtained from ***Gelidium*** and ***Gracilaria*** which is used in ice-creams and jellies and to grow microbes.
- ***Algin*** obtained from brown algae and ***carrageen*** from red algae used commercially as ***hydrocolloids.***
- ***Chlorella*** and ***Spirullina*** are unicellular algae, rich in protein and used even by space travellers.
- Algae are unicellular like ***Chlamydomonas***, colonial like ***Volvox*** or or filamentous like ***spirogyra*** and ***Ulothrix.*** Occur in water, soil, wood moist stones etc.

Algae are divided into 3 classes.

(i) Chlorophyceae

- Green algae, Main pigment is chlorophyll 'a' and 'b'.
- Cell wall has inner layer of cellulose and outer layer of pectose.
- Has pyrenoids made up of starch and proteins.
- Pigment and pyrenoids are located in ***Chloroplast***.

e.g., ***Chlamydomonas, Volvax, Spirogyra, Ulothrix, Chara.***

(ii) Phaeophyceae

- Brown algae are brown coloured due to main pigments chlorophyll 'a',

'c' and fucoxanthin (xanthophyll)

- Cell wall has cellulose with gelantionous coating of algin.
- Has mannitol and laminarin (complex carbohydrate) as reserve food material.
- Body divisible into holdfast, stipe and frond.
- *e.g.,* ***Ectocarpus, Fucus, Laminaria, Dictyota, Sargassum***

(iii) Rhodophyceae

- Red algae are red coloured due to pigments chlorophyll 'a', 'd' and r-phycoerythrin.
- Found on surface as well great depths in oceans.
- Cell wall has cellulose.
- Reserve food material is floridean starch.

e.g., ***Polysiphonia, Porphyra, Gelidium,Gracilaria.***

Reproduction in Algae

Vegetative reproduction : by fragmentation

Asexual Reproduction : Flagellated zoospores in Chlorophyceae, Biflagellated zoospores in Phaeophycease, By non-motile spores in Rhodophyceae.

Sexual Reproduction : Isogamous, anisogamous or oogamous in chlorophyceae and Phaeophyceae.

By non-motile gametes and oogamous in Rhodophyceae.

Bryophytes :

- 'Amphibians of plant kingdom'.
- Occur in damp, humid and shaded places.
- Lack true roots, stem or leaves.
- Main plant body is haploid and thallus like (prostrate or erect)
- **Economic Importance :** Food for herbaceous animals.

Sphagnum in from of peat is used as fuel and also used as packing material for trans-shipment of living material, as it has water holding capacity.

Prevents soil erosion, alongwith lichens are first colonizers on barren rock.

- Is divided into two classes ***Liverworts*** (thalloid body, dorsiventral, *e.g.,* ***Marchantia***) and ***Mosses*** (have two stages in gametophyte–creeping, green, branched, filamentous ***protonema stage*** and the ***leafy stage*** having spirally arranged leaves *e.g.,* ***Funaria, Polytrichum and Sphagnum***).

Reproduction in Bryophytes

- Vegetative reproduction by fragmentation.
- Asexual reproduction by gemmae formed in gemma cups.
- Sexual reproduction : Main plant body is haploid, produces gametes and so called ***Gametophyte***. By fusion of antherozoids produced in antheridium and egg cell produced in archegonium, results in formation of zygote which develops into sporophytic structure differentiated into foot, seta and capsule. ***Spores*** produced in a capsule germinate to from free-living gametophyt e (Protonema). ***Sporophyte*** is not free living but attached to photosynthetic gametophyte from which derives nutrition.

Pteridophytes :

- First terrestrial plants.
- Prefer cool, damp and shady places to grow.
- Grown as ornamentals.
- Used for medicinal purpose, as soil binder.
- Main plant body is sporophyte which is differentiated into true root, stem and leaves.
- Leaves may be small as in ***Selaginella*** or large as in ferms.
- Sporangia having spores are subtended by leaf-like appendages called sporophylls. (Sporphylls may be arranged to form strobili or cones.)
- In Sporangia, the spore mother cells give to spores after meiosis.
- Spores germinate to form haploid gametophytic structure called **prothallus** which is free living, small, unicellular and photosynthetic.
- Prothallus bears antheridia and archegonia which bear antherozoids and egg cell respectively which on fertilisation from zygote. Zygote produces

multicellular, well differentiated sporophyte.

- The four classes are : Psilopsida (*Psilotum*), Lycopsida (*Selaginella*), Sphenopsida (*Equisetum*) and Pteropsida (*Pteris*).

Heterospory : Two kinds of spores *i.e.,* large (macro) and small (micro) spores are produced. *e.g.,Selaginella* and *Salvinia.*

Seed Habit : The development of zygote into young embryos takes place within the female gametophyte which is retained on parent sporophyte. This event is precursor to seed habit and this is an important step in evolution and is found ***Selaginella*** and ***Salvinia*** among the pteridophytes.

Gymnosperms :

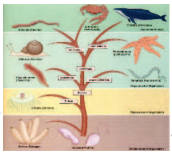
- Have naked seeds as the ovules are not enclosed by any ovary wall and remain exposed.
- Includes shrubs and trees (medium and tall sized).
- Have generally tap roots, stem may be unbranched (***Cycas***) or branched (***Pinus, Cedrus***), leaves–needle like (***Pinus***) and pinnate (***Cycas***).
- Roots of ***Pinus*** have fungal association in the form of mycorrhiza.
- Cycas have small specialized roots called ***coralloid root*** which are associated with N_2 fixing cyanobacteria.
- Heterosporous–Produce haploid microspores and megaspores.
- Male cone has microsporophylls which bear microsporangia having microspores which develop into reduced gametophyte called pollengrain.
- Female cone has megasporophylls which bear megasporongia having megaspores which are enclosed within the megasporangium (Nucellus). One megaspore develops into female gametophyte bearing two or more archegonia.
- Pollen grains carried in air currents reach ovules, form pollen tube which reach archegonia and release male gametes which fertilise egg cell and form zygote which produce embryos. Ovules develop into seeds which are not covered.

Angiosperms :

- Called flowering plants and have seeds enclosed in fruits.
- Divided into two classes–Dicotyledons (have two cotyledons) and Monocotyledons (have one cotyledon).
- **Smallest angiosperm :** *Wolfia*
- **Large tree :** *Eucalyptus* (Over 100 meters)
- Stamen has filament and anther. Anthers bear pollen grains. Pollen grains have two male gametes.
- Pistil has stigma, style and ovary. Ovary has ovule in which female gametophyte (embryo sac) develops.
- Embryo sac has 7 cells and 8 nuclei.One egg cell 2 synergids, 3 antipodals and two polar nuclei which fuse to form secondary nucleus.
- Pollen grain is carried by wind, water, insects and other agents reaches to stigma and produces pollen tube which enters embryo sac.
- **Double fertilisation :** One male gemate fuses with egg cell (Syngamy) to form zygote which develops into embryo.

Other male gamete fuses with secondary nucleus (triple fusion) which forms triploid primary endosperm nucleus (PEN). PEN develops into endosperm which nourishes the developing embryo.

- Ovules develop into seeds and ovaries into fruits.



Chapter - 4

Animal Kingdom

Point to Remember

Basis of Classification :

Animals are classified on the basis of following few fundamental features—

1. **Levels of Organisation :**
   (1) Cellular level : Cells are arranged as loose cell aggregates, *e.g.*,sponges.
   (2) Tissue level : The cells performing the same function are arranged into tissues, *e.g.,* Coelenterates.
   (3) Organ level : Tissues are grouped together to form organs, each specialised for a particular function. *e.g.,* platyhelminthes.
   (4) Organ system level : organs are associated to form functional systems *e.g.,* Annelids, Arthropods, Molluscs, Echinoderms and Chordates.
   Example : Circulatory System.

   Open type : Blood pumped out through heart. Not confined to blood vessels. Cells and tissues are directly bathed in it.

   Closed types : Blood is circulated through blood vessels (arteries,veins and capillaries)
2. **Symmetry :**
   - **Asymmetrical :** Cannot be divided into equal halves through median plane *e.g.,* Sponges.
   - **Radial symmetry :** Any plane passing through central axis can divide organism into identical halves. *e.g.,* coelentrates,Ctenophores and echinoderms.
   - **Bilateral symmetry :** Only one plane can divide the organism into two identical left and right halves *e.g.,* Annelids and Arthropods.
3. **Germinal Layers :**

   Diploblastic : Cells arranged in two embryonic layers *i.e.,* external ectoderm and internal endoderm. (Mesoglea may be present in between ectoderm and endoderm) *e.g.,* porifers and Coelentrates. (Cnidarians)

   Triploblastic : Three layers present in developing embryo *i.e.,* ectoderm, mesoderm and endoderm. *e.g.,* Platyhelminthes to Chordates.

4. **Coelom** (Body cavity which is lined by mesoderm)
   Coelomates : Have coelom *e.g.,* Annelids, Arthropods, molluscs, Echinoderms, Chordates etc.
   Pseudocoelomates : No true coelem as mesoderm is present in scattered pouches between ectoderm and endoderm. *e.,g.,* Aschelminthes.
   Acoelomates : Body cavity is absent *e.g.,* Platyhelminthes.
5. **Segmentation** (A) True Metamerism : Found Annelida,Arthropoda, Chordata :
   - Segmentation is external as well as a internal in Annelids.
   - Segmentation is external in Arthropods.
   - Segmentation is internal in chordates.
   - **Metamerism :** If body is externally and internally divided into segments (metameres) with serial repetition of atleast some organs, then phenomenon is called metamerism *e.g.,* Earthworm. (B) Pseudometamerism : Found in tapeworm. The proglottids (segments of tapeworm) budded off from neck not embryonic in origin.
6. **Notochord :**
   - Rod-like structure formed during embryonic development on t he dorsal side. It is mesodermally derived *e.g.,* Chordates.
   - Non-chordates do not have notochord .*e.g.,* porifera to echinoderms.

Phylum Porifera :

- Also called sponges.
- Are usually marine and asymmetrical.
- Have cellular level of organisation and diploblastic animals.
- Food gathering, respiratory exchange and removal of wastes occurs through water canal system. Digestion intracellular.
- Ostia (minute pores on body), spongocoel (body cavity) and osculum help in water transport. They are lined by choanocytes (collar cells).
- *Body wall* has skeleton of spicules or spongin fibres.
- Animals are hermaphrodite. Fertilisation internal. Development is indirect (*i.e.,* has a larval stage distinct from adult stage) *e.g.,* ***Sycon, Euspongia. Spongilla*** (Fresh water sponge)

Phylum Coelenterata :

- Also called Cnidarians.
- Are usually marine and radially symmetrical.
- Sessile or free swimming.

- Have tissue level of organisation.
- Are diploblastic (with mesogloea)
- Capture of prey, anchorage and defence occurs through cnidoblasts/cnidocytes (have stinging capsules nematocytes) present on tentacles.
- Digestion extracellular and intracellular.
- Have a central gastro-vascular cavity and an opening, hypostome.
- Body wall of some composed of calcium carbonate. e.g. corals.
- exhibit two body forms : polyp and medusa *e.g.,* ***Hydra, Aurelia.***
- Alternation of generation between body forms called ***metagenesis*** ocurs in ***Obelia*** where :

Medusa (free swimming & umbrella shaped) $\underset{\text{Asexually}}{\overset{\text{sexually}}{\rightleftharpoons}}$ Polyp. (Sessile and cylindrical)

- *e.g.,* ***Physalia, Adamsia,*** **Pennatula, Gorgonia,Meandrina.**

Phylum Ctenophora :

- Also called as sea walnuts or comb jellies.
- Are exclusively marine, radially symmetrical.
- Have tissue level organisation, are diploblastic.
- Digestion both extra and intracellular.
- Body has eight external rows of ciliated comb plates for locomotion.
- Show Bioluminescence (Property of living organisms to emit light).
- Hermaphrodite (sexes are not separate).
- Only sexual reproduction occurs. Exernal fertilization. Indirect development.

  e.g., ***Ctenoplana,*** **Pleurobrachia.**

Phylum Plathyhelminthes :

- Also called as 'flat worms'.
- Have dorsoventrally flattened body. Are mostly endoparasites in animals.
- Are bilaterally symmetrical, triploblastic, acoelomate,with organ level of orgnisation.
- Absorb nutrients through body surface.
- Parasitic forms have hooks and suckers.
- 'Flame cells' help in osmoregulation and excretion.

- Sexes not separate.
- Fertilisation internal. Many larval stages present. ***Planaria*** has high regeneration capacity. *e.g.,* ***Taenia, Fasciola.***

Phylum Aschelminthes :

- Also called 'round worms'.
- May be free living, parasitic, aquatic or terrestrial.
- Are bilaterally symmetrical, triploblastic, pseudocoelomate.
- Alimentary canal complete (has muscular pharynx), wastes removed through excretory pore.
- Sexes separate. (dioecious)
- Females longer than males.
- Fertilisation internal. Development direct or indirect. *e.g.,* ***Ascaris,Wuchereria*****, Ancylostoma.**

Phyum Annelida :

- Are aquatic or terrestrial, free-living or parasitic.
- Are bilaterally symmetrical, triploblastic, organ-system level of organisation and metamerically segmented body.
- Are coelomate animals.
- Have longitudinal and circular muscles for locomation.
- Have closed circulatory system.
- ***Nereis*** (dioecious and aquatic annelid) has lateral appendages called parapodia for swimming.
- Have nephridia for osmoregulation and excretion.
- Neural system consists of paired gangila connected by lateral nerves to a double ventral nerve cord.
- Reproduction is sexual.
- *e.g.,* Earthworm (*Pheretima*) and Leech (*Hirudinaria*) which are hermaph rodites **(*i.e.*, monoecious)**.

Phylum Arthropoda :

- Largest phylum of Animalia.
- Are bilaterally symmetrical, triplobastic, segmented externally and organ system level of organisation, coelomate.
- Body divisible into head, thorax, abdomen and has a chitinous exoskeleton. Jointed appendages are present.

- Respiration by gills, book gills, book lungs or tracheal system. Excretion through ***malpighian tubules***.
- Sensory organs : Antennae, eyes; Organs of balance : ***Statocysts.***
- Fertilisation usaully internal. Development is indirect or direct. Are mostly oviparous.

  e.g., ***Apis, Bombyx, Laccifer, Anopheles, Culex, Aedes, Locusta, Limulus.***

Phulum Mollusca :

- Second largest phylum of Animalia.
- Terrestrial or aquatic
- Are bilaterally symmetrical, triplobastic and organ system level of organisation, coelomate.
- Body vidisble into ***head, muscular foot*** **and** ***visceral hump*** and is covered by calcareous shell and is unsegmented.
- ***Mantle*** : Soft and spongy layer of skin; *Mantle cavity* : Space between visceral hump and mantle.
- Respiration and excretion by feather like gills in mantle cavity.
- Head has sensory tentacles. Radula a rasping organ for feeding in mouth.
- Are oviparous, dioecious, have indirect development.

  e.g., ***Plia, Pinctada, Octopus,*** **Sepia, Loligo, Aplysia, Dentalium, Chaetopleura.**

Phylum Echinodermata :

- Are spiny bodied organisms with endoskeleton of calcareous ossicles.
- Are exclusively marine, ***radially symmetrical*** in ***adult*** but ***bilaterally symmetrical in larval stage.*** Organ system level of organisation.
- Triploblastic and coelomate.
- Digestive system complete. Mouth ventral, Anus on dorsal side.
- Food gathering, respiration, locomotion carried out by ***water vascular system.***
- Excretory system is absent.
- Reproduction–sexual, sexes are separate.
- Fertilisation external. Development indirect (free swimming larva)
- *e.g.,* ***Asterias, Cucumaria, Antedon, Echinus, ophiura.***

Phyum Hemichordata :

- Represents small group of worm-like organisms.
- Was earlier placed as sub-phylum of Phyum Chordata.

- Bilaterally symmetrical, triploblastic and coelomate with organ system level of organisation.
- Body cylindrical, has proboscis, collar and trunk.
- Circulatory System–open.
- Respiration by gills, excretion by proboscis gland.
- Sexes separate, external fertiliastion, indrect development.

e.g, ***Balanoglossus,*** **saccoglossus.**

Phylum Chordata :

- Presence of ***Notochord.***
- Have ***dorsal hollow nerve chord.***
- Have ***paired pharyngeal gill slits.***
- Bilaterally symmetrical, triploblastic, coelomate, organ system level of organisation.
- Heart is ventral.
- Post anal tail present, closed circulatory system.

(i) Sub-Phyla Urochordata /Tunicata

- Notocohord present only in larval tail.

e.g., ***Ascidia,*** **Salpa, Doliolum**

(ii) Sub-phyla Cephalochordata

- Notochord extends from head to tail (Persistent)

e.g., ***Amphioxus.***

(iii) Sub-Phyla Vertebrata

- Have notochord only during embryonic period.
- Notochord gets replaced by bony or cartilaginous vertebral column.
- Have ventral muscular heart, kidneys for excretion and osmoregulation, paired appendages (fins or limbs)

Vertebrata have two Division :

(a) Agnatha (Lacks Jaw) : Class : Cyclostomata

- Live as ectoparasites on some fishes.
- Have sucking and circular mouth without jaws.
- Have 6-15 paris of gill slits for respiration.
- No scales, no paired fins.
- Cranium and vertebral column is cartilagenous.

- Marine, Migrate to fresh water for spawning and die after spawning.
- Larva returns to ocean after metamorphosis.

e.g., ***Petromyzon, Myxine***

(b) Gnathostomata (Bear Jaws)–divides into two super classes :

Super-class : Pisces

1. Class : Chondrichthyes :

- Have cartilagenous endoskeleton, are marine with streamlined body.
- Mouth ventral.
- Gill slits without operculum (gill cover).
- Skin has placoid scales; jaws–very powerful.
- No air bladder, so swim constantly to avoid sinking.
- Teeth are backwardly directed, modified placoid scales.
- Notochord is persistent throughout life.
- Two chambered heart; poikilotherms (cold-blooded)
- Sexes separate; males have ***claspers*** on pelvic fins.
- Internal fertilisation; viviparous.

e.g., **Tarpedo, Trygon, Scoliodon, *Pristis, Carcharodon***

2. Class : Osteichthyes

- Have bony endoskeleton, Aquatic
- Mouth is usually terminal. Body-Streamlined
- Four pairs of gill slits covered by operculum, heart two chambered, cold blooded.
- Sking has cycloid/ctenoid scales.
- Have air bladder which regulates buoyancy.
- Sexes separate.
- Usually oviparous, fertilisation external.
- Development direct.
- *e.g.,* ***Hippocampus, Labeo, Catia, Betla, Clarias, Exocoetus***

Sub-Phylum Vertebrata : Gnathostomata

Super Class : Tetrapoda

1. Class : Amphibia

- Can live in aquatic as well as terrestrial habitats.
- Body divisible into head and trunk, paired limbs.

- Skin moist. No scales.
- Tympanum represents ear. Eyes have eyelids.
- Cloaca is the common chamber where alimentary canal, urinary and reproductive tracts open.
- Respiration by gills, lungs or skin.
- Heart is 3-chambered; cold-blooded; Sexes separate; fertilisation external.
- Oviparous. Indirect development.
- *e.g.,* ***Bufo, Rana, Hyla, Salamandra, Ichthyophis***

2. Class : Reptilla

- Creep or crawl to locomote. Mostly terrestrial.
- Body has dry and cornified skin and epideremal ***scales or scutes.***
- Tympanum represents ear.
- Limbs, when present, are two pairs
- Snakes and lizards shed, scales as ***skin cast***.
- Heart 3-chambered but 4-chambered in crocodiles.
- Sexes Separate; fertilisation internal.
- Oviparous. Direct development.
- *e.g.,* ***Testudo, Naja, Vipera, Calotes, Crocodilus, Hemidactylus***

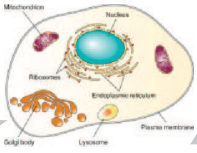
3. Class : Aves

- Presence of feathers except flightless birds and beak (modified jaws) without teeth.
- Forelimbs are modified into wings.
- Hind limbs have scales, modified for walking, swimmng or clasping.
- Skin is dry as no glands on skin except oil gland at base of tail.
- Endoskeleton bony with air cavities (pneumatic) and hollow bones to assist in flight.
- Crop and Gizzard—Additional chamber in digestive tract.
- Air sacs are connected to lungs to supplement respiration.
- Warm blooded (homoiothermous), Heart–Four chambered.
- Sexes separate, fertilization internal
- Oviparous. Direct development.
- *e.g.,* ***Columba, Struthio, Pavo, Corvus, Neophron, Pstittacula Aptenodytes.***

4. Class : Mammalia

- Have mammary glands to nourish young ones.
- Have two pairs of limbs, adapted to perform special work.
- Skin has hairs.

- External ears or, pinna present.
- Different types of teeth in jaw.
- Homoiothermous; Heart–Four chambered, Lungs for respiration.
- Sexes are separate, fertilisation internal.
- Viviparous. Direct development.
- *e.g.,* ***Rattus, Canis, Elephas, Equus.*** Oviparous mammal is ***Ornithorhynchus.***



Chapter - 8

Cell : The Unit of Life

Points to Remember

Cell Theory : Cell Theory was formulated by Schleiden and Schwann, and was modified by Rudolf Virchow. Cell theory States.

(A) All living organisms are composed of cells and products of cells.

(B) All cells arise from pre-existing cells.

Cell : Cell is the structural and functional unit of life.

Prokaryotic Cell	Eukaryotic Cells
• Generally small sized (1–10 μm)	• Generally large sized (5–10 μm)
• Well defined nucleus absent	• Well defined nucleus present
• Membrane bounded cell organelles absent	• Membrane bounded cell organelles present
• DNA without histone protein e.g., Bacteria, Mycoplasma, Blue green Algae	• DNA with histone protein e.g., Amoeba, Euglena and other higher organism
Gram Positive Bacteria	**Gram Negative Bacteria**
• Bacteria that take up gram Stain. e.g., Bacillus	• Bacteria do not take up gram stain e.g., Escherichia Coli

PROKARYOTIC CELL :

Modification of cell envelope

- Slime layer : Glycocalyx in form of loose sheath.
- Capsule : Glycocalyx in form of thick and tough sheath.
- Mesosomes : Extension of plasma membrane. These can be in the form of vesicles, tubules and lamellae.

Functions : Cell wall formation, DNA replication and distribution to daughter cells, respiration, secretion processes, to increase surface area of plasma membrane and enzyme content.

- Flagella : Extension of cell wall. It is composed of three structure–filament, hook and basal body. It help in motility of bacteria.
- Pili and fimbriae : Surface structure of some bacteria which attaches them to rocks in streams and to host tissues.

Genetic Material : It is not covered by nuclear envelope. In addition to the genomic DNA (the single chromosome/circular DNA), many bacteria have small circular self replicating, double straned DNA which is called as plasmid, plasmid contain genes like antibiotic resistance.

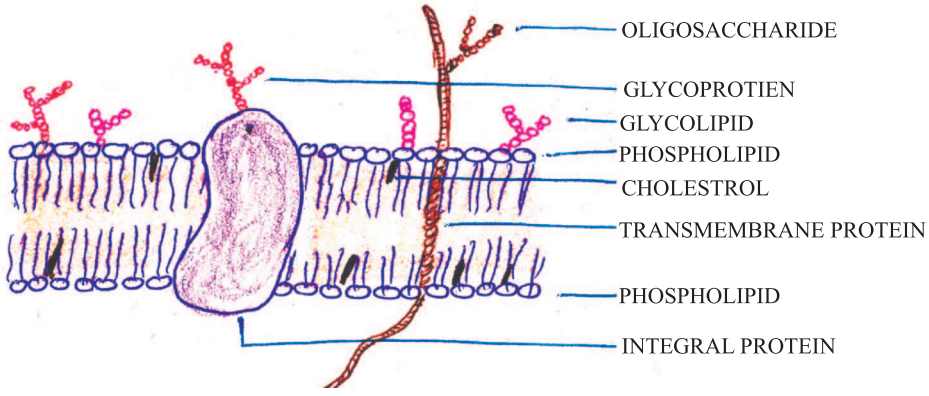
Eukaryotic cells

Possess an oragnized nucleus with nuclear envelope and have a variety of complex locomotory and cytoskeletal structures.

Cell Membrane — Singer and Nicolson (1972) gave 'fluid mosaic model'. According to this the quasi-fluid nature of lipid enables lateral movement of proteins within the overall bilayer; two types of proteins (Peripheral and integral proteins) with cholesterol, glycolipids and glycoporteins. Erythrocyte membrane has 52% protein and 40% lipids.

Function—It is semi permeable and helps in transport of molecule across it.

Passive transport	Active transport
• Transport of molecules from higher to lower concentration.	• Transport of molecules from lower to higher concentration
• It do not utilise energy (ATP). *e.g.,* diffusion	• It utilises energy (ATP) *e.g.,* Na^+/k^+ ATPase Pump.



Fluid Mosaic Model of Plasma Membrane

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

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

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

Plasmodesmata connect the cytoplasm of neighbouring cells.

Endoplasmic Reticulum (ER)

Consists of network of tiny tubular structure. ER divides the intracellular space into two distinct compartments–luminal (inside ER) and extra luminal (cytoplasm).

(i) Rough Endoplasmic Reticulum (RER) :

- Ribosomes attached to outer surface.

Function : ● Involved in protein synthesis and secretion.

(ii) Smooth Endoplasmic Reticulum (SER) : ● Lack ribosomes.

Function ● Site for synthesis of lipid.

Golgi apparatus : First observed by Camillo Golgi (in 1898)

Consist of cisternae stacked parallel to each other. Two faces of the organelle are convex/cis or forming face and concave/**trans** or maturing face.

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

Lysosomes :

Membrane bound vesicular structures formed by the process of packaging in the golgi apparatus. Contain hydrolysing enzymes (lipases, proteases, carbohydroses) which are active in acidic pH. Also called 'Suicidal Bag'.

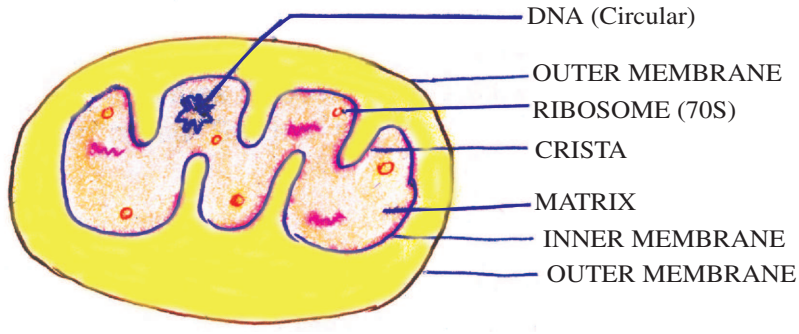
Function : Intracellular digestion.

Vacuoles : Member bound space found in the cytoplasm. Contain water, sap, excretory product, etc. In plant cell, vacoule occupies 90% of space.

Function : In plants **tonoplast** (single membrane of vacuole) faciliates transport of ions and other substances.

Contractile vacuole for excretion in ***Amoeba*** and food vacuoles formed in protists for digestion of food.

Mitochondria : Double membraned structure. Outer membrane smooth and inner membrane forms a number of infoldings called cristae The inner compartment is called matrix. The cristae increase the surface area.



Mitochondria

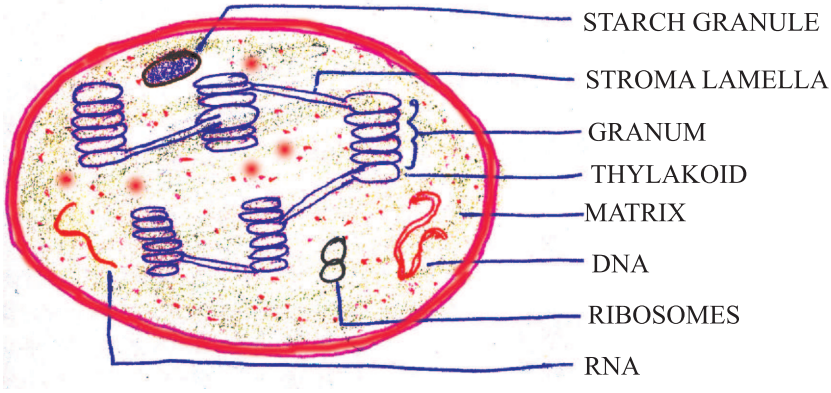
Function : Sites of aerobic respiration. Called 'power houses' of cell as produce cellular energy in the form of ATP. Matrix possesses single circular DNA molecule, a few RNA molecules, ribsomes (70S). It divides by binary fission.

Plastids : Found in plant cells and in euglenoides. Chloroplasts, chromoplasts and leucoplasts are 3 types of plastids depending on pigments contained.

Types of Plastids

Chloroplast	Chromoplast	Leucoplast
(green coloured plastids)	carotenoid (fat souble	Amyloplast (Starch)
contains chlorophyll, double	carotene (give colour to plant parts)	Elaioplasts (oil + fat)
stranded DNA and 70S	Xanthophylls.	Aleuroplast
ribosomes	Others (Yellow, red, orange)	(store proteins)

Function : Site of photosynthesis, and imparts colours to fruits and flowers.



Fluid Mosaic Model of Plasma Membrane

Ribosomes

Composed of RNA and proteins; without membrane. Eucaryotic ribosomes are 80S. S = Svedberg's unit)

Function : Site of protein synthesis.

Cytoskeleton : Network of filaments.

Proteinaceous structure in cytoplasm made up of microtubules and micro filaments.

Function : Mechanical support, motility, maintenance of the shape of the cell.

Cilia and Flagella

Cilia are small structures which work like oars which help in movement.

Flagella are longer and responsible for cell movement. They are covered with a plasma membrane. Core is called **axoneme** which has 9 + 2 arrangement of axonemal microtubules.

Centrosome and Centrioles

Centrosome contains two cylindrical structures called centrioles. Surrounded by amorphous pericentriolar material. Has 9 + 2 arrangement. Centrioles form the basal body of cilia or flagella and spindle fibres for cell division in animal cells. They produces spindle apparatus during cell divison.

Nucleus : With double membrane with perinuclear space and nuclear pores; has Chromatin, nuclear matrix and nucleoli (site for rRNA synthesis). (Named by Robert Brown – 1831)

Chromatin DNA + nonhistone proteins. (Named by Flemming)

Nucleoplasm – Nucleolus + Chromatin

Nulear membrane—It is with perinuclear space and nucleopores.

Chromosomes—DNA/RNA + Histone protein/Nonhistone protein.

Centromere : Primary constriction–disc is known as kinetochores.

No nucleus in Erythrocyctes (RBC) of mammals and sieve tubes in vascular plants.

Chromosomes (on basis of position of centromere) :

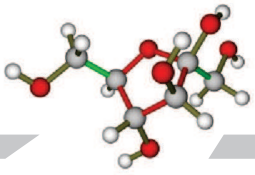
Metacentric : Middle centromere.

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

Acrocentric : Centromere situated close to its end.

Telocentric : Has terminal centromere.

Satellite : Some chromosomes have non-staining secondary constructions at a constant location, which gives the appearance of small fragment called satellite.



Chapter - 9
Biomolecules

Points to Remember

Biomolecules : All the carbon compounds that we get from living tissues.

Biomicromolecules : Molecules which have molecular weights less than one thousand dalton. They are also known as monomers.

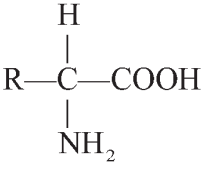
Biomacromolecules : Have molecular weight more than 10000 daltons (generally 10,000 deltons and above). They are generally polymers.

Biomacromolecules : A biomolecule a with molecular weight in the range of ten thousand daltons and above; found in acid insoluble fraction. e.g. polysaccharides, nucleic acids, proteins and lipids.

Primary and secondary metabolites :

- Primary metabolites have identifiable functions and play important roles in normal physiological process eg. Amino acids, nitrogenous bases, proteins and nucleic acid.
- Secondary metabolites are product of certain metabolic pathways from primary metabolites, eg. carotenoids, drugs, alkaloids, essential oils, rubber, gum, cellulose and resins etc.

Amino acids : Organic compounds containing an amino group and one carboxyl group (acid group) and both these groups are attached to the same carbon atom called α carbon and so they are called $\propto$ amino acids.



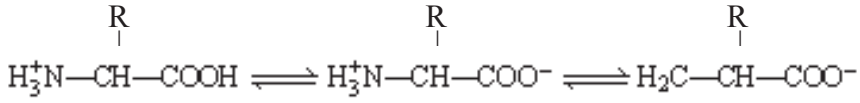
e.g. (1) In Glycine R = H

(2) In alanine R = CH_3

(3) In serine R = CH_2 – OH

- Twenty types of amino acids.

  Amino acid exists in Zwitterionic form at different pHs.

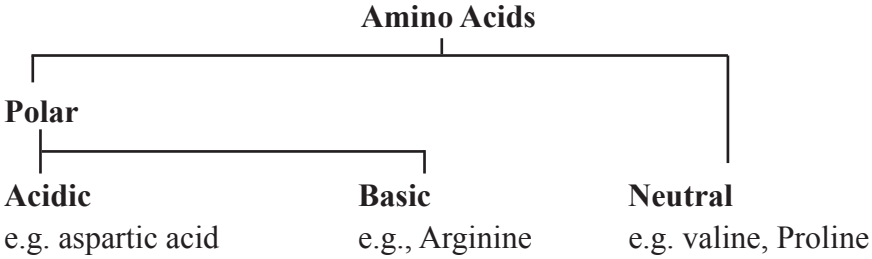


(A) (B) (C)

(Zwitterionic form)

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

  (i) **Aromatic**–Tryptophan, phenylalanine and Tyrosine are aromatic (give smell) amino acids.



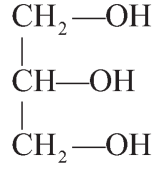
  (ii) **Non Polar**—Glutamine, tyrosine, serine

Lipids :

Lipids are not strictly macromolecules as their molecular weight do not exceed 800 Da but form a part of the acid insoluble pool.

- Water insoluble, containing C, H, O.
- Fats on hydrolysis yield fatty acids.
- Fatty acid has a carboxyl group attached to an R group (contains 1 to 19 carbons).
- **Fatty Acids : Saturated :** With single bonds in carbon chain, *e.g.,* Palmitic acid, butyric acid.

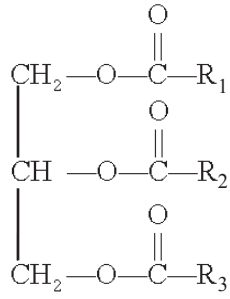
  Unsaturated : With one or more double bonds, *e.g.,* oleic acid, linoleic acid.
- **Glycerol :** A simple lipid, is trihydroxy propane.



- Some lipid have fatty acids esterified with glycerol.

  Example of fatty acid (Palmitic acid) ($CH_3—(CH_2)_{14}—COOH$)

- They can be monoglycerides, diglycerides and triglycerides.



Triglyceride (R_1, R_2, R_3 are alkyl groups in fatty acids.)

Phospholipids (Lecithin) found in cell membrane and lipids made complex structure in neural tissue.

- **Phospholipids** are compound lipids with phosphorus and a phosphorylated organic compound *e.g.,* Lecithin.

Nitrogen bases

(Carbon compounds with heterocyclic rings)

Purine : Adenine, Guanine, **Pyrimidine :** Cytosine, Uracil, Thymine.

Nucleoside : Nitrogenous base + Sugar e.g. Adenosine, guanosine.

Nucleotide : Nitrogenous base + Sugar + Phosphate group. e.g. Adenylic acid, Guanylic acid. Thymidylic acid.

Nucleic acids : Deoxyribonucleic acid (DNA) and ribonucleic acid (RNA).

DNA structure (Watson and Crick Model) : DNA is a right handed, double helix of two polynucleotide chains, having a major and minor groove. The two chains are antiparallel, and held together by hydrogen bonds (two between A and T and three between C and G). The backbone is formed by sugar-phosphate-sugar chain. The nitrogen bases are projected more or less perpendicular to this, backbone and face inside. The pitch is 34A°. At each step of ascent, the strand turns 36°. The rise per base pair is 3.4°A, so one full turn involves ten base pairs.

Protein : proteins are polypeptides.

- They are polymers of aminoacids linked by peptide bond.
- Is a heteropolymer (different monomers repeating 'n' number of times).
- For functions of proteins refer Table 9.5, Page no. 147 NCERT, Text Book of Biology for Class XI.

Structure of Proteins

(a) Primary structure : Is found in the form of linear sequence of amino acids. First amino acid is called N-terminal amino acid and last amino acid is called C-terminal amino acid.

(b) Secondary structure : Polypeptide chain undergoes folding or coiling which is stabilized-by hydrogen bonding. Right handed helices are observed; *e.g.,* fibrous protein in hair, nails.

(c) Tertiary structure : Long protein chain is folded upon itself like a hollow woollen ball. Gives a 3-dimensional view of protein, *e.g.,* myosin.

(d) Quaternary structure : Two or more polypeptides with their foldings and coilings are arranged with respect to each other, *e.g.,* Human haemoglobin molecule has 4 peptide chains - 2 α and 2 β Subunits.

Monosaccharides are joined by glycosidic bond, right end is reducing and left end is non reducing

Polysaccharides : Are long chain of polymers of monosaccharides.

(a) Starch : Store house of energy in plant tissues. Forms helical secondary structures, made of only glucose monomers.

(b) Cellulose : Homopolymer of glucose. It does not certain complex helices. Cotton fibre is cellulose.

(c) Glycogen : Is a branched homopolymer, found as storage polysaccharide in animals.

(d) Inulin : Is a polymer of fructose.

(e) Chitin : Chemically modified sugar (amino-sugars) N-acetyl galactosamine form exoskeleton of arthropods; heterpolymer.

Metabolic Pathways :

(a) Anabolic pathways : Lead to formation of more complex structure from a simpler structure with the consumption of energy, *e.g.,* Protein from amino acids., also known as biosynthetic pathways.

(b) Catabolic pathway : Lead to formation of simpler structure from a complex structure, *e.g.,* Glucose $\rightarrow$ Lactic Acid + energy

The most important energy currency in living systems is ATP (adenosine tri – phosphate).

"There is no uncatalysed metabolic conversion in living system"

The living state is a non-equilibrium steady state to be able to perform work. Without metabolism, there cannot be a living state.

Bonds linking monomers in a polymer

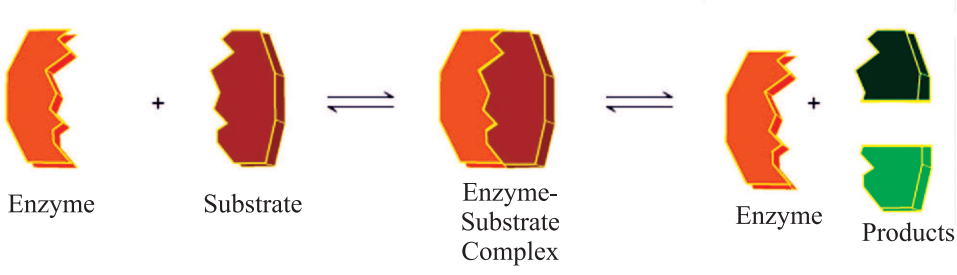
Peptide bond—formed between the carboxyl (–COOH) group of one amino acid, and the amino ($-NH_2$) group of the next amino with the elimination of water moiety, (dehydration).

Glycosidic bond—bond formed between two carbon atoms of two adjacent monosaccharides., by dehydration.

Phosphodiester bond—bond formed in nucleic acids where in a phosphate moiety links the 3-carbon of one sugar of one nucleotide to the 5-carbon of the sugar of the succeeding nucleotide. (The bond between phosphate group and hydroxyl group of sugar)

Ezymes : Are biocatalyst.

- Almost all enzymes are proteins.
- Ribozymes–Nucleic acid that behave like enzymes.
- Has primary, secondary and tertiary structure.
- Active site of an enzyme is a crevice or pocket into which substrate fits.
- Enzymes get damaged at high temperatures.
- Enzymes isolated from thermophilic organisms (live under high temperatures) are thermostable.
- Enzymes accelerate the reactions many folds.
- Enzymes lower the activation energy of reactions. (Fig. 9.6, Page no. 156, NCERT Text Book of Biology for Class XI).
- $E + S == ES \rightarrow EP \rightarrow E + P$
  where E = Ezymes, S = Substrate, P = Product



Steps of Enzyme Action

Factors affecting enzyme activity :

(a) Temperature : Show highest activity at optimum temperature. Activity declines above and below the optimum value.

(b) pH : Enzymes function in a narrow range of pH. Highest activity at optimum pH. (Fig. 9.7, Page no. 157, NCERT, Text Book of Biology for Class XI).

(c) Concentration of substrate : The velocity of enzymatic reaction rises with increases in substrate concentration till it reaches maximum velocity (V_{max}). Further increase of substrate does not increase the rate of reaction as no free enzyme molecules are available to bind with additional substrate.

KM value : The substrate concentration at which V_{max} x is half of a reaction.

Enzyme inhibition : When the binding of a chemical shuts off enzyme activity, the process is called inhibition and chemical is called **inhibitor.**

Competitive inhibition : Inhibitor closely resembles the substrate in its molecular structure and inhibits the enzyme activity. E.g., inhibition of succinic dehydrogenase by malonate. (Actual is succinic acid).

Classification of enzymes :

1. **Oxidoreductase/dehydrogenases :** Catalyse oxidoreduction between 2 substrates. S reduced + S′ oxidised → S′ oxidised + S′ reduced.
2. **Transferases :** Catalyse transfer of a group between a pair of substrates.

   S – G + S′ → S + S′ – G
3. **Hydrolases :** Catalyse hydrolysis of ester, ether, peptide, glycosidic, C–C, P-N bonds.
4. **Lyases :** Catalyse removal of groups from substrates by mechanisms other than hydrolysis. Leave double bonds.
5. **Isomerases :** Catalyse inter-conversion of optical, geometrical or positional isomers.
6. **Ligases :** Catalyse linking together of 2 compounds.

   C–O, C–S, C–N, P–O

   Co-factors : Enzymes becomes catalytically become active when it binds to non protein constituent called co-factors. Protein portion of enzyme is called apoenzyme.

- **Prosthetic group :** These are organic compound which tightly bound to the apoenzyme.

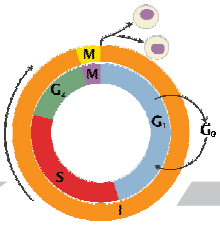
  e. g., Haem is prosthetic group in peroxidase and catalase.

- **Coenzyme :** These are organic compounds whose association with the apoenzyme is only transient, usually occurring during the course of catalysis.

  e.g., Coenzyme Nicotinamide adenine dinucleotide (NAD) and NADP contain vitamin niacin.

- **Metal ions :** Metal ions form coordination bond with side chains at the active site and at the same time form one or more coordination bond with substrate.

  e.g. zinc in enzyme carboxy peptidase.



Chapter - 10

Cell Cycle and Cell Division

Points To Remember

Cell cycle : 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.

Phases of cell cycle
- Interphase (G_1 phase + S phase + G_2 Phase)
- M Phase (Mitosis phases)
  - Karyokinesis (division of nucleus)
  - Cytokinesis (division of cytoplasm)

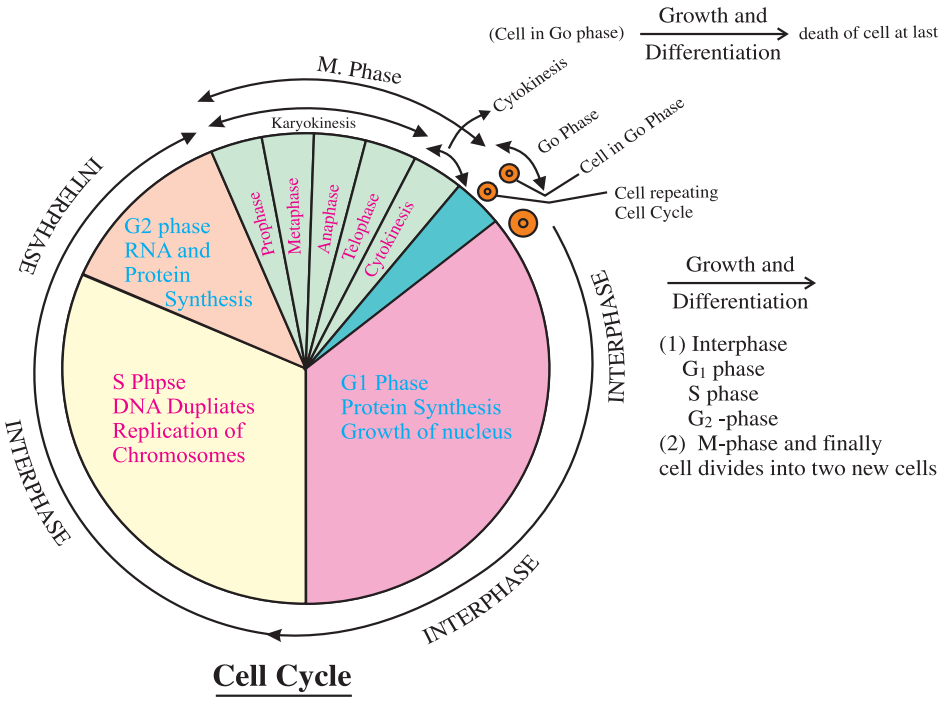
Interphase : (Resting Phase)

- **G_1 Phase :** Cell metabolically active and grows continuously but does not replicate DNA
- **S Phase :** DNA synthesis occurs, DNA content increases from 2C to 4C, but the number of chromosomes remains same *i.e.,* 2*n*.
- **G_2 Phase :** Proteins are synthesised in preparation for mitosis while cell growth continues.

M Phase (Mitosis Phase) : Starts with nuclear division, corresponding to separation of daughter chromosomes (karyokinesis) and usually ends with division of cytoplasm, (cytokinesis).

Quiescent stage (G_0) In adult animals cells that do not divide and exit G_1 phase to enter an inactive stage called G_0. Cells at this stage remain metabolically active but do not proliferate.

e.g., Heart cells

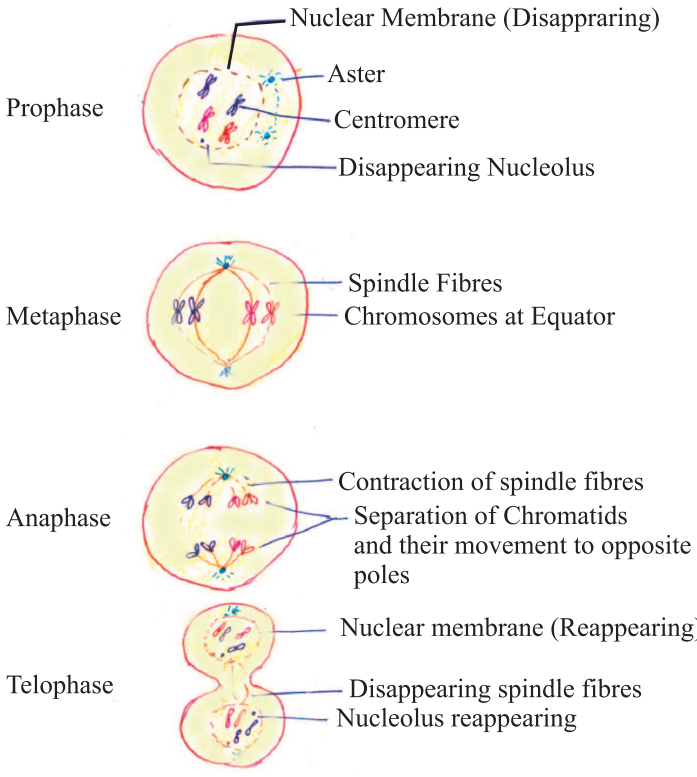


Cell Cycle

Mitosis

Since the number of chromosomes in the parent and progeny cells is the same, it is called as equational division. Mitosis is divided into four sub stages.

1. **Prophase :** (i) Replicated chromosomes, each consisting of 2 chromatids, condense and become visible.
   (i) Microtubules are assembled into mitotic spindle.
   (iii) Nucleolus and nuclear envelope disappear.
   (iv) Centriole moves to opposite poles.
2. **Metaphase :** (i) Spindle fibres attached to kinetochores (small disc-shaped structures at the surface of centromere) of chromosomes.
   (ii) Chromosomes line up at the equator of the spindle to form metaphase plate.
3. **Anaphase :** (i) Centromeres split and chromatids separate.
   (ii) Chromatids move to opposite poles due to shortening of spindle fibres.
4. **Telophase :** (i) Chromosomes cluster at opposite poles.
   (ii) Nuclear envelope assembles around chromosomes clusters'.
   (iii) Nucleolus, Golgi Complex, E.R. reforms.



Stages of Mitosis

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

Animal Cytokinesis :

Appearance of furrow in plasma membrane which deepens and joins in the centre, dividing cell cytoplasm into two.

Plant cytokinesis : Formation of new cell wall begins with the formation of a simple precursor — **cell plate** which represents the middle lamella between the walls of two adjacent cells.

- When karyokinesis is not followed by cytokinesis, a multinucleated condition arises. This is called **syncytium.**

Significance of Mitosis :

1. Growth-addition of cells.
2. Maintenance of surface/volume ratio. Maintain Nucleo–cytoplasmic ratio.
3. Maintenance of chromosomes number.
4. Regeneration.

5. Reproduction in unicellular organisms, lower plants and some insects.
6. Repair and wound healing.
7. Vegetative reproduction in plants takes place by mitosis.

Meiosis :

- Specialised kind of cell division that reduces the chromosomes number by half. hence it is called reductional division.
- Occurs during gametogenesis in plants and animals.
- Involves two sequential cycles of nuclear and cell division called Meiosis I and Meiosis II.
- It results in 4 haploid daughter cells.
- Interphase occurs prior to meiosis which is similar to interphase of mitosis except the S phase is prolonged.

Meiosis I

Prophase I : Subdivided into 5 phases.

(i) Leptotene :

- Chromosomes make their appearance as single stranded structures.
- Compaction of chromosomes continues.

(ii) Zygotene :

- Homologous chromosomes start pairing and this process of association is called synapsis.
- Chromosomal synapsis is accompanied by formation of Synaptonemal complex.
- Complex formed by a pair of synapsed homologous chromosomes is called bivalent or tetrad.

(iii) Pachytene : Crossing over occurs between non-sister chromatids of homologous chromosomes. The enzymes involved in the process is 'recombinase'. Recombination between homologous chromosomes is completed. Exchange of genetic material.

(iv) Diplotene : Dissolution of synaptonemal complex occurs and the recombined chromosomes separate separate from each other except at the sites of crossing over. These X-shaped structures are called **chaismata.** In oocytes of some vertebrates diplotene can last for month or years.

(v) Diakinesis : Terminalisation of chaismata.

- Chromosomes are fully condensed and meiotic spindles assembled.
- Nucleolus disappear and nuclear envelope breaks down.

Metaphase I : Bivalent chromosomes align on the equatorial plate.

- Microtubules from opposite poles of the spindle attach to the pair of homologous chromosomes.

Anaphase I : Homologous chromosomes, separate while chromatids remain associated at their centromeres.

Telophase I :

- Nuclear membrane and nucleus reappear.
- Cytokinesis follows (diad of cells).

Interkinesis : Stage between two meiotic divisions, (meiosis I and meiosis II) generally short lived.

Meiosis II: (It resembles the normal mitosis).

Prophase II

- Nuclear membrane disappears.
- Chromosomes again become compact.

Metapahse II

- Chromosomes align at the equator.
- Microtubules from opposite poles of spindle get attached to kinetochores of sister chromatids.

Anaphase II

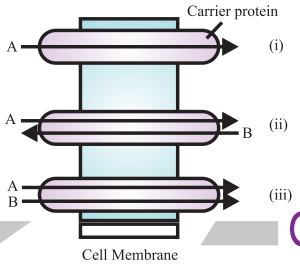
- Simultaneous splitting of the centromere of each chromosome, allowing them to move towards opposite poles of the cell.

Telophase II

- Two groups of chromosomes get enclosed by a nuclear envelope.
- Cytokinesis follows resulting in the formation of tetrad of cells *i.e.,* 4 haploid cells.

Significance of Meiosis

1. **Formation of gametes :** In sexually reproducing organisms.
2. **Genetic variability : Variations are very important for evolution.**
3. **Maintenance of chromosomal number :** By reducing the chromosome number in gametes. Chromosomal number is restored by fertilisation of gametes.



Chapter - 11

Transport In Plants

Points To Remember

Translocation (Long distance transport) : Transport of substances in plants over longer distances through the vascular tissue (Xylem and Phloem) The transport of water and mineral in Xylem is unidirectional while transport of organic and mineral nutrients in phloem is multi-directional.

Means of transport (Short distance transport) : The transport of material into and out of the cells is carried out by a number of methods. These are diffusion, facilitated diffusion and active transport.

(i) **Diffusion :** Diffusion occurs from region of higher concentration to region of lower concentration across the permeable membrane. It is passive and slow process. No energy expenditure takes place.

Factors affecting diffusion : Permeability of membrane, Temperature, pressure, gradient of concentration and the size of substances.

(ii) **Facilitated diffusion :** The diffusion of hydrophilic substances along the concentration gradient through fixed membrane transport protein without involving energy expenditure. For this the membrane possess aquarporins and ion channels. No ATP energy is utilized in this process.

Porins—The proteins that form huge pores in the outer membranes of the plastids, mitochondria and some bacteria which allow the small size molecules to pass through.

Aquaporins—Proteins that facilitate diffusion of water molecules through/ across the plasma membrane of cell.

Methods of Facilitated Diffusion

Symport	Antiport	Uniport
(Two molecules cross the membrane in the same direction at the same time.)	(Two molecules move in opposite direction at the same time.)	(Single molecule moves across membrane indpendent of other molecules.)

Transport Proteins—They are present in the membrane. They allow the passage of substances through membrane.

(i) **Carrier Proteins**—They bind to the particular solute particle to be transported and deliver these to other side of membrane.

(ii) **Channel Proteins—Ion Channel**—They are specific for different ions like

K^+, Cl^-, NO_3^-, PO_4^{3-}, Mg^{2+}

Water Channel—Surrounded by eight proteins called aqua protein and allow passage of water or water soluble substance.

(iii) **Active transport :** Active transport is carried by the movable carrier proteins (pumps) of membrane. Active transport uses energy to pump molecules against a concentration gradient from a low concentration to high concentration (uphill-transport). It is faster than passive transport.

Different Transport Mechanisms

S. No.	Property	Simple Diffusion	Faciliated Transport	Active Transport
1.	Required Special membrane protein	No	Yes	Yes
2.	Uphill transport	No	No	Yes
3.	Requires ATP Energy	No	No	No

- **Water potential**—(ψ_w)–Greater the concentration of water in a system, greater is its kinetic energy and greater is the water potential. It is measured in pascal (Pa). or mega pascal.
- If two systems are in contact, then there is movement of water from the solution with higher potential to lower water potential.
- **Solute potential**—(ψ_s)–Magnitude of lowering of water potential, when a solute is added to the water.
- **Pressure Potential**—(ψ_p)—Magnitude of increase of water potential, when pressure greater than atmospheric pressure is applied to pure water or a solution.
- Water potential of pure water is zero (0).
- Solute potential is always negative (–) and pressure potential is always positive (+).

$$\Psi_w = \Psi_s + \Psi_p$$

- **Osmotic Pressure**—External pressure applied to prevent the diffusion of water. It depends upon solute concentration.
- Numerically, osmotic pressure is equal to osmotic potential. Osmotic pressure has positive (+) sign. Osmotic potential has negative (–) sign.

Turgor Pressure—Due to osmotic entry of water, the protoplasm of a plant cell presses the cell wall towards the outside with a force, it is called Turgor Pressure.

Diffusion Pressure—The pressure exerted by the tendency of the particles to diffuse from the area of higher concentration to lower concentration. It is directly proportional to the concentration of particles of diffusing substance.

Osmosis : Osmosis is movement of solvent or water molecules from the region of their higher diffusion pressure or free energy to the region of their lower diffusion pressure of free energy across a semipermeable membrane.

Water molecules move from higher water potential to lower water potential until equilibrium is reached.

Plasmolysis : Process of shrinkage of protoplast in a cell due to exosmosis in hypertonic solution. If a plasmolysed cell is placed in water or a hypotonic solution it becomes turgid.

Hypotonic solution : The external solution which is more dilute than the cytoplasm.

Hypertonic solution : The external solution, which is more concentrated than the cytoplasm.

Isotonic solution : When the external solution balances the osmotic pressure of the cytoplasm.

Casparian strip : It is the tangential as well as radial walls of endodermal cells having the deposition of water impermeable suberin.

Imbibition : Imbibition is the phenomenon of absorption of water by the solid particles of an adsorbent causing it to enormously increase in volume without forming a solution.

Some examples of Imbibition :

(i) If a dry piece of wood is placed in water, it swells and increases in its volume.
(ii) If dry gum or pieces of agar-agar are placed in water, they swell and their volume increases.
(iii) When seeds are placed in water they swell up.
(iv) Swelling of wooden door during rainy season.

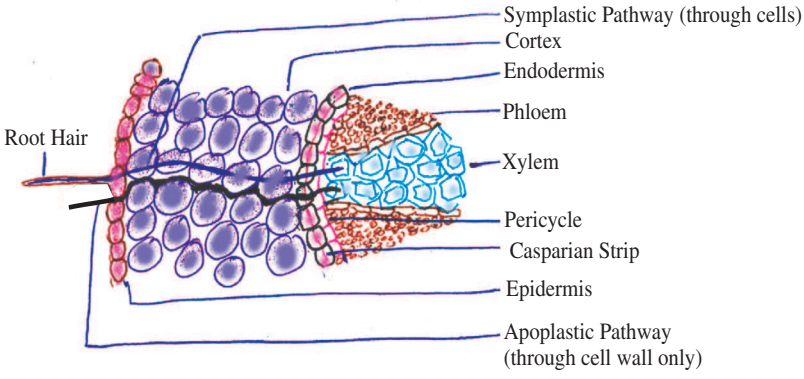
Conditions essential for imbibition

1. Water potential gradient between the surface of the adsorbent and the imbibed liquid, is essential.
2. Affinity between the adsorbent and the imbibed liquid.

Transport of water in plants : Water is absorbed by root hairs by diffusion. Then water moves upto xylem by two pathways–apoplast and symplast pathway.

Apoplast Pathway—Movement occurs through the intercellular spaces or walls of the cell, without entering the cytoplasm. This movement is fast. In roots, movement of water occurs via apoplast except at the carparian strip, most of water enters through apoplast.

Symplast Pathway—Water enters the cell through cell membrane and travels intercellularly through plasmodesmata. This movement is slow. At casparian strip region water moves through symplast.



Apoplastic And Symplastic Pathways of Water Transport

Ascent of Sap—Upward movement of water in the form of dilute solution of mineral ions from roots to the top aerial parts of plants through tracheary elements of xylem against the gravitational force is called ascent of sap. It involves two theories—

(i) **Cohesion**—Tension-transpirtation pull theory.

(ii) **Root pressure theory.**

(1) **Cohesion-Tension-transpiration pull theory**—

(i) **Continuity of water column**—The transport of water to the top of trees occurs through xylem vessels. The forces of adhesion and cohesion maintain a thin and unbroken column of water in the capillaries of xylem vessels through which it travels which is travels upward. Water is mainly pulled by transpiration from leaves.

(ii) **Transpiration Pull**—Transpiration accounts for loss of 99% of water in the form of water vapours the surface of leaves. The loss is mainly through stomata.

- Pull of water as a result of tension created by transpiration is the major diving force of water movement upward in a plant.

  Three physical properties of water which affect the ascent of xylem sap due to transpiration pull.

(iii) **Cohesion force or Tensile strength of water**—

- **Cohesion**—Mutual attraction between water molecules.
- **Adhesion**—Attraction of water molecules to polar surface.
- **Surface tension—**Attraction of water to each other in liquid phase to a greater extent than to water in gaseous phase.

(2) **Root pressure Theory :** A hydrostatic pressure existing in roots which pushes the water up in xylem vessels upto certain height to herbaceons plant.

Guttation : The water loss in its liquid phase in the form of water droplets at night and early morning through special openings of vein near the tip of leaves. These opening are called hydathodes.

Transpiration : The loss of water through stomata of leaves and other aerial parts of plants in form of water vapours.

Factors affecting transpiration : Temperature, light, relative humidity, wind speed, number and distribution of stomata, water status of plant, canopy structure.

Significance of transpiration—Advantages—Helps in ascent of sap removal of excess water, cooling effect, distribution of mineral salts, supply water for photosynthesis.

Disadvantages—May cause reduced growth, wilting (loss of turgidity), reduced yield and waste of energy.

Since there are advantages as well as disadvantages of transpiration so—'Transpiration is called a necessary evil'.

Opening and closing of stomata—Mechanism of opening and closing of stomata involves two steps—

(i) Change to the turgidity of gaurd cells.

(ii) Orientation of cellulose microfibrils in the cell wall of gaurd cells.

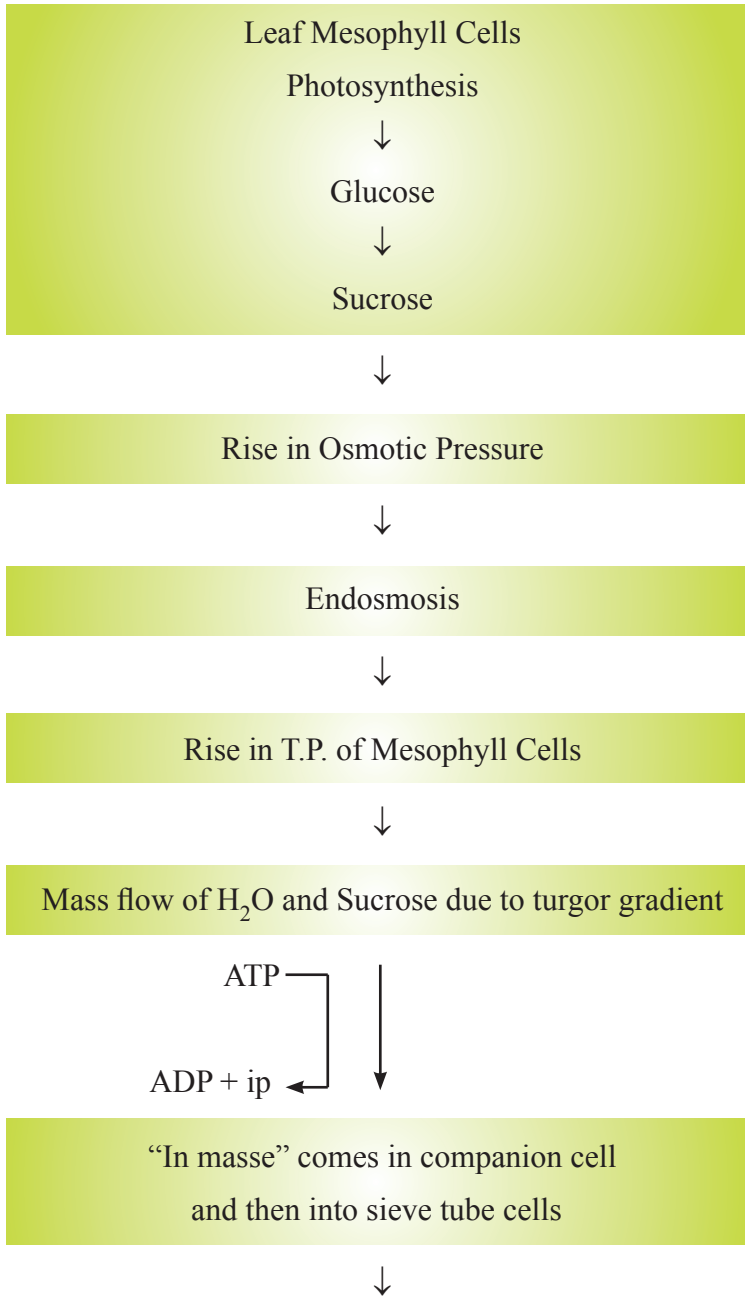
Endosmosis—When a cell is placed in water or hypotonic solution, water enters into the cell. This in called endosmosis. Due to it the volume of cell increases and it creates turgor pressure.

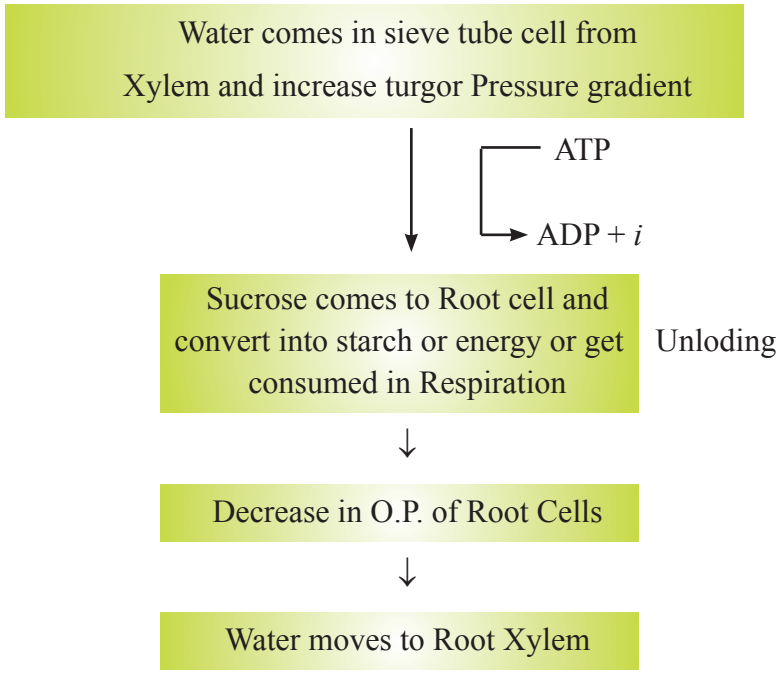
Exosmosis—When a cell is placed in hypertonic solution, water comes out of the cell, this is called exosmosis. It decreases volume of the cell.

Uptake and transport of mineral nutrients—Ions are absorbed by the roots by passive and active transport. The active uptake of ions require ATP energy. Specific proteins in membranes of root hair cells activity pump ions from the soil into the cytoplasm of epidermal cells and then xylem. The further transport of ions to all parts of the plant is carried through the water stream. Older dying leaves export much of their mineral content to younger leaves. Elements phosphorus, sulphur, nitrogen and potassium are most readily mobilised.

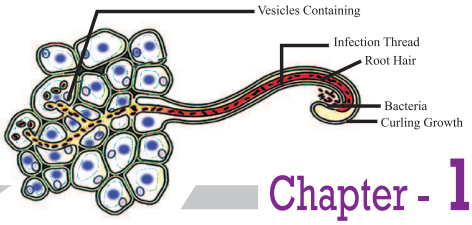
Mass flow : Mass flow is the movement of substances (water, minerals and food) in bulk from one point to another as a result of pressure differences between two points.

The pressure or mass flow Hypothesis :





Mycorrhiza—A mycorrhiza is a symbiotic association of a fungus with a root system. The fungal hyphae absorb mineral ions and water from the soil, and provide them to the roots of plant, in turn the roots provide sugars and nitrogen containing compounds to the mycorrhizae.



Chapter - 12

Mineral Nutrition

Points To Remember

Autotroph : An organism that sythesize its required nutrients from simple and inorganic substance; Example—plants, blue green algae (cyanobacteria)

Heterotroph : An organism that cannot synthesise its own nutrients and depend on others. Example—Bacteria, protists, members of animalia.

Biological nitrogen fixation: Conversion of atmospheric nitrogen into organic compounds by living organisms.

Chlorosis : Yellowing of leaves due to loss of chlorophyll.

Nitrification : Conversion of ammonia (NH_3) into nitrite and then to nitrate.

Denitrification : A process of conversion of nitrate into nitrous oxide and nitrogen gas (N_2).

Leg-hemoglobin : Pinkish pigment found in the root nodules of legumes. It acts as oxygen scavenger and protects the nitrogenase enzyme from oxidation.

Flux : The movement of ions is called flux. Influx is inward movement of ions into the cells and efflux is the outward movement of ions.

Inhibition of cell division : Deficiency of N, K, S. and Mo.

Necrosis : Death of tissues particularly leaf tissue due to deficiency of Ca, Mg, Cu, K.

Delayed Flowering : due to deficiency of N, S, Mo.

Mineral Nutrition : Plants require mineral elements for their growth and development. The utilization of various absorbed ions by a plant for growth and development is called mineral nutrition of the plant.

Hydroponics : Soil-less culture of plants, where roots are immersed in nutrient solution (without soil) is called hydroponics. The result obtained from hydroponics may be used to determine deficiency symptoms of essential elements.

Active Transport : Absorption occuring at the expense of metabolic energy.

Passive Transport : Absorption of minerals with concentration gradient by the process of diffusion without the expense of metabolic energy.

Essential Elements

Macronutnents	Micro-nutrients
Macronutrients are present in plant tissues in concentrations of more than 10 m mole Kg^{-1} of dry matter. C, H, O, N, P, K, S, Ca, Mg	Micro-nutrients are needed in very low amounts : less than 10 m mole Kg^{-1} matter. Fe, Mn, Cu, Mo, Zn, B, Cl, Ni

In addition to the 17 essential elements, Na, Si, Co and Si are required by some higher plants.

Criteria for essentiality :

1. The element must be necessary for supporting normal growth and reproduction.
2. Requirement must be specific and not replaceable by another element.
3. The element must be directly involved in the metabolism of the plant.

Role of Minerals Elements in Plants
MACRO NUTRIENTS

Element	Obtained as	Functions	Deficiency symptoms
Nitrogen (N)	Mainly as NO_3^- some as NO_2 or NH_4^+	Constituent of proteins, nucleic acids, vitamins and hormones.	Stunted growth Chlorosis, dormancy of causal buds.
Phosphorus (P)	Phosphate ions ($H_2PO_4^-$ or HPO_4^{2-}).	Constituent of cell membrane. Required for the synthesis of nucleic acids, nucleotides, ATP NAD and NADP for phosphory-lation reactions.	Poor growth of plant. Leaves dull green, delay in seed germination purple or red spots on leaves, premature leaf fall.

Potasium (K)	K^+	Helps to maintain an anion-cation balance in cells. Involved in protein synthesis, in opening and closing of stomata; activation of enzymes; maintenance of turgidity of cells.	Stunted growth; yellow leaves edges of leaves; mottled appearance of leaves. Premature death.
Calcium (Ca)	Ca^{2+}	Required in formation of mitotic spindle; involved in normal functioning of cell membranes; activates certain enzymes; as calcium pectate in middle lamella of the cell wall.	Stunted growth, chlorosis of young leaves.
Magnesium (Mg)	Mg^{2+}	Activates enzymes in phosphate metabolism, constituent of chlorophyll; maintains ribosome structure.	Chlorosis between the leaf veins narcosis purple colours spots on older leave
Sulphur (S)		Constituent of two amino-acids-Crysteine and methionine and proteins, coenzymes, vitamins and ferredoxin.	Chlorosis of younger leaves, stunted growth

MICRO NUTRIENTS

Element	Obtained as	Functions	Deficiency symptoms
Iron (Fe)	Fe^{3+}	Constituent of Ferredoxin and cytochrome; needed for synthesis of chlorophyll.	Chlorosis of leaves
Manganese (Mn)	Mn^{2+}	Activates certain enzymes involved in photosynthesis, respiration and nitrogen metabolism.	Chlorosis, grey spots on leaves.

Zinc (Zn)	Zn^{2+}	Activates various enzymes like carboxylases. Required for synthesis of auxins.	Malformation of leaves
Copper (Cu)	Cu^{2+}	Activates certain enzymes. Essential for overall metabolism	Stunted growth, inter-veinal chlorosis in leaves. Necrosis of the tip of young leaves, die back of shoot.
Boron (B)	BO_3^{3-}, $B_4O_7^{2-}$	Required for uptake of water and Ca, for membrane functioning, pollen germination, cell elongation carbohydrate translocation.	Death of stem and root apex, loss of a foical dominance, abscission of flowers, small size of fruits
Molybdenum (Mo)	MoO_2^{2+} (molybdate ions)	Activates certain metabolism.	Nitrogen deficiency inter-veinal chlorosis retardation of growth
Chlorine (Cl)	Cl^-	Maintains solute concentration along with Na+ & K+; maintain anion-cation balance in cells; essential for oxygen evolution in photosynthesis.	Wilted leaves; stunted root growth and reduced fruiting.

Critical Concentration : The concentration of the essential element below which plant growth is retarted. The element is said to be deficient when present below the critical concentration.

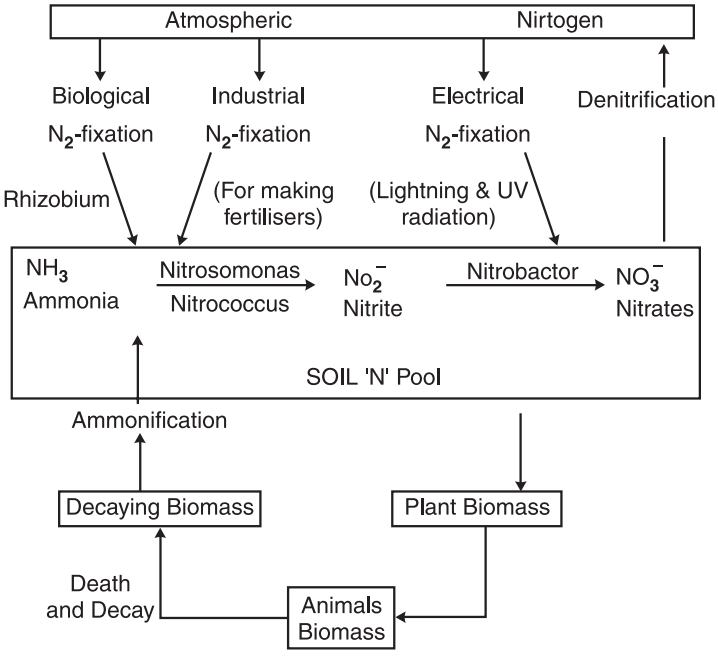
Deficiency symptoms : Chlorosis, stunted growth, premature fall of leaves and buds and inhibition of cell division.

Toxicity of micronutrient : Any mineral ion concentration in tissues that reduces the dry weight of tissues by 10% is considered toxic. Toxicity of one element may lead to deficiency of other element since the former may inhibit the uptake of latter., e.g., Mn competes with Fe, Mg for uptake and also inhibits Ca translocation to shoot apex. Therefore Mn toxicity symptoms are actually same as deficiency symptoms of Fe, Mg and Ca.

Role of microbes in nitrogen cycle :

- *Rhizobium, Azotobacter, Rhodospirillum;* Fix atmospheric nitrogen
- *Nitrosomonas and/or Nitrococcus* :—Conversion of ammonia to nitrite
- *Nitrobacter :* Conversion of nitrite into nitrate.
- *Pseudomonas* and *Thiobacillus* : reduce nitrate into nitrogen.

Nitrogen Cycle:



Nitrogen Cycle

Nitrogen fixation—The process of conversion of Nitrogen (N_2) into ammonia (NH_3).

Ammonification—The process of decomposition of organic nitrogen of plants and animals (proteins) into ammonia.

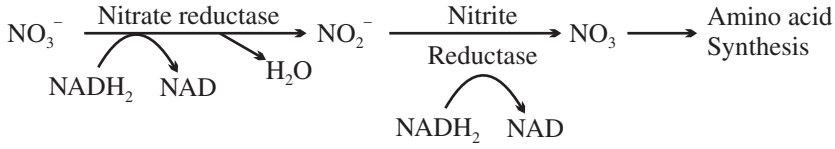
$$\text{Protien in Dead Plants and Animals} \xrightarrow[\text{Bacteria}]{\text{Ammonifying}} NH_3$$

Nitrification—The ammonia so formed may volatilise and re-enter the atmosphere, or some of the ammonia may be converted first into nitrite and then into nitrate by soil bacteria

$$2NH_3 + 3O_2 \xrightarrow{\text{Nitrosomonas}} 2NO_2^- + 2H_2O + 2H^+$$

$$2NO_2^- + O_2 \xrightarrow{\text{Nitrobactor}} 2NO_3^-$$

The Nitrate so formed can be easily absorbed by the plants and transported to leaves. In leaves, nitrate is reduced to ammonia to form amino-acids, because nitrate can not used by plants as such.



Denitrification—Process of reduction of the nitrate present in soil to nitrogen. It is carried out by bacteria like *Pseudomonas* and *Thiobacillus*.

Biological Nitrogen Fixation—Reduction of nitrogen to ammonia by living organisms. Certain prokaryotes are able to fix nitrogen because of presence of 'nitrogenase' enzyme in them.

Nitrogen fixing microbes may be

(a) Free living—(i) Aerobic—*Azotobacter*
(ii) Anaerobic—*Rhodospirillum*
(b) Cyanobacteria—*Nostoc, Anabaena*
(c) Symbiotic—(i) With leguminous plants—*Rhizobium*
(ii) With non-leguminous plants—*Frankia*

Enzyme nitrogenase—The enzyme nitrogenase is Mo-Fe protein and catalysis the conversion of atmospheric nitrogen to ammonia (First stable product of nitrogen fixation)

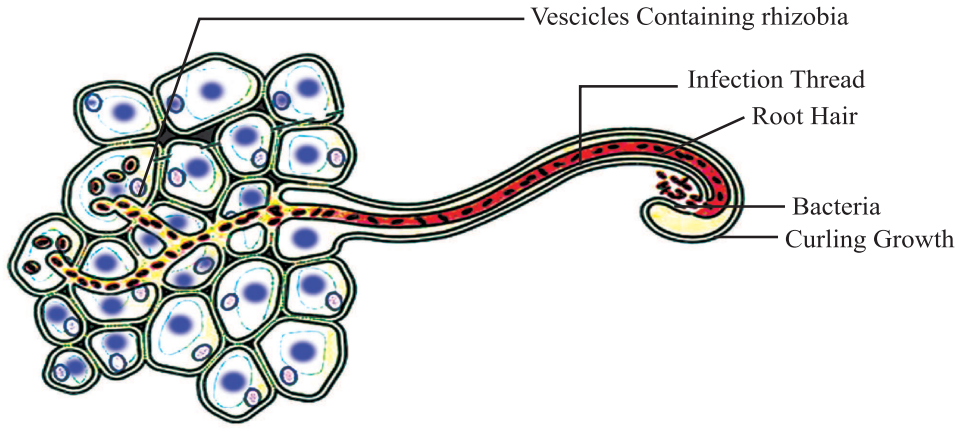
Leg-hemoglobin—A pink colour pigment, similar to hemoglobin of vertebrates and functions as an oxygen scavenger and protects nitrogenase from oxygen.

$$N_2 + 8e^+ + 8H^+ \ 16ATP \ \text{dinitrogenase} \ 2NH_3 + H_2 + 16\ ADP + 16\ Pi$$
$$\longrightarrow$$

Steps of nodule formation :

(a) *Rhizobium* bacteria present in soil contact a susceptible root hair.
(b) Infection of the root hair cause it to curve and deformed due to chemical secretion.
(c) An infection thread is produced carrying the bacteria into the cortex of the root.
(d) The bacteria get modified into rod-shaped bacteria and cause inner cortical and pericycle cells to divide plant produce cytokinin and auxin to stimulate cell division and enlarge to form nodules.

(e) Division and growth of cortical and pericycle cells lead to nodule formation.



Nodule Formation in Roots of Leguminous Plants

(Refer Figure 12.4 page 203 NCERT Text Book)

Mechanisms of N_2 fixation

It require 3 components—

(a) A strong reducing agent like $FADH_2$, $NADPH_2$

(b) Nitrogenase enzyme

(c) ATP (as energy service)

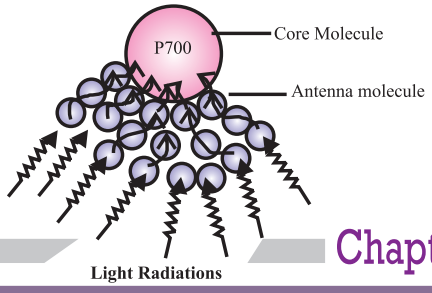
Steps

(a) Formation of Diamide

(b) Formation of Hydrazine (N_2H_4)

(c) Formation of Ammonia,

See Fig. 12.5 Page 203 NCERT



Chapter - 13

Photosynthesis in Higher Plants

Points To Remember

Photosynthesis : Photosynthesis is an enzyme regulated anabolic process of manufacture of organic compounds inside the chlorophyll containing cells from carbon dioxide and water with the help of sunlight as a source of energy.

$$6CO_2 + 12H_2O \xrightarrow[\text{Chlorophyll + enzymes}]{\text{Sun Light}} C_6H_{12}O_6 + 6H_2O + 6O_2 \uparrow$$

Historical Perspective

Josheph Priestley (1770) : Showed that plants have the ability to take up CO_2 from atmosphere and release O_2. (Candle with bell jar and mouse expt.)

Jan Ingenhousz (1779) : Release of O_2 by plants was possible only in sunlight and only by the green parts of plants. (Expt. with aquatic plant in light & dark)

Theodore de Saussure (1804) : Water is an essential requirement for photosynthesis to occur.

Julius Von Sachs (1854) : Green parts in plant produce glucose which is stored as starch.

T.W. Engelmann (1888) : The effect of different wavelength of light on photosynthesis and plotted the first action spectrum of photosynthesis.

C.B. Van Niel (1931) : Photosynthesis is essentially a light dependent reaction in which hydrogen from an oxidisable compound reduces CO_2 to form sugar. He gave a simplified chemical equation of photosynthesis.

$$2H_2A + CO_2 \xrightarrow{\text{Sun Light}} 2A + CH_2O + H_2O$$

Hill (1937) : Evolution of oxygen occurs in light reaction.

Calvin (1954-55) : Traced the pathway of carbon fixation.

Site for photosynthesis : Photosynthesis takes place only in green parts of the plant, mostly in leaves. Within a leaf, photosynthesis occurs in mesophyll cells which contain the chloroplasts. Chloroplasts are the actual sites for photosynthesis. The thylakoids in chloroplast contain most of pigments required for capturing solar energy to initiate photosynthesis : The membrane system (grana) is responsible for trapping the light energy and for the synthesis of ATP and NADPH. Biosynthetic phase (dark reaction) is carried in stroma.

(Refer figure 13.2, Page 209, NCERT Text Book of Biology, Class XI)

Importance of Photosynthesis—(1) Synthesis of organic compounds (2) Change of radiant energy into chemical energy (3) Useful products are obtained from plants gums, oils timber fire wood, resins rubber, fibers and drugs, etc. (4) Balance the percentage of O_2 and CO_2 in atmosphere (5) Fossil fuels like coal, natural gas and petroleum have been formed inside the earth indirectly as a product of photosynthesis.

Pigments involved in photosynthesis :

Chlorophyll a : (Bright or blue green in chromatograph). Major pigment, act as reaction centre, involved in trapping and converting light into chemical energy. It is called universal photo-synthetic pigment.

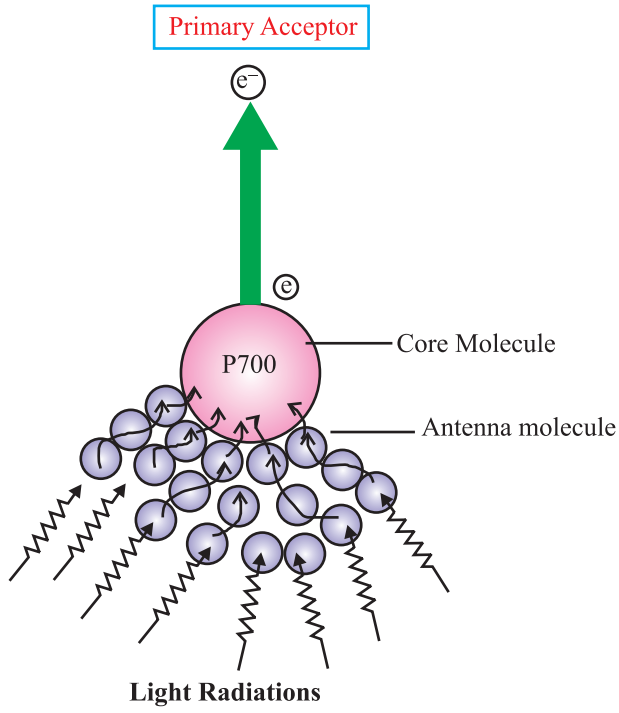
Chlorophyll b : (Yellow green)

Xahthophylls : (Yellow)

Carotenoids : (Yellow to yellow-orange)

- In the blue and red regions of spectrum shows higher rate of photosynthesis.

Light Harvesting Complexes (LHC) : The light harvesting complexes are made up of hundreds of pigment molecules bound to protein 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 light harvesting system (antennae). The reaction centre (chlorophyll a) is different in both the photosystems. (Refer fig. 13.4, Page 211, NCERT-Biology).



Light Harvesting Complex

Photosystem I (PS-I) : Chlorophyll 'a' has an absorption peak at 700 nm (P700).

Photosystem II (PS-II) : Chlorophyll 'a' has absorption peak at 680 nm (P680),

Process of photosynthesis : It includes two phases-Photochemical phase and biosynthetic phase. (Formerly known as Light reaction and dark reaction)

(i) **Photochemical phase (Light reaction) :** This phase includes-light absorption, splitting of water, oxygen release and formation of ATP and NADPH. It occurs in grana region of chloroplast.

(ii) **Biosynthetic phase (Dark reaction) :** It is light independent phase, synthesis of food material (sugars). (Calvin cycle). It occurs in stroma region of chloroplast.

Photophosphorylation : The process of formation of high-energy chemicals (ATP and NADPH) in presence of light.

Non-Cyclic photophosphorylation : Two photosystems work in series–First PSII and then PSI. These two photosystems are connected through an electron transport chain (Z. Scheme). Both ATP and NADPH + H^+ are synthesised by this process. PSI and PSII are found in lamellae of grana, hence this process is carried here. (Fig. 13.6) Page 213, NCERT-BIOLOGY. Class-XI.

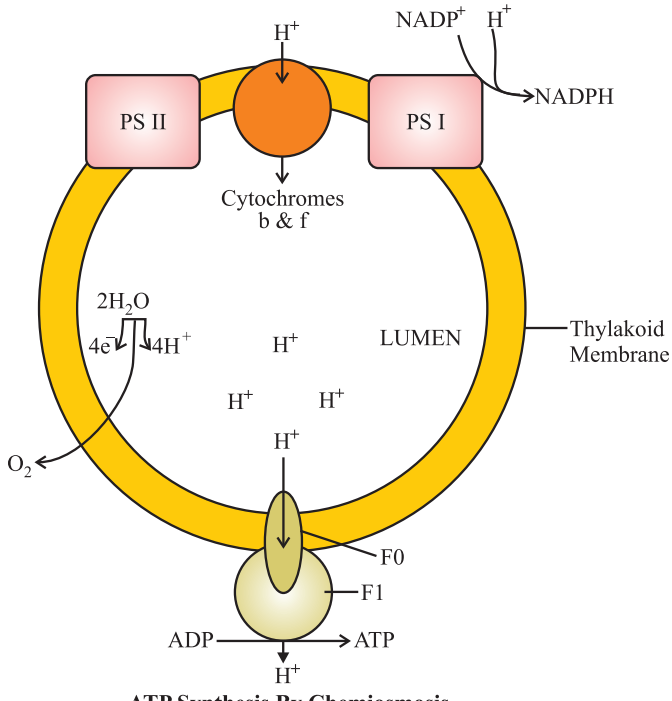
Cyclic photophosphorylation : Only PS-I works, the electron circulates within the photosystem. It happens in the stroma lamellae (possible location) because in this region PSII and NADP reductase enzyme are absent. Hence only ATP molecules are synthesised. It occurs when only light of wavelengths beyond 680 nm are available for excitation.

The electron transport (Z-Scheme) : In PS II, reaction centre (chlorophyll a) absorbs 680 nm wavelength of red light which make the electrons to become excited. These electrons are taken up by the electron acceptor that passes them to an electron transport system (ETS) consisting of cytochromes. The movement of electron is down hill. Then, the electron pass to PS I and move down hill further. (Fig. 13.5) Page 212, NCERT-BIOLOGY-Class XI

The splitting of water : It is linked to PS II. Water splits into H^+, [O] and electrons.

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

Chemiosmotic Hypothesis : Chemiosmotic hypothesis explain the mechanism of ATP synthesis in chloroplast. In photosynthesis, ATP synthesis is linked to development of a proton gradient across a membrane. The protons are accumulated inside of membrane of thylakoids (in lumen). ATPase enzyme has a channel of that allow diffusion of protons back across the membrane. This release energy to activate ATPase enzyme that catalyses the formation of ATP. (Fig. 13.7). Page 214



ATP Synthesis By Chemiosmosis

Biosynthesis phase in C_3 plants :

ATP and NADPH, the products of light reaction are used in synthesis of food. The first CO_2 fixation product in C_3 plant is 3-phosphoglyceric acid or PGA. The CO_2 acceptor molecule is RuBP (ribulose bisphosphate). The cyclic path of sugar formation is called Calvin cycle on the name of Melvin Calvin, the discover of this pathway. **Calvin cycle** proceeds in three stages.

(1) Carboxylation : CO_2 combines with ribulose 1, 5 bisphosphate to form 3 PGA in the presence of RuBisCo enzyme (present in stroma)

(2) Reduction : Carbohydrate is formed at the expense of ATP and NADPH.

It involves 2ATP for phsophorylation and $2NADH_2$ for reduction per CO_2 molecule fixed.

(3) Regeneration : The CO_2 acceptor ribulose 1, 5-bisphosphate is formed again.

6 turns of Calvin cycles and 18 ATP molecules are required to synthesize one molecule of glucose. (Fig. 13.8)

$6CO_2$ + 6 RuBP + 18ATP + 12NADPH$\rightarrow C_6H_{12}O_6$ + 6RuBP + 18ADP + 18Pi + 12NADP

Input		**Output**
$6CO_2$	—	One Glucose
18 ATP	—	18 ADP
18NADPH	—	12 NADP

The C4 pathway : C_4 plants such as maize, sorghum, sugarcane have special type, of leaf anatomy, they tolerate higher temperatures. In this pathway, oxaloacetic acid (OAA) is the first stable product formed. It is 4 carbon atoms compound, hence called C_4 pathway (Hatch and Slack Cycle). The leaf has two types of cells : mesophyll cells and Bundle sheath cells (Kranz anatomy). Initially CO_2 is' taken up by phosphoenol pyruvate (PEP) in mesophyll cell and changed to oxaloacetic acid (OAA) in the presence of PEP carboxylase. Oxaloacetate is reduced to maltate/asparate that reach into bundle sheath cells.

The decarboxylation of maltate/asparate occurs with the release of CO_2 and formation of pyruvate (3C). In high CO_2 concentration RuBisCO carboxylase and not as oxygenase, hence the photosynthetic losses are prevented. RuBP operates now under Calvin cycle and pyruvate transported back to mesophyll cells and changed into phosphoenol pyruvate (PEP) to keep the cycle continue. (Fig., 13.9) Page 219, NCERT BIOLOGY.

$$6CO_2 + 6PEP + 6RuBP + 30ATP + 12NADPH + 12H^+ \text{ Enzymes}$$
$$C_6H_{12}O_6 + 6PEP + 6RuBP + 30ADP + 12NADP^+ + 3OH_3PO_4$$

Photorespiration : The light induced respiration in green plants is called photorespiration. In C_3 plants some O_2 binds with RuBisCO and hence CO_2 fixation is decreased. In this process RuBP instead of being converted to 2 molecules of PGA binds with O_2 to form one molecule of PGA and phosphoglycerate.

$$RuBP + O_2 \xrightarrow{RuBP} PGA + \text{Phosphoglycolate}$$

There is neither synthesis of ATP nor $NADPH_2$ or sugar. There is 25% loss of fixed CO_2 so it is wasteful process.

C_4 Plants :

(1) Lack Photorespiration
(2) Show response to high light intensities
(3) Have greater productivity of biomass.

Adaptations in C_4 Plants :

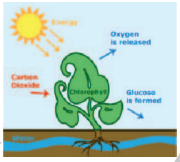
(i) Kranz Anatomy
(ii) Occurrence of two types of cells
(iii) Dimorphic chloroplast
(iv) Presence of RuBisCO in Bundle Sheath cells and PEPase in mesophyll cells.
(v) Mechanism to increase CO_2 concentration near RuBisCO in Bundle Sheath cells.

CAM (Crassulacean Acid Metabolism) Plants—Stomata open at night. *e.g.,* Cacti, Bryophyllum, Pineapple.

Law of Limiting Factors : 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 the factor which directly affects the process if its quantity is changed Factors affecting photosynthesis :

1. **Light :** Rate of photo-synthesis increases at low light intensities. At high intensities of light beyond a point the rate of CO_2 fixation decreases. Longer hours of light duration favour more photosynthesis rate.
2. **Carbon dioxide :** Increase in CO_2 concentration causes increases in CO_2 fixation. It is the major limiting factor for photosynthesis.
3. **Temperature :** The rate of photosynthesis at optimum temperature is, high. It is 20°C-25°C For C_3 plants and 30-45°C for C_4 plants.

4. **Water :** Water is one of the reactant in photosynthesis, but it effects the rate of CO_2 fixation. Low water content causes the stomata to close and reduces the CO_2 availability.



Chapter - 14

Respiration in Plants

Points To Remember

Aerobic respiration : Complete oxidation of organic food in presence of oxygen thereby producing CO_2, water and energy.

Anaerobic respiration : Incomplete breakdown of organic food to liberate energy in the absence of oxygen.

ATP Synthetase : An enzyme complex that catalysis synthesis of ATP during oxidative phosphorylation.

Biological oxidation : Oxidation in a series of reaction inside a cell.

Cytochromes : A group of iron containing compounds of electron transport system present in inner wall of mitochondria.

Dehydrogenase : Enzyme that catalyses removal of H atom from the substrate.

Electron acceptor : Organic compound which receive electrons produced during oxidation-reduction reactions.

Electron transport : Movement of electron from substrate to oxygen through respiratory chain during respiration.

Fermentation : Breakdown of organic substance that takes place in certain microbe like yeast under anaerobic condition with the production of CO_2 and ethanol.

Glycolysis : Enzymatic breakdown of glucose into pyruvic acid that occurs in the cytoplasm.

Oxidative phosphorylation : Process of formation of ATP from ADP and Pi using the energy from proton gradient.

Respriation : Biochemical oxidation food to release energy.

Respiratory Quotient : The ratio of the volume of CO_2 produced to the volume of oxygen consumed.

Proton gradient : Difference in proton concentration across the tissue membrane.

Mitochondrial matrix : The ground material of mitochondria in which pyruvic acid undergoes aerobic oxidation through Kreb's cycle.

Electron Transport Chains (ETC)—A series of co-enzymes and electron/ carriers where electrons can pass along increasing redox potential losing a bit of energy at every step of transfer.

Abbreviations

ATP	—	Adenosine tri phosphate
ADP	—	Adenosne di phosphate
NAD	—	Nicotinamide Adenine dinucleotide
NADP	—	Nicotinamide Adenine dinucleotide Phosphate
NADH	—	Reduced Nicotinamide Adenine dinucleotide
PGA	—	Phosphoglyceric acid
PGAL	—	Phospho glyceraldehyde
FAD	—	Flavin adenine dinucleotide
ETS	—	Electron transport system
ETC	—	Electron transport chain
TCA	—	Tricarboxylic acid
OAA	—	Oxalo acetic acid
FMN	—	Flavin mono nucleotide
PPP	—	Pentose phosphate pathway

Cellular Respiration—The process of oxidation/breakdown of food materials within the cell to release energy. Respiratory substarate to be oxidized during respiration is usually glucose, but these can also be proteins, fats or organic acids. In plants, respiratory gaseous exchange occurs through stomata and lenticels :

Overall cellular respiration is :

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + \text{Energy (36ATPs)}$$

Aerobic Respiration

Overall mechanism of aerobic respiration can be studied under the following steps :

(A) Glycolysis (EMP pathway) in cytoplasm

(B) Oxidative Decarboxylation—(Gateway Reaction)—in Mitochondrial matrix

(C) Kreb's cycle (TCA—cycle)—Matrix of mitochondria

(D) Oxidative phosphorylation

A. Glycolysis : The term has origianted from the Greek word, *glycos* = glucose, *lysis* = splitting, or breakdown means breakdown of glucose molecule to pyruvic acid. It was given by Embden Meyerhof and Parnas. It is a chainof 10 reactions to convert glucose into pyruvate. It is common for acerobic and anaerdomic respiration.

Steps for Glycolysis—(EMP Pathway)

1. Phosphorylation of Glucose into Glucose-6-phosphate
2. Isomerisation of Glucose-6-Phosphate into fractose-6-phosphate
3. Second phosphorylation in which Fructose-6-phosphate changes into Fructose-1, 6-biphosphate
4. Splitting of Fructiose-1, 6-biphosphate into DiHAP and PGAL
5. Isomerisation of DiHAP into PGAL
6. Oxidation of PGAL into 1, 3-biphosphosphoglycerate
7. Synthesis of ATP and converssion of 1, 3-biphosphoglycerate into 3-phospholycerate
8. Isomerisation of 3-phosphoglycerate into 2-phospholycerate
9. Dehydration of 2-phosphoglycerate into PEP
10. Substrate level ATP synthesis and formation of Pyruvic Acid.

- It is also called Embden—Meyerhof—Paranas pathway. (EMP pathway)
- It is common in both aerobic and anaerobic respiration.
- It takes palce outside the mitochondria, in the cytoplasm.
- One molecule of glucose (Hexose sugar) ultimately produces two molecules of pyruvic acid through glycolysis.'
- During this process 4 molecules of ATP are produced while 2 molecules ATP are utilised. Thus net gain of ATP is of 2 molecules.

Input and Output of glycolysis

S. No.	Input	Output
1.	Glucose (6—C) —1 molecule	Pyruvate (3—C) 2 molecules
2.	2 ATP	2 ADP
3.	4 ADP + 2 Pi	4 ADP + $2H_2O$
4.	2 NAD^+	2 NADH (H^+)

Net out put ..... 2 Pyruvate + 2ATP + 2NADH (+ H^+) OR 2 Pyruvate + 8 ATP

The pyruvate, so produced, may under go (i) Lactic acid fermentation, Alcoholic fermentation of Aerobic Respiration (Krebs Cycle)

B. Oxidative decarboxylation : Pyruvic acid is converted into Acetyle CoA in presence of pyruvate dehydrogenase complex.

$$\text{Pyruvic acid} + \text{CoA} + \text{NAD} + \xrightarrow[\text{pyruvate dehydrogenase}]{Mg^{2+}} \text{Acetyle CoA} + CO_2 + \text{NADH} + H+$$

The Acetyle CoA enters in TCA cycle.

C. Tri Carboxylic Acid Cycle (Kereb's cycle) or Citric acid Cycle : This cycle starts with condensation of acetyle group with oxaloacitic acid and water t o yield citric acid which under goes a series of reactions.

- It is aerobic and takes a place in mitochondrial matrix.
- Each pyruvic acid molecule produces 4 NADH + H^+, one $FADH_2$, one ATP.
- One glucose molecule has been broken down t o release CO_2 and eight molecules of NADH + H^+, two molecules of $FADH_2$ and 2 molecules of ATP.

Compensation Point : It is the value of a factor at which the rate of photosynthesis controlled by it is just equal to the rate of respiration and photorespiration so that there is not net exchcange of gases between the phtosynthetic organ and the environment.

At compensation point the photosynthetic tissue manufacture only such amount of food which of sufficient for it to remain alive. No food is supplied to rest of the plant. Therefore, net photosynthesis is zero.

(D) Oxidative Phosphorylation

The synthesis of ATP from ADP and inorganic phosphate using energy from proton gradient is called oxidative phosphorylation. This takes place in elementry particles present on the inner membrane of cristae of mitochondria. This process in mitochondria is catalysed by ATP synthestase (complex V). This compmlex has two major components F_0 and and F_1, F_0 acts a channel for proton and F_1 acts as an ATP synthetase.

Electron Transport System and Oxidative Phosphorylation

Name of Complex	Components of ETS
Complex I	FMN and Fe-S are prosthetic groups and NADH dehydrogenase
Complex II	$FADH_2$ dehydrogenase (succinate dehydrogenase), Fe-S, UQ
Complex III	Cytochrome bc, complex–cytochrome b, cytochrome C, Fe-S, UQ
Complex IV	Cytochrome Coxidase–Cytochrome a_1, cytochrome a_3 which posses two copper centres.
Complex V	F_0–F_1 particles Flow of protein through F_0 channel induces F_1 partcile to function as ATP synthatase.

Respiratory Balance Sheet :

$$glucose + 6O_2 + 36ADP + 36Pi \rightarrow 6CO_2 + 6H_2O + 36\ ATP$$

Total ATP Production

	Process	Total ATP produced
1.	Glycolysis	$2ATP + 2NADH_2\ (6ATP) = 8ATP$
2.	Oxidative decarboxylation	$2NADH_2\ (6ATP) = 6ATP$
3.	Kreb's Cycle	$2GTP\ (2ATP) + 6NADH_2\ (18ATP) + 2FADH_2\ (4ATP) = 24\ ATP$

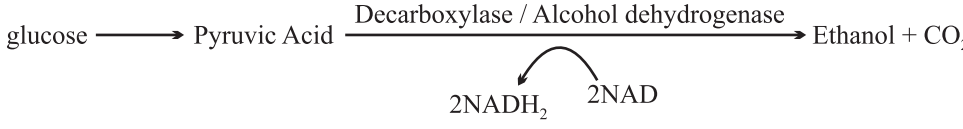
Energy production in prokaryotes during aerobic respiration = 38 ATP

Energy poroduction in eukaryotes during aerobic respiration = 38 –2 = 36 ATP

In eukaryotes 2 ATP are used in transporting 2 molucules of $NADH + H^+$ formed in glycolysis from cytoplasm to mitochandria for oxidation through ETS shuttle.

(2) **Anaerobic Respiration**—In anaerobic respiration, Glycolysis is followed by formation of ethanol or lactic acid in the cytoplasm.

Fermentation : It is the process of anaerobic respiration which occurs in yeast and some bacteria. Fermentation involves incomplete oxidation of food into enthanol and carbon-dio-oxide. It results in the production of 2 ATP molcules.



(i) Conversion of Acetyl CoA into fatty acid and PGA.

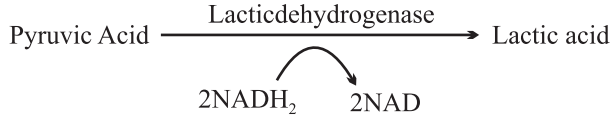
(ii) Synthesis of chlorophyll and cytochromes from Succinyl CoA

(iii) Synthesis of Amino acids from OAA and α-ketoglutaric acid

(iv) Synthesis of Alkaloid from OAA.

Enzymes involved-Pyruvic acid decarboxylase, Alcohol dehydrogenase

Anaerobic respiration in muslces : During vigrous exercise a person feels pain and fatigue in his muscles. This is due to accumulation of lactic acid in muscles. When oxygen is inadequate pyruvic acid is reduced to lactic acid in presence of enzyne-lactic dehydrogenase.



During rest lactic acid is reconverted to pyruvic acid.

Amphibolic Pathway :

During the process of cellular respiration Carbohydrates, fats and protiens are broken down to release energy and hence respiration is a catabolic process/ catabolic pathway. From this pathway many compound are withdrawn for synthesis of substrates. Some anabolic processes are formation of pyruvic acid from amino acids, and formation of Acetyl CoA from Fatty acid. So—Respiratory pathway is involved in both catabolism and anabolism, it is better to consider the respiratory pathway as an amphibalic pathway.

RQ (Respiratory quotient)

(a) RQ = 1 (When carbohydrate is used as substrate)

$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6\ H_2O$ + Energy

(b) RQ is less than 1 (*i.e.,* < 1) for fats.

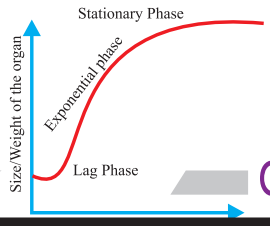
$2C_{51}H_{98}O_6 + 145O_2 \rightarrow 102CO_2 + 98\ H_2O$ + Energy

$$\text{R.Q.} \Rightarrow \frac{102\ CO_2}{145\ O_2} = 0.7$$

(c) RQ is 0.9 for proteins.

(d) RQ is more than 1 (*i.e.,* > 1) for organic acids.

(e) RQ is inifinite in case of anerobic respiration, because CO_2 is evolved but O_2 is not consumed.



Chapter - 15

Plant Growth and Development

Points To Remember

Seed Germination : The seed germinates only when favourable conditions for growth exists in the environment. In absence of favourable conditions it goes into a period of suspended growth or rest, called dormancy.

Abscission : Shedding of plant organs like leaves, flowers and fruits etc. from the mature plant.

Apical dominance : Suppression of the growth of lateral buds in presence of apical bud.

Dormancy : A period of suspended activity and growth usually associated with low metabolic rate. Some, seeds undergo a period of dormancy and can germinate only after dormancy period gets over.

Phytochrome : A pigment, found in plants which control the light dependent developmental process.

Phytohormone : Chemicals' secreted by plants in minute quantities which influence the physiological activities.

Sensecene : The last phase of growth when metabolic activities decrease.

Vernalisation : A method of promoting flowering by exposing the young plant to low temperature.

Growth : An irreversible permanent increase in size, volume and weight of an organ or its parts or even of an individual.

Quiescence : Non germination of a viable seed due to non-availability of proper environmental conditions.

Vivipary : It is the germination of seed while it is still attached to the parent plant and is nourished by it. *e.g., Rhizophora* and *Sonneratia*. As the germinating seed forms a seedling. It all down into the mud due to increase in weights. In the mud, lateral roots develops for anchorage.

Heterophylly : Occurrence of more than one type of leaves in plants *e.g.,* larkspur, Coriander leaves of Juvenile plant are different in shape from mature plant.

Bolting : Elongation of internodes prior to flowering in plants like Cabbage.

Photoperiodism : Response of Plants to relative periods of day/night to induce flowering.

According to duration of exposure of plants to light, plants are divided in 3 categories :

1. **Long Day Plants (LDP)**—Plants which need exposure to light for period exceeding critical duration *e.g.,* wheat, rice, cucumber.
2. **Short Day Plants (SDP)**—Plants that need exposure to light for period less than the critical length *e.g.,* Cabbage.
3. **Day Neutral Plants (DNP)**—There is no correlation between exposure to light duration & induction of flowering *e.g.,* Tomato.

Abbreviations

IAA	Indole acetic acid
NAA	Napththalene acetic acid
ABA	Abscisic acid
IBA	Indole-3 butyric acid
2.4D	2.4 dichlorophenoxy acetic acid
PGR	Plant growth regulator

Seed Dormancy	Quiescence
It is the condition of seed when it is unable to germinate in spite of the availability of all environmental conditions suitable for germination.	The condition of a seed when it is unable to germinate because the conditions for germination are not available.

Measurement of growth : Plant growth can be measured by a variety of ft parameters like increase in fresh weight, dry weight, length, area, volume and cell number.

Phases of growth : The period of growth is generally divided into three phases, namely, meristematic, elongation and maturation.

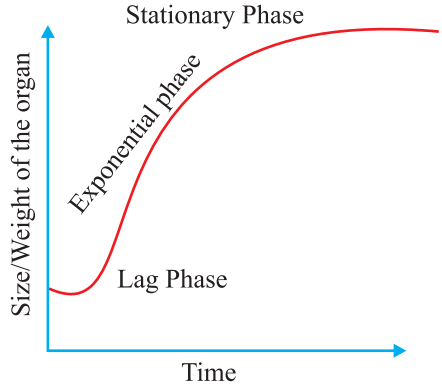
(i) Meristematic zone : New cell produced by mitotic division at root-tip and shoot-tip thereby show increase in size. Cells are rich in protoplasm and nuclei.

(ii) Elongation zone : Zone of elongation lies just behind the meristematic zone and concerned with enlargement of cells.

(iii) Maturation zone : The portion lies proximal to the phase of elongation. The cells of this zone attain their maximum size in terms of wall thickning and protoplasmic modification.

Growth rate : The increased growth per unit time is termed as growth rate. The growth rate shows an increase that may be arithmetic or geometrical.

Growth	Mathematical expression	Curve
In Arithmetic growth : Only one daughter cell continues to divide mitotically while other differentiate and matures.	$L_1 = L_0 + rt$ L_1 = Length at time t L_0 = Length at time zero r = growth rate	Linear curve



Sigmoid Growth Curve

Geometrical growth	Formula	Shape of curve
The initial growth is slow (lag phase) and increase rapidly there-after at an exponential rate (log phase) In both, the progeny cells divide mitotically and continue to do so. However, with limited nutrient supply, the growth slow down leading to stationary phase.	$W_1 = W_0 e^{rt}$ W_0 = Initial size W_1 = Final Size r = growth rate t = time of growth e = base of natural logarithms	Sigmoid or S-curve

Sigmoid growth curve

Lag phase—Growth is slow in initial stage.

Log phase : Period of maximum growth

Stationary phase—When the nutrients become limiting, growth slows down.

Relative Growth : The growth per unit time as percentage of initial size

$$\text{RGR} = \frac{\text{Growth per unit time}}{\text{Initial size}} \times 100$$

Differentiation : A biochemical or morphological change in meristemic cell (at root apex and shoot apex) to differentiate into permanent cell is called differentiation.

Dedifferentiation : The phenomenon of regeneration of permanent tissue to become meristematic is called dedifferentiation.

Redifferentiation : Meristems/tissue are able to produces new cells that once again lose the capacity to divide but nature to perform specific functions.

Conditions or factors influencing Growth

1. Nutrition 2. Availability of water 3. Temperature 4. Oxygen 5. Light 6. Gravity 7. Stress factors like minerals, water or temperature etc.

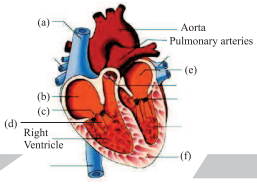
Phytohormone or Plant Growth-Regulator

Growth promoting hormones : These are involved in growth promoting activities such as cell division, cell enlargement, flowering, fruiting and seed formation. *e.g.,* Auxin, gibberellins, cytokinis.

Growth inhibitor : Involved in growth inhibiting activities such as dormancy and abscission. *e.g.,* Abscisic acid and Ethylene.

Hormones	Functions
1. Auxins (Growth Promoters) e.g.Indole 3-Acetic Acid [2, 4-D and 2, 4, 5,-T etc.]	1. Apical dominance, cell elongation, Promote flowering prevent premature leaf and fruit falling, initiate rooting in stem cutting, as weedicide, induce parthenocarpy.
2. Gibberellins (Growth Promoters) eg. [$GA_3 (C_{19}H_{22}O_6$, GA_4, GA_7, GA_{19} and GA_{20} etc.]	2. Delay senescence, speed up malting process, increase in length of axis (grape stalk), increase in length of stem (sugarcane), bolting in beet, cabbages and many plants with rosette habit.

3. Cytokinins (Growth Promoters) *e.g.* [Zeatin (trans 6-purine DMAA-Dimethylalyl adenine and Isopentyl adenine (IP) etc.]	3. Promote cell division, induce cell enlargement, reduce apical dominance, induce growth in auxiliary bud, chlorophyll preservation, lateral shoot growth, adventitious root formation.
4. [Ethylene ($H_2C = CH$) A goreous PGR which acts as Growth Promoters as well growth inhibitor (mainly as growth inhibitor)	4. Promotes senescence and abscission of leaf and fruits, promotes ripening of fruits, break seed and bud domancy, initiate germination in peanut, sprouting of potato tuber, promotes root growth and root hair formation.
5. Abscisic acid (ABA) eg. (Abscisin II Dormin)	5. Inhibit seed germination, stimulate closer of stomata, increase tolerance to various stress, induce dormancy in seed and bud, promotes ageing of leaf (senescence). Can delay the ripening of stored fruits as it absorbs the ethylene.



Chapter - 18

Body Fluids and Circulation

Points To Remember

Blood : A special connective tissue that circulates in principal vascular system of man and other vertebrates consisting of fluid matrix, plasma and formed elements (Blood = Plasma + All blood cells).

Plasma : (Blood – All blood cells = Plasma) The liquid part of blood which is straw coloured, viscous fluid and contains about 90-92% of water and 6-8% proteins.

Lymph : A clear yellowish, slightly alkaline, coagulable tissue fluid, containing white blood cells (Only lymphocytes), a liquid resembling blood plasma.

Serum : Blood plasma from which fibrinogen and other clotting factors have been removed. (Plasma– (fibrinogen & other clotting factor) = blood serum.

Heart Beat : The rhythmic contraction and relaxation of the heart, which includes one systole (contraction phase) and one diastole (relaxation phase) of the heart. Heart beat count of healthy person is 72 times per minute.

Stroke Volume : The volume of blood pumped out by the heart during a systole. If is approximately 70 ml.

Cardiac output : The amount of blood pumped by heart per minute is called cardiac or heart output. The value of cardiac output of a normal person is about $72 \times 70 = 5040$ mL or about 5L per minutes.

Cardiac Cycle : The rhythmic contraction and dilation of different parts of heart in one beat.

Systole : Contraction of heart muscles.

Diastole : Relaxation of heart muscles

TYPES OF BLOOD CELLS THEIR NUMBER, STRUCTURE & FUNCTIONS

Name and Number/ Percentage	Structure	Life Span and Formation	Function
(A) Erythrocytes RBCs - 4.5 to 5.5 million per cubic millimetre of blood	Red colour Circular, biconcave denucleated, elastic lack of cell organelles like ER, ribosomes, mitochondria etc.	Formed from birth onward by red bone marrow Life-120 days excess RBCs are stored in spleen	Transport of oxygen and some amount of carbon dioxide through haemoglobin
(B) Leucocytes (WBCs) 5000-8000 per cubic mm of blood	Colourless rounded or irregular, nucleated 12 to 20mm wide, life 1-4 days	Formed in red bone marrow, Lymph nodes, spleen and thymus	Acts as soldiers scavenger and some help in healing
(i) Agranulocytes (a) Lymphocytes 20-45% of leucocytes	Large rounded nucleus, 6-10 mm	Lymph nodes, spleen, thymus red bone marrow, life few days to months or even years	Non Phagocytic secrete antibodies
(b) Monocytes 6-8% of leucocytes,	Largest of all (12-15 mm) bean shaped nucleus	Red Bone marrow, life 10-20 hours	phagocytic, very motiles engulf germs
(ii) Granulocytes (a) Eosinophils 2-3% of leucocytes	bilobed nucleus, granules in cytoplasm	Red Bone marrow, life 4 to 8 hrs. in blood	play role in immunity non phagocytic
(b) Basophils 0-5% of leucocytes	Three lobed nucleus (s-shaped)	Red Bone marrow, life 4 to 8 hours in blood	release heparin and histamine
(c) Neutrophils 60-65% of leucocytes	Many lobed nucleus fine granules	Red Bone marrow, life 4 to 8 hours in blood	phogocytic, engulf germ and dead cells
(C) Platelets thrombocytes 1,50,000-3,50,000 per cubic mm of blood	Colourless, rounded or oval, or irregular non-nucleated fragments	Red Bone marrow worm out ones phagocytized in blood	help in blood clotting

Blood Pressure—The resistance offered by the lumen of the artery to the flow of Blood.

Hypertension : The condition when blood pressure is higher than normal (120/80 mmHg)

Electrocardiograph : (ECG) the machine used to record electrocardiogram.

Electrocardiogram ECG : The print out of pattern of heart beat taken on a graph paper from Electrocardiograph. (EGC machine)

Lymph

The colourless mobile fluid connective tissue drains into the lymphatic capillaries from the intercellular spaces. It is formed by squeezing of blood through capillaries, within tissues. Its flow is unidirectional *i.e.,* from tissues to heart.

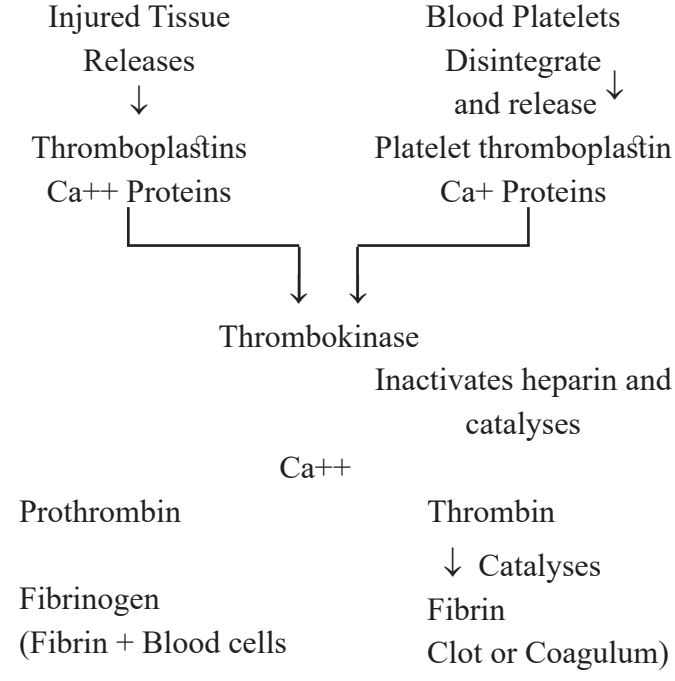
Composition : It is composed of fluid matrix, plasma having only lymphocytes of white blood corpuscles or leucocytes.

Functions : (i) It drains excess of tissue fluid from extra cellular spaces back into the blood.

(ii) It contain lymphocytes and antibodies.

(iii) It transport digested fats.

Blood Clotting : Coagulation of Blood :



Functions of Blood

Transport, of food, respiratory gases (O_2 and CO_2), hormones, metabolic intermediates, waste products, supply of raw materials, regulation of water balance, regulation of pH and body temperature, and provides immunity.

Blood Groups : Based on presence of Antigens and Antibodies in blood.

Blood Group	Antigen (on the Surface of R.B.Cs)	Anti body : (in plasma)	Possible recipients having blood group	Possible donors having blood group	Remarks
A	A	Anti B	A, AB	O, A	—
B	B	Anti A	B, AB	O, B,	—
AB	A and B	None	AB	O, A, B, AB	Universal recipient
O	None	Anti A and Anti B	O, A, B, AB	O	Universal Donor

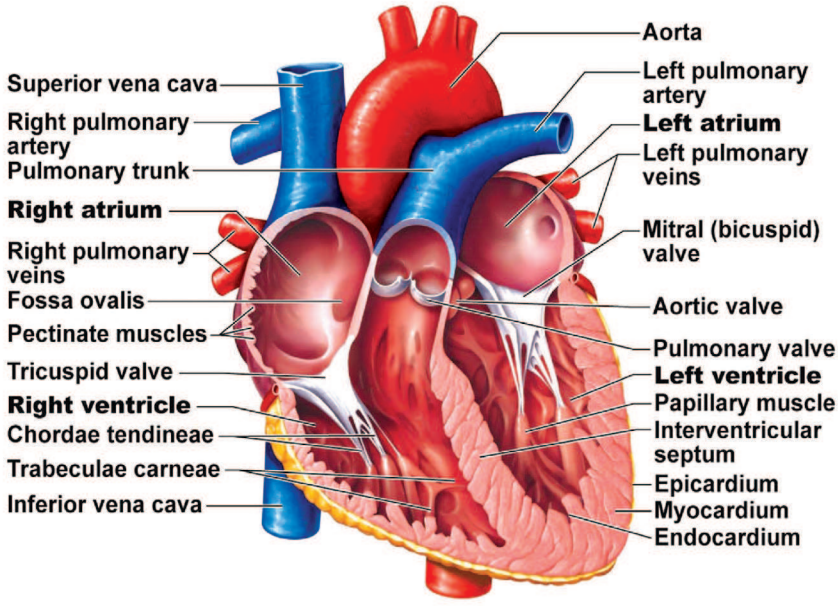
Rh (Rhesus) Group :

Discovered by Landsteiner and Wiener in **1940** the antigen found on the surface of RBCs. The presence of this antigen is termed as Rh-positive (Rh+) and its absence as (Rh–). It plays a crucial role in childs birth born out of a marriage between Rh– woman and Rh+ man, causing to produce anti Rh antibodies.

→**SAN (Sino-artrial node) :** A patch of tissues present in the right upper corner of the right atrium, acts are pacemaker due to having a unique property of self exitation.

→**AVN (Atrio Ventricular Node) :** A mass of tissues seen in the lower left corner of the right atrium close to the atrio-ventricular septum. Fresh wave of contraction generated here, passes over both the ventricles simultaneously along the bundle of his.

Human Heart



Human Heart

- It is the mesodermally derived organ situated in thoracic cavity in between the two lungs. Protected by a double membrane covering called Pericardium.
- Four chambers–two (left and right) atria, and two ventricels (left and right)
- Inner-artrial septum separates the two atria and inter ventricular septum separates the two ventricles, while the atria and ventricles are separated by atrioventricular septum.
- The valves between right atrium and right ventricle is tricuspid while between left atrium and ventricle is bicuspid or mitral value.
- The opening of the right ventricle into the pulmonary artery and the opening of left ventricle in to aorta are guarded by semilunar values.
- The valves allow the flow of blood only in one direction, *i.e.,* from atria to ventricles and from ventricles to pulmonary artery or aorta.

Heart Valves

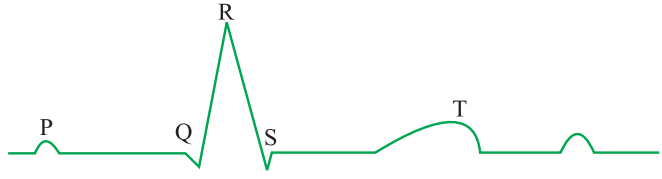
Tricuspid Valve : The valves formed of three muscular flaps or cups, which guard the opening between the right atrium and the right ventricle.

Bicuspid Valve (Mitral Valve) : The valves which guard the opening between the left atrium and the left ventricle, made up of two flaps.

Semilunar Valves : The valves present at the opening of the right and the left ventricles and allow the entry of blood into pulmonary artery and the aorta respectively.

Standard ECG & Reading of ECG : 'P' Wave represents the electrical excitation (or depolarisation) of the atria and leads to the contraction of both the atria.

Electrocardiogram ECG : The graphic record of the electric current produced by the excitation of the cardiac muscles. It is composed of a 'P' wave, 'QRS' wave. (complex) and 'T' wave (for a standard ECG) (Refer fig. 18.3, page 286 (NCERT class XI Biology)



Diagrammatic presentation of a standard ECG.

'QRS' complex : represents the depolarisation of the ventricles, which initiates the ventricular contraction.

'T' Wave : represents the return of the ventricles from excited to normal state (repolarisation). The end of T-wave marks the end of sytole.

Double circulation :

The passage of same blood twice through heart in order to complete one cycle. i.e. It is completed in following two steps.

(i) **Pulmonary Circulation :** The blood pumped by the right ventricle (deoxygenated blood) is transported through pulmonary artery to lungs where CO_2 is exchanged with O_2 through diffusion and returns back to the heart through pulmonary vein. It is called pulmonary circulation.

(ii) **Systemic Circulation :** The oxygenated blood from left ventricle is transported through aorta to different body parts (cells and tissues) where O_2 is exchanged with CO_2 through diffusion and then returned back to the heart through vena-cava. It is called systemic circulation.

Disorders of circulatory System

Hypertension (High blood Pressure) : It results from narrowing of arterial lumen and reduced elasticity of arterial walls in old age. It can cause rupturing of capillaries. It is a silent killer.

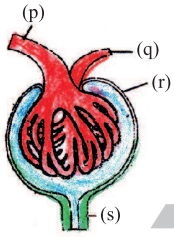
Coronary Artery Disease : (CAD) Atherosclerosis. The supply of the blood to heart muscles is affected. It is "caused by deposits of Calcium, fat, cholesterol and fibrous tissues to make the lumen of arteries narrower.

Angina Pectoris : Caused due to arteriosclerosis, when no enough oxygen is reaching the heart muscle due to which the person experiences acute chest pain.

Heart attack : Caused when the heart muscle is suddenly damaged by an inadequate blood supply.

Cardiac arrest : The state in which the heart stops beating.

Arteriosclerosis : The state of hardening of arteries and arterioles due to thickening of the fibrous tissue and consequent loss of elasticity. It causes hypertension.



Chapter - 19

Excretory products and Their Elimination

Points To Remember

Ammonotelism :

The animals which excrete ammonia are called ammonotelic and excretion of ammonia is known as ammonotelism eg. Amoeba, sycon, hydra, liver fluke, tapeworm, Leech, Prawn, bony fishes etc.

Ureotelism :

excretion of urea is known as ureotelism and the animals which excrete urea are ureotelic animals eg. mammals, many terrertrial amphibians and marine fishes and sting rays etc.

uricotelism :

Excretion of uric-acid is known as uricotelism and the animals are called uricotelic eg. most insects, land snails, lizards, snakes and birds.

Nephrons :

The structural and functional unit of kidneys. Each kidney contains about one million of nephrons.

Structure of Nephron :

A nephron consists of Glomerulus, Bowman's capsule, PCT (Proximal Convoluted Tubule). JG A (Juxaglomerular Apparatus), DCT (Distal Convoluted Tubule) and the collecting duct. (Refer fig., 19.3, page 292 (NCERT Text Book of Biology for Class XI)

Structure of Kidney :

Size 10-12 cm in length, 5-7 cm in width, 2-3 cm thick, average weight about 120-170 g.

- The blood vessels, ureter and nerves enter in the kidney through hilum (a notch).

- The outer layer of kidney is a tough capsule.
- The outer zone of kidney is cortex and the inner is medulla.
- The medulla is divided into few conical masses (medullary pyramids) projecting into calyces.
- The cortex extends between medullary pyramids called columns of Bertini. Refer figure 19.2, page 292 (NCERT—Class XI Biology)

Glomerular Filtration :

The filtration of blood in glomerulus, about 1100-1200 ml of blood is filtered by the kidney per minute.

Glomerular Filtration Rate (GFR) :

The amount of filtrate formed by the kidney per minute is called GFR. In a healthy individual it is about, 125 ml/minute, i.e. 180 litres per day.

Types of Nephrons :

(i) Juxtamedullary Nephron—About 15% of total nephrons, Glomeruli are found in inner region of cortex, large in size, long loop of Henle and found deep in medulla, associated with vasa recta control plasma volume when water supply is short.

(ii) Cortical Nephron—About 85% of total nephron mainly lie in renal cortex, glomeruli found in outer cortex, short loop of Henle, extends very little in medulla. They do not have vasa recta or vasa recta is highly reduced.

Functions of Tubules :

(i) PCT—absorption of all essential nutrients and 70-80% of electrolytes and water, helps to maintain the pH and ionic balance of body fluids by selective secretion of H^+, ammonia and K^+ into filtrate.

(ii) Henele's Loop—reabsorption in this segment is minimum, it plays a significant role in maintenance of higher molarity of medullary interstitial fluid.

(iii) DCT—conditional reabsorption of Na^+ and water takes place here, reabsorption of HCO_3^- and selective secretion of H^+ and K^+ and ammonia to maintain the pH and sodium-potassium balance in blood.

(iv) Collecting duct—Large amount of water is absorbed from this region to produce concentrated urine, it plays a role in maintenance of pH and ionic balance of blood by selective secretion of H^+ and K^+ ions.

Steps of Urine Formation

1. **Gromerular Filtration**—Blood is filtered by glomerulus through three membranes i.e., endothelium of blood vessel, filtration slits of Bowman's capsule and basement membrance between these two layers. This filtration is called ultrafiltration as all constituents of plasma comes into filterate except proteins.
2. **Reabsorption**—90% of filtrate is reabsorbed by the renal tubules by active or passive mechanism.

   It is evident by the fact that out of 180L of filtrate formed per day only 1.5 L of urine released.
3. **Secretion**—Tubular cells secrete H^+, K^+, ammonia into the urine. It maintains acid-base balance of body fluids.

Mechanism of concentration of the Filtrate (Countercurrent Mechanism) :

Refer fig 19.6 page 296 (NCERT-Class XI Biology)

- This mechanism is said to be countercurrent mechanism because the out flow (in the ascending limb) runs parallel to and in the opposite direction of the inflow (in the descending limb).
- NaCl is transported by the ascending limb of Henle's loop which is exchanged with the descending limb of vasa-recta.
- NaCl is returned to the interstitium by the ascending portion of **vasa recta.**
- Henle's loop and vasarecta as well as the counter current in them help to maintain an increasing osmolality towards the inner medullary interstitium i.e., from 300 mosmol/L in cortex to about 1200 mosmol/L in inner medulla.
- Small amount of urea enter, the thin segment of ascending limb of Henle's loop which is transported back to the interstitium by the collecting tubule.
- This mechanism helps to maintain a concentration gradient in the medullary tubule interstitium.
- It helps in an easy passage of water from the collecting tubule to concentrate the filtrate i.e. urine.

Anti Diuretic Hormone (ADH) Controls the urine formation when there is less blood volume due to excessive loss of fluid from the body, osmoreceptors send the signal to hypothalamus to release ADH which in turn facilitates water reabsorption thus preventing diuresis (increase in frequency of urination)

Micturition :

The expulsion of urine from the urinary bladder is called micturition. It is a reflex process but can be controlled voluntarily up to some extent in grown up children and adults.

- The CNS (Central Nervous System) sends the signal which cause the stretching of the urinary bladder when it gets filled with urine.
- In response, the stretch receptors on the walls of the bladder sends signals to the CNS.
- The CNS passes on motor message to initiate the contraction of smooth muscles of the bladder and simultaneous relaxation of the urethral sphincter causing the release of urine.
- An adult human excretes on an average 1 to 1.5 Litres res of urine per day.
- On an average 25-30 gram of urea is excreted out per day.

Renin Angiotensin System

Fall in GFR

↓ Renin from JG cells

Angiotensinogen → Angiotensin I → Angiotensin II

↓ Acts on

Adrenal Cortex

↓ Secretes aldosterone

Reabsorption from DCT

↓

Increase in GFR

Role of other organs in excretion :

- **Lungs**—removes CO_2 (18L/day) and water.
- **Liver**—secretes bilirubin, biliverdin etc. helps to eliminate these substances along. with cholesterol, vitamins, drugs and degraded steroid hormones through digesive wastes.
- **Sweat and sebaceous glands**—These glands of skin help to eliminate small amount of urea, NaCl and lactic acid etc. through sweat while sebaceous glands help to eliminate some substances like steroids, hydrocarbons and waxes through sebum.
- **Saliva**—It can help to eliminate small amount of nitrogenous wastes.

Disorders of Excretory system :

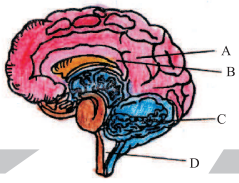
- **Uremia**—The accumulation of urea in blood due to malfunctioning of kidney.
  Hemodialysis—The process; of removal of urea from the blood artificially. In this process the blood from an artery is passed into dialysing unit after adding an anticoagulant like heparin. The blood passes through coiled cellophane tube surrounding by dialysing fluid. The nitrogenous wastes from the concentration gradient and the blood becomes clear. This blood is pumped back to the body through vein after adding anti-heparin to it.
- **Renal calculi**—The format ion of insoluble mass of crystallised salts (oxalates or phosphates of calcium.
- **Glomerulonephritis**—Inflamation of glomeruli of kindney.

Kidney Transplantation

- Kidney transplantation is done in a patient in which both the kidneys fail to work i.e. at total failure of kidney. Kidney transplantation is the ultimate method for treatment of renal failure. In case of kidney transplantation both the damaged kidneys of patient are removed by surgery. And a functional kidney from a healthy donar preferably from close relative is taken and transplanted in the body of patient. After successful transplantation the patient and donar can survive on one kidney.

Precautions taken for successful transplantation of Kidney :

1. Kidney should be taken from a healthy donor preferably from close relative.
2. Matching of blood group and other factor and compatibility should be done carefully before transplantation.
3. The patient (recipient) has to take some prescribed medicines immunosuppresses through out the life to suppress the immune system.



Chapter - 21 Neural Control and Coordination

Points To Remember

Coordination : Process through which two or more organs interact and complement the functions of one another surrounding the brain.

Action potential : A sudden change in the electrical charges in the plasma membrane of a nerve fibre.

Aqueous humour : The thin watery fluid that occupy space between lens and cornea in eye.

Blind spot : A spot on ratina which is free from rods and cones and lack the ability for vision.

Cerebrospinal fluid : An alkaline fluid present in between inner two layer of meninges, surrounding the brain and spinal cord.

Cerebellum : A part of hind brain that controls the balance and posture of the body.

Cochlea : A spirally coiled part of internal ear which is responsible for hearing.

Corpus callosum : A curved thick bundle of nerve fibres that joins two cerebral hemisphere.

Depolarisation : A condition when polarity of the plasma membrane of nerve fibre is reversed.

Endolymph : The fluid filled within membranous labyrinth.

Ecustachian tube : A tube which connect ear cavity with the pharynx.

Fovea : An area of highest vision on the ratina which contain only cones.

Meninges : Three sheets of covering of connective tissue wrapping the brain.

Grey Matter : This shows many convolutions which increase the amount of vital nerve tissue.

Medula oblongata : Posterior most part of the brain which is continuous with spinal cord and control respiration, heart rate,swallowing,vomiting.

Pons : Thick bundles of fibres on the ventral side of brain below cerebellum.

Foramen magnum : A big aperture in the skull posteriorly through which spinal cord emerges out.

Spinal cord : A tubular structure connected with medulla oblongata of brain and situated in the neural canal of the vertebral column, covered by meninges.

Synaptic cleft : A narrow fluid filled space which separates two membranes of the two neurons at the synapse.

Synaptic vesicles : These are membrane bound vesicles in the axoplasm of the axon terminal and these store neurotransmitter.

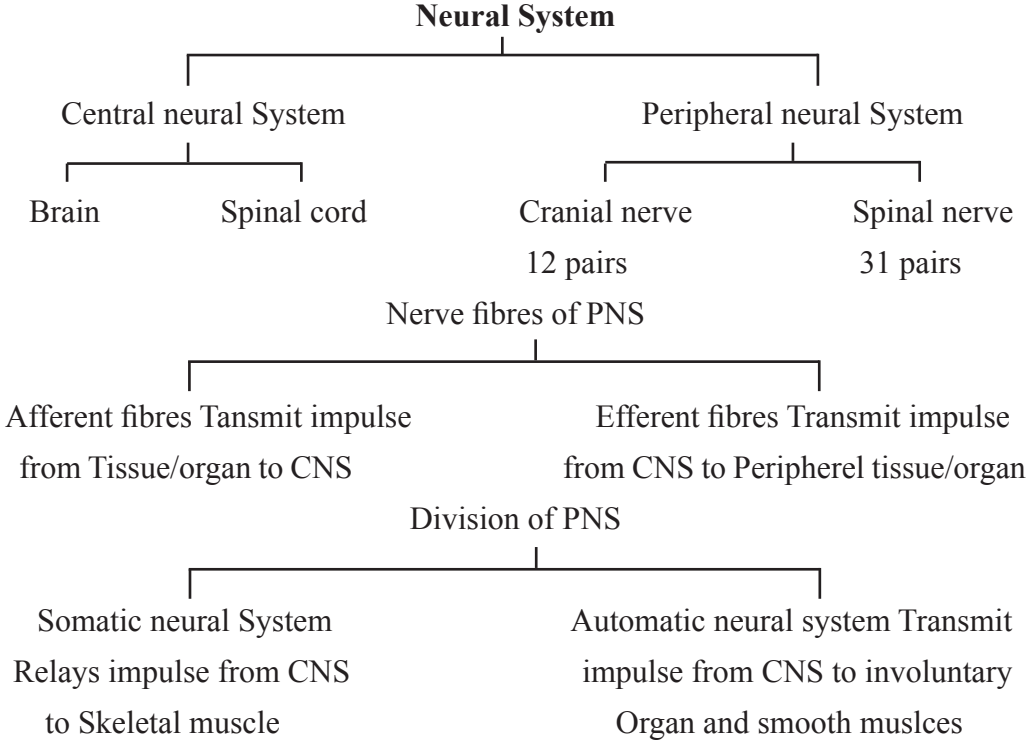
Neurotransmitter : These are chemicals stored in synaptic vesicles, diffuse to reach the membrane of next neuron for its stimulation.

Synapse : A physiological junction between axon of one neuron and dendrite of next neuron.

CNS—Central neural system

PNS—Peripheral neural system

ANS—Autonomic neural system



Parts of Neuron
- Cell body = Cytoplasm with nucleus, cell organelles and Nissl's granules
- Dendrites = Short fibres which branch rapidly and project out of cell
- Axon = Single, long fibre, branched at distal endit

(Refer fig. 21.1, page 317, NCERT - Biology, Class-XI)

Neuron
- Multipolar = : One axon and two or more dentrites
  : Found in cerebral Cortex
- Bipolar = : One axon and one dendrite
  : Found in ratina of eye
- Unipolar = : Cell body with axon only
  : Found usually in the embryonic stage

Conduction of nerve impulse along axon

Polarised membrane/Resting Potential

In resting phase when neuron is not conducting an impulse, the axonal membrane is called polarised. This is due to difference in concentration of ions across the axonal membrane.

At Rest :

- Axoplasm inside the axon contain high conc. of K^+ and low conc. of Na^+.
- The fluid outside the axon contain low conc. of K^+ and high conc. of Na^+.

As a result the outer surface of axonal membrane is positively charged and inner surface is negatively charged. The electric potential difference across the resting plasma membrane is called resting potential.

Action Potential : When a nerve fibre is stimulated, the permeability of membrane to Na^+ is greatly increased at the point of stimulus (rapid influx of Na^+) and hence polarity of membrane is reversed and now membrane is said to be depolarised. The electric potential difference across the plasma membrane at that site is called action potential, which infact termed as nerve impulse.

Depolarisation is very rapid, so that conduction of nerve impulse along the entire length of axon occurs in fractions of second.

Transmission of Impulses at Synapse

(i) At electrical synapses : Here the membrane of pre and post-syneptic neuron are in very close proximity. Electric current can flow directly from one neuron into other across these synapses, like impule conduction along a single axon.

(ii) At chemical synapses : Here the membrane of pre and post-syneptic neuron are separated by fluid filled space called synaptic cleft. Neurotransmitter are involved here.

When an impulse arrives at the axon terminal, it stimulates the movement of the synaptic vesicles towards membrane and they fuse with the plsama membrane and release their neurotransmitter in the syneptic cleft. These chemicals bind to specific receptors, present on the post-syneptic membrane. Their binding opens ion channels and allow the entry of ion which generate new potential in post synaptic neuron.

Human brain : Human brain is the major portion of central neural system. Which is well protected by the skull.

The brain is surrounded by three cranial meninges—

(i) Duramater—outer alyer

(ii) Arachnoid—middle layer

(iii) Piamter—Inner layer-remain incontact with brain

Parts of Brain

Fore brain	Mid brain	Hind brain
(a) Cerebrum		(a) Cerebellum
(b) Thalamus		(b) Pons
(c) Hypothalamus		(c) Medulla oblongata

Functions of pars of brain :

Cerebrum : Centre of intelligence, memory and imagination, reasoning, judgement, expression of will power.

Thalamus : Acts as relay centre to receive and transmit general sensation of pain, touch and temperature.

Hypothalamus : Centre for regulation of body temperature, urge for eating and drinking.

Midbrain : Responsible to coordinate visual reflexes and auditory reflexes.

Cerebellum : Maintains posture and equilibrium of the body as well as coordinates and regulates voluntary movement.

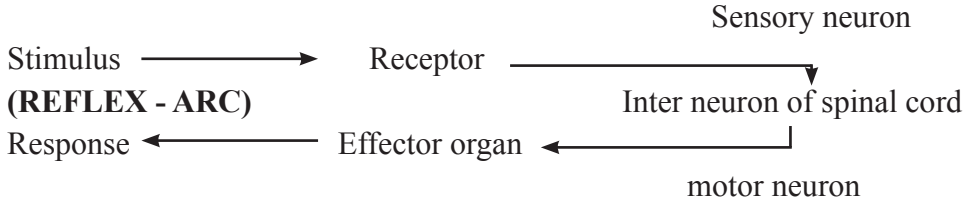
Pons : Relays impulses between medulla oblongata and cerebral hemisphere and between the hemisphere of cerebrum and cerebellum. It also heps to regulate breathing.

Medulla oblongata : Centre that control heart beat, breathing, swallowing, salivation, sneezing, vomitting and coughing.

Reflex action : It is spontaneous, autonomic and mechanical response to a stimulus that occurs at the level of spinal cord, without involvement of brain.

Reflex arc : The flow of nerve along the specific during reflex action. It consist of—

(a) A receptor
(b) An Afferent neuron (sensory neuron)
(c) An inter neuron
(d) An efferent neuron (motor neuron)
(e) An effector organ



Organ of Sight-Eye

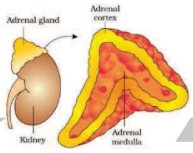
Layer	Component	Function
1. External layer	Sclera	Protects and maintain shape of the eye ball
	Cornea	Outermost transparent portion of eye which allows light to enter
2. Middle layer	Choroid	Absorb light and prevent light from being reflected within the eye ball.
	Ciliary body	Holds lens, regulate shape of the lens.
	Iris	Control amount of light entering.
3. Inner layer	Retina	Vision in dim light, colour vision, vision in bright light. Sends the image to brain through optical nerves.

(Refer-Fig. 21.6, Page 323 NCERT-Biology, Class XI)

Organ of Hearing–Ear

Portion of the ear	Component	Function
1. External ear	Pinna	Collect sound waves
	External auditory canal	Direct sound waves towards ear drum, ear wax prevents the entry of foreign bodies.
2. Middle ear	Tympanic membrane	Acts as resonator that reproduces the vibration of sound.
	Ear ossicles	Transmit sound waves to internal ear.
	Eustachian tube	Helps in equalising the pressure on either side of ear drum.
3. Internal ear	Cochlea	Hearing organ.
	Vestebular apparatus	Balancing of body.

(Refer Fig. 21.7, page 325-NCERT-Biology, Class XI)



Chapter - 22 Chemical Coordination and Integration

Points To Remember

Endocrine glands : These are ductless glands which secrete hormones directly into the blood stream.

Hormones : Non-nutrient chemicals synthesised in trace amount by Endocrine glands that act as intracellular messengers and are specific in their action which are transported by blood from site of production to site of action.

Hypothalamus :

- It is basal part of diencephalon.
- Has neurosecretory cells called nuclei which produce hormones to regulate the synthesis and secretion of pituitary gland hormones.
- Two types of hormones released are :

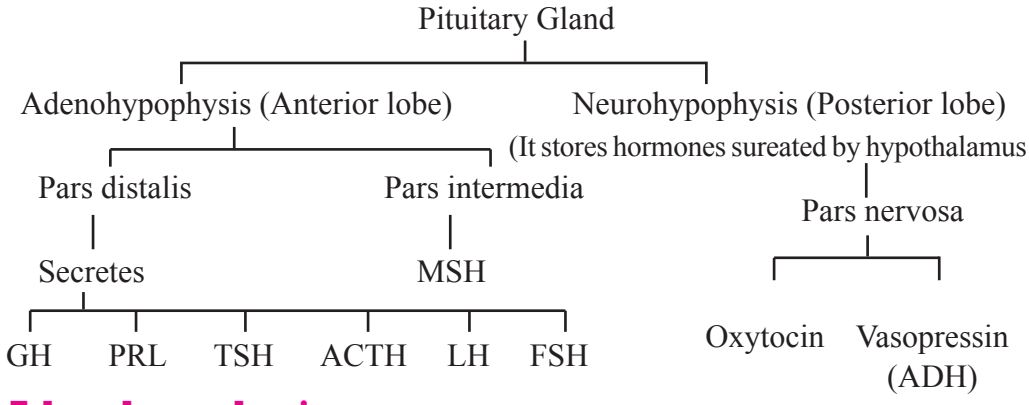
  Releasing hormones : Simulate secretion of pituitary hormones, *e.g.,* *Gonadotrophin* releasing hormone stimulates pituitary gland to synthesise gonadotrophins.

  Inhibiting hormones : Inhibit secretions of pituitary hormones, *e.g.,* Somatostatin inhibits secretion of growth hormone.

Pituitary Gland :

- Located in bony cavity called as sella tursica.
- Attached to hypothalamus by a stalk.
- Divided anatomically into : Adenohypophysis (Anterior lobe) and Neurohypophysis (Posterior lobe).
- Hormones released from hypothalamic neurons reach anterior pituitary through portal system and through neurons in Posterior pitutary.
- Posterior pituitary is under neural control of hypothalamus.

1. **Pituitary Gland**



Adenohypophysis :

- **Growth hormone (GH) :** Oversecretion leads to gigantism and low secretion causes dwarfism and Proper reaction leads to proper growth of body.
- **Prolactin (PRL) :** Growth of mammary gland and formation of milk in them.
- **Thyroid stimulating hormone (TSH) :** Stimulates synthesis and secretion of thyroid hormones from thyroid gland.
- **Adrenocorticotrophic hormone (ACTH) :** Stimulates synthesis and secretion of steroid hormones called glucocorticoids from adrenal cortex.
- **Luteinizing hormone (LH) :** Synthesis and secretion of hormones called androgens in males, and helps in ovulation and maintenance of corpus luteum in females.
- **Follicle stimulating hormone (FSH) :** Regulate spermatogenesis in males, and growth and development of ovarian follicles in females.
- **Oxytocin** helps in contraction of uterus during child birth and milk ejection from mammary gland in females.
- **Vasopressin :** Acts on kidney and stimulates reabsorption of water and electrolytes by distal tubules to reduce water loss through urine. It is also called as Anti Diuretic Hormone (ADH).
- **Acrommegaly :** It is a condition when the pituitary gland makes too much growth hormone. It is due to a tumour in pituitary gland. Person suffering from acromegaly (acro means tip and megaly means enlargement) may gradually develop a long face with protruding lower law, enlarged nose and wider spacing between teeth and enlarged hands and feet.

2. **Pineal Gland :**

- Located on dorsal side of forebrain.

- Secretes Melatonin to regulation 24-hours rhythm, sleep-wake cycle, menstrual cycle, pigmentation etc.

3. Thyroid Gland :

- Has two lobes on either side of trachea interconnected by isthmus (connective tissue).
- Composed of follicles and stromal tissues.
- Follicular cells synthesis thyroxine (T_4) and tri-iodothyronine (T_3).
- Iodine is necessary for normal functioning in of thyroid.
- **Goitre (Hypothyroidism) :** Enlargement of thyroid gland; Hypothyroidism may lead to mental retardation and stunted growth (cretinism) Deaf-mutism in the baby if it occurs during pregnancy.
- **Hyperthyroidism :** Occurs due to cancer or due to development of nodules in thyroid glands. Effects body physiology as abnormal high levels of thyroid hormones is synthesised. Basic metabolic rate increase.
- **Exophthalmic goitre :** It is a form of hyperthyroidism, characterised by enlargement of thyroid gland, protrusion of eye balls and increased BMR
- Thyroid hormone controls protein, carbohydrate metabolism.
- Also secretes a protein hormone called Thyrocalcitonin (TCT) which regulates blood calcium level.

4. Parathyroid Gland :

- Present on back side of thyroid gland. Each lobe of thyroid gland has its one pair.
- Secrete peptide hormone called parathyroid hormone (PTH) which increases calcium levels in blood so called **hypercalcemic** hormone.
- PTH stimulates bone resorption, and reabsorption of calcium from blood and reabsorption of calcium by renal tubules, thus increasing blood Ca^{++} level.

5. Thymus Gland

- Located on dorsal side of heart and aorta.
- Secrete peptide hormones called Thymosins which play role in differentiation of T-lymphocytes (help in cell mediated immunity.)
- Thymosins also produce antibodies and provide humoral immunity.
- Immunity of old people usually becomes weak as thymus gets degenerated with age.

6. Adrenal Gland

- Located at anterior part of each kidney.
- Has centrally located adrenal medulla and at periphery in adrenal cortex.

- Adrenal medulla secretes adrenaline (epinephrine) and nor adrenaline (norepinephrine), commonly called as catecholamines or emergency hormones or hormones of fight or flight.
- These hormones increase heart beat, rate of respiration, breakdown of glycogen thus increase blood glucose level, breakdown of lipids and protein, alertness, raising of hairs, sweating etc.
- Adrenal Cortex-(3 layers) : Zona reticularis (inner layer)
  Zona fasciculata (middle layer)
  Zona glomerulosa (outer layer)
- **Adrenal cortex secretes :**

1. **Androgenic steroids :**

- Secreted in small amounts.
- Play role in growth of axial pubic and facial hair during puberty.

2. **Glucocorticoids :**

- Involved in carbohydrate metabolism.
- Stimulates gluconeogenesis, lipolysis and proteolysis.
- *e.g.,* Cortisol which is also involved in cardio-vascular and kidney functions.
- It also suppresses immune response and stimulates RBC production.

3. **Mineralocorticoids :**

- Regulate balance of water and electrolytes in body.
- *e.g.,* Aldosterone which also helps in reabsorption of NA^+ and water excretion of K^+ and phosphates ions from renal tubules.
- When adrenal cartex is damaged, it does not produce enough cortisols (which regulate body's reaction to stressful situations) and aldosterone.
- It result in Addison's disease. Symptons of addison's disease are weak muscles, extreme fatigue, increased skin pigmentation, weight loss, sores in mouth and depression.

Two major causes :

1. Primary adrenal insufficiency where our immunity system mistakes adrenal for an antigen and tries to damage it.
2. Secondary adrenal insufficiency-when pituitary gland can't produce ACTH

7. **Pancreas :** It is called composite/dual gland. As it acts as Exocrine and endocrine gland i.e. has both exocrine and endocrine function.

- Contains about 1-2 million islets of Langerhans which has glucagon secreting α-cells and insulin secreting β-cell.
- **Glucagon :** Peptide hormone, stimulates glycogenolysis by acting on liver cells. Also, stimulates gluconeogenesis. Hence called hyperglycemic hormone.
- **Insulin :** Peptide hormone, acts on hepatocytes and adipocytes to enhance cellular glucose uptake, stimulates conversion of glucose to glycogen (glycogenesis), so decrease blood glucose level called hypoglycemic hormone.
- Deficiency of insulin causes diabetes mellitus in which loss of glucose occurs through urine. Excessive hunger and thirst (polydipsia) are other symptoms of Diabetes.
- Insulin and glucagon are antagonistic hormones i.e. play apposite role.

  Glycogenolysis : Breaking of glycogen into glucose.

  Gluconeogenesis : Formation of glucose from substances other than glycogen.

  Glycogenesis : Conversion of glucose into glycogen.

8. **Testis :**

- A pair of testis composed of seminiferous tubules and interstilial cells is present in the scrotal sac of males.
- Leydig cells (interstitial cells) produce androgens (mainly testosterone) which regulate development and maturation of male accessory sex organs, formation of secondary sex characters and play stimulatory role in spermatogenesis. Male sexual behaviour (libido) is influenced by androgens.

Ovary : A pair of ovaries which produce one ovum in each menstrual cycle are present in abdomen in females.

- Ovary composed of ovarian follicles and stromal tissue.
- Estrogen synthesised by growing ovarian follicles helps in stimulation of growth of female secondary sex organs, female behaviour, mammary gland development and female secondary sex characters.

- Ruptured follicle form corpus luteum which secretes progesterone. Progesterone supports pregnancy and stimulates alveoli formation and milk secretion in mammory glands.

Hormones secreted by tissues which are not endocrine glands :

(a) Heart : Atrial wall secrets Atrial Natriuretic factor (ANF) which decreases blood pressure by dilation of the blood vessels.

(b) Kidney : Juxtaglomerular cells secretes erythropoietin which stimulates erythropoiesis (RBC formation).

(c) Gastro-intestinal tract : it secrets four peptide hormones.

- **Gastrin :** Acts on gastric glands and stimulates secretion of hydrochloric acid and pepsinogen.
- **Secretin :** Acts on pancreas and stimulates secretion of water and bicarbonation.
- **Cholecystokinin (CCK) :** Act on pancreas and gall bladder to stimulate secretion of pancreatic juice and bile juice respectively.

Gastric inhibitory peptide (GIP) : Inhibits gastric secretion and motility.

Mechanism of hormone action : By hormone receptors of two kinds, *i.e.*,

(a) Located on membrane of target cell

- These are membrane bound receptors.
- From hormone receptor complex.

  ↓

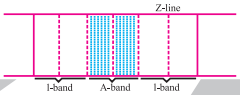
  Leads to biochemical changes in tissue.

  ↓

  Release of second messengers like (cyclic AMP, IP_3, Ca^{2+} etc.) which regulate cellular metabolism.

(b) Located inside the target cell

- These are intra cellular receptors.
- Hormones (steroid hormones iodothyronines etc.) interact with them and cause physiological and developmental effects of regulating gene expression.



Chapter - 20

Locomotion and Movement

Points To Remember

Arthritis : an inflammatory joint disease characterised by inflammation of joints.

Coccyx : tail bone formed by fusion of four coccygeal vertebrae in man.

Dicondylic Skull : A Skull with two occipital condyles.

Endo Skeleton : A skeleton present in side the body.

Fascicle : Bundles of muscles fibres held together by connective tissue.

Fascia : Collagenous connective tissue layer that surrounds muscle bundles.

Floating ribs : The ribs that remain free anteriorly, **(last 2 pairs)**

False ribs : 8th, 9th and 10th pair of ribs not directly joins the sternum but to seventh pair of ribs, hence called pseudoribs.

Myoglobin : A red colored pigment present in sarcoplasm of muscle.

Sarcomere : A portion of myofibril between two successive 'Z' lines.

Sarcocolema : The plasma membrane of a muscle.

Gout : Inflammation of joints due to accumulation of uric acid crystal.

Suture : immovable joints between skull bones.

Synovial joints : Freely movable joints between limb bones.

Patella : A seasmoid bone acting as kneecap.

Intervertebral disc : Fibro cartilaginous pad present between the vertebrae **that** act as shock absorbers.

Tendon—Connective tissue made of yellow fibrous tissue which connect muscle to bone. It is not flexible.

Ligament—Connective tissue made of white fibrous tissue which joins two bones. It is flexible.

L.M.M. : Light meromyosin

HMM : Heavy meromyosin

Types of Movement :

1. **Amoeboid movement :** These movements takes place in phagocytes where leucocytes and macrophages migrate through tissue. It is affected by pseudepodia formed by the streaming of protoplasm (as in amoeba)
2. **Ciliary movement :** These movement occurs in internal organs which are lined by ciliary epithelium.
3. **Muscular Movement :** This movements involve the muscle fibers, which have the ability to contract and relex.

Properties of Muscle : (i) Excitability (ii) Contractility (iii) Extensibility (iv) Elasticity

Types of Muscles :

(a) Skeletal muscles or striated muscles—These involved in locomotion and change of body postures. These are also known as voluntary muscles.

(b) Visceral muscles or smooth muscles—These are located in inner wall of hollow visceral organ, smooth in appearance and their activity are not under control of voluntary nervous system. They are called involuntary muscles.

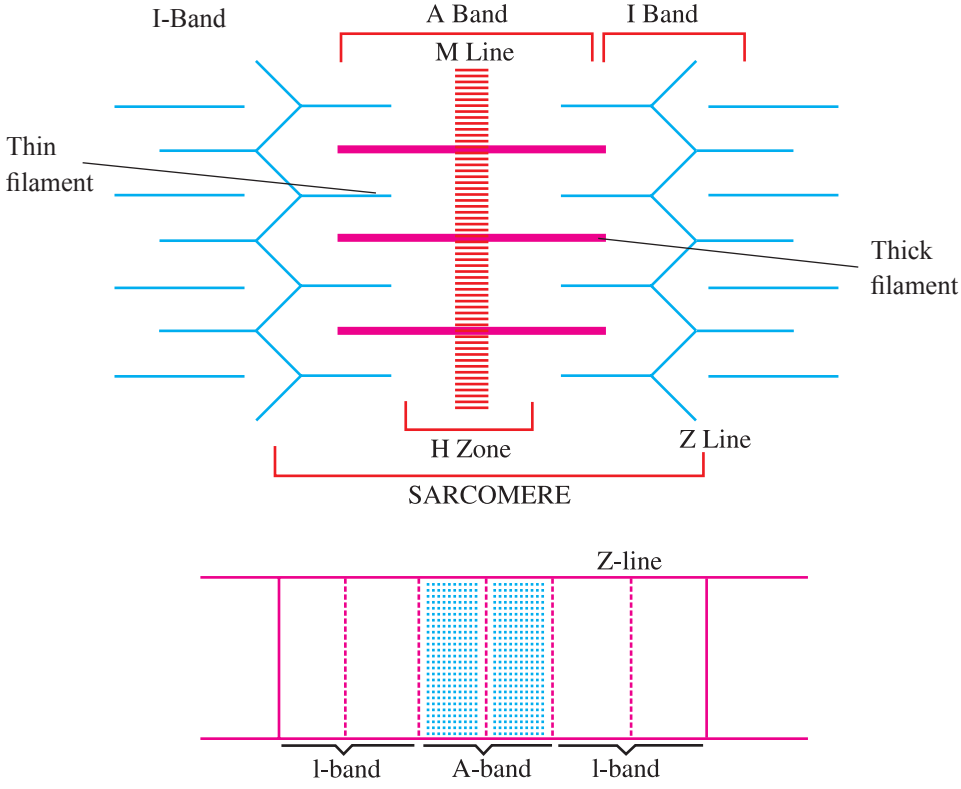
(c) Cardiac muscles—The muscles of heart, involuntary in nature, striated and branched, These are uninucleated.

Characteristic	Skeletal Muscle	Smooth Muscle	Cardiac Muscle
Location	Muscles attached with skeletal components	muscles found in the inner walls of hollow visceral organs	Muscles found only in heart.
Appearance	Striated having light and dark bands.	unstriped, smooth in appearance with tapering ends.	Striated in appearance and branched
Control	They are controlled by our will hence called voluntary muscles.	They are not under the control of our will hence called involuntary muscles.	not under the direct control of nervous system.

Structure of myofibril :

- Each myofibril consist of alternate dark and light band.
- Dark band—contain myosin protein and is called A-band or Anisotroic band.
- Light band—Contain actin protein and is called I Band or Isotropic band.
- I Band is bisected by an elastic fiber called 'Z' line. Actin filament (thin filament) are firmly attached to the 'Z' lines.
- Myosin filament (thick filament) in the 'A' Band are also held together in the middle of T Band by thin fibrous membrane called 'M' line.
- The portion between two successive 'Z' lines is considered as functional unit of contraction and is called a sarcomere.

Structure of Actin and Myosin Filament



1. **Actin filament :** An actin filament is made of two 'F' actins which are helically wound to each other. Two filaments of tropo myosin protein also run close to 'F' actins throughout its length. A complex protein Troponin is distributed at regular intervals on tropomyosin which mask the actin binding site for myosin.
2. **Myosin filament :** Each myosin filament is a polymer of meromyosin. Each meromyosin has two components—a globular head with a short arm and a tail. Head is made of heavy meromyosin while tail is made of light meromyosin. The head with its short arm project outward at regular distance and angle from each other and is known as cross arm. The head has an active site for actin and binding site for ATP.

Red muscle fibres :

— These are red in colour due to presence of high content of myoglobin.
— These contain plenty of mitochondria.
— Sarcoplasmic reticulum is less in these fibres.
— Show slow but sustained contractions for longer periods.

White muscle fibres

— These are pale or whitish due to presence of less content of myoglobin.

— These contain fewer mitochondria

— Sarcoplasmic reticulum is more/high

— During strenuous exercise, lactic acid accumulates in large quantity so muscle fatigues

Mechanism or Muscle contraction : Sliding filament theory

The contraction of muscle fiber takes place by the sliding of actin (thin filament) on myosin (thick filament)

- Muscle contraction is initiated by a signal sent by the CNS via a motor neuron.
- Impulse from motor nerve stimulates a muscle fiber at neuro muscular junctions.
- Neurotransmitter releases here which generates an action potential in sarcolema.
- This causes release of Ca^{++} into sarcoplasm. These Ca^{++} binds with troponin, thereby remove masking of active site.
- Myosin head binds to exposed active site on actin to form a cross bridge, utilising energy from ATP hydrolysis.
- This pulls the acin filament towards the centre of 'A' band.
- 'Z' lines also pulled inward thereby causing a shortening of sarcomere i.e. contraction.
- I band get reduced, whereas the 'A' band retain the length.
- During relexation, the cross bridge between the actin and myosin break. Ca^{++} pumped back to sarcoplasmic cisternae. Actin filament slide out of 'A band and length of I band increase. This returns the muscle to its original state.

Vertebral formulae of man $C_7T_{12}L_5S_{(5)}\ C_{(4)} = 33$