# BIOLOGY

## CODE - 314

## Self Learning Material

Author

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(M.Sc., B.Ed.)

# AXIS ACADEMY

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We pray for your bright future and hope that studying in NIOS will make your life successful and bright.

*With best wishes from :*

**Co-ordinator**
**(National Institute of Open School)**

# *Why we join NIOS AXIS ACADEMY?*

It will not be exaggeration that in this competitive world NIOS is a boon for the students.

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NIOS is an easy solution of this problem of students, Motto of NIOS 'for all and for everyone' and NIOS follow 'Principal of freedom of learning' NIOS provides freedom from class. It is class free educational system so students get not only sufficient time but freedom to appear class anywhere in India.

NIOS is a ray of home for us parents they are overburdened wih wanted end unnecessary high fee and extra-costly books of Public School. In NIOS, there is nominal registration fee and NIOS Board provides free study materials / vedio lectures and live classes to all the students. NIOS also provides free classes from time to time as well as remedical classes for all the students.

NIOS is the only board which conducts examination two times in an academic calendar April-May and Oct-Nov. In this board these is system 'Transfer of credit marks'.

NIOS provides 'On demand examination' every month through out year.

Now-a-days, NIOS Board's percentile in I.I.T., and other competitive examination is better than CBSE Board marks. So its success ratio is increased by leaps and bounds.

So, Let us join NIOS and Shape your golden future.

# PREFACE

*The Primary aim to this edition of Biology is to present the study material in a straight forward and dependent on new syllabus of NIOS Biology. It is not difficult, or even necessary these days. To convince NIOS Board and medical student that Biology is an important subject to study.*

*The problem and need of student preparing for NIOS Board and competition are to a large extent quit diffferent from those engaged in other academic pusuits. While preparing this book have tried to bear in mind the diverse need to various students. Needless to say, many of my brilliant student gave me feedback over the year concerning the study material style and its velevancy.*

*It is a pleasure to acknowledge the debt I woe to Mr. Vikash K. Singh, the author of the popular books NIOS Biology. I thanks to many person have worked for months together for the production of this book.*

*I like to extend due apology for any error of commision and omission. Suggestion from togethers and student for further improvement of this book, will be highly appreciated.*

*With my Best wishes -*
**VIKASH KUMAR SINGH**
(M.Sc., BEd.)

# NIOS
# AXIS ACADEMY
# CLASS - XII$^{th}$ (BIOLOGY)

## SENIOR SECONDARY BIOLOGY COURSE
## Overview Of The Learning Material

| Module | Lesson No. | Name of the Lesson | Mode of Assessment TMA / PE | |
|---|---|---|---|---|
| **Module-I** | 01 | Origin and Evolution of Life and Introduction | | |
| Diversity and Evolution of Life | | to Classification | TMA | |
| | 02 | The Kingdom Monera, Protista and Fungi | | PE |
| | 03 | Kingdom Plantae and Animalia | | PE |
| | 04 | Cell Structure and Function | TMA | |
| | 05 | Tissues and Other Level of Organization | | PE |
| **Module-II** | 06 | Root system | TMA | |
| Forms and Functions of | 07 | Shoot system | | PE |
| Plants and Animals | 08 | Absorption, Transport and Water Loss in Plants | | PE |
| | 09 | Nutrition in Plants – Mineral Nutrition | | PE |
| | 10 | Nitrogen Metabolism | | PE |
| | 11 | Photosynthesis | | PE |
| | 12 | Respiration in Plants | TMA | |
| | 13 | Nutrition and Digestion | TMA | |
| | 14 | Respiration and Elimination of Nitrogenous Wastes | | PE |
| | 15 | Circulation of Body Fluids | | PE |
| | 16 | Locomotion and Movement | | PE |
| | 17 | Coordination and Control – The Nervous and | | |
| | | Endocrine Systems | | PE |
| | 18 | Homeostasis - The steady state | TMA | |
| **Module-III** | 19 | Reproduction in Plants | | PE |
| Reproduction and Heredity | 20 | Growth and Development in Plants | | PE |
| | 21 | Reproduction and Population Control | | PE |
| | 22 | Principles of Genetics | | PE |
| | 23 | Molecular Inheritance and Gene Expression | | PE |
| | 24 | Genetics and Society | TMA | |
| **Module-IV** | 25 | Principles of Ecology | | PE |
| Environment and Health | 26 | Conservation and Use of Natural Resources | | PE |
| | 27 | Pollution | TMA | |
| | 28 | Nutrition and Health | | PE |
| | 29 | Some Common Human Diseases | TMA | |
| **Module-V** | 30 | Biotechnology | | PE |
| Emerging Areas in Biology | 31 | Immunobiology: An Introduction | | PE |

Total Lessons = 31
Lessons for public Examination (PE) = 22
Lessons for Tutor Marked Assignment (TMA) = 09

# CONTENT

*This book contains chapters of PE (Public Examination)

CHAPTER 01

# KINGDOM - MONERA PROTISTA AND FUNGI

**KINGDOM – Monera** – It included only prokaryotic organism.

It includes three groups -
1. Archaebacteria
2. Eubacteria
3. Cynobateria

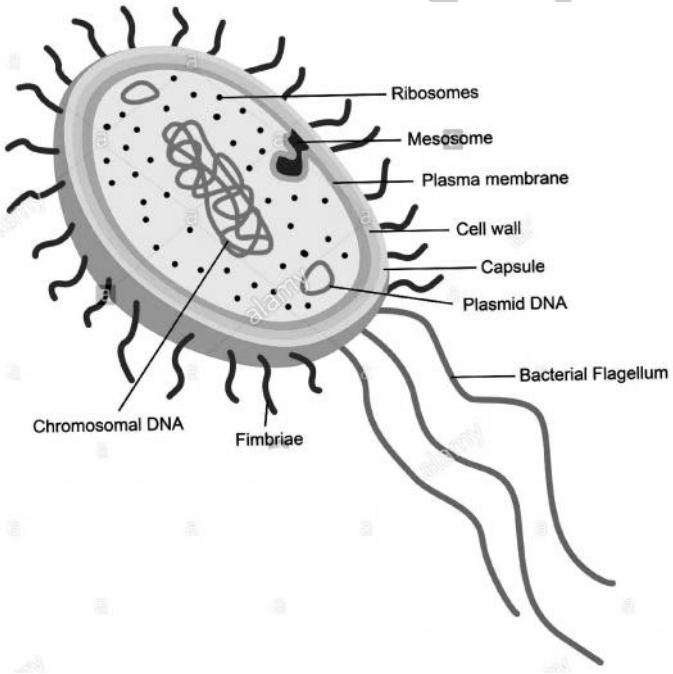
1. **Archaebacteria :** It occurs in those environment which have low $O_2$ levels and high temperature main type –

**(i) Methanogenic Bacteria :** They are live in sewage and intestinal tract of Animals.

**(ii) Thermoacidophilic :** They are live in hot spring.

**(iii) Halophilic :** They are live in salty condition.

**STRUCTURE OF A BACTERIAL CELL**




**2. Eubacteria –** It includes most developed Bacterium. Bacteria do not contain membrane bounded organelles but ribosomes are present.

**Bacterial cell contain following structure.**

- **Cell Wall –** Bacteria have rigid cell wall composed of peptidoglycan. It give shape to bacteria.
- **Pili –** It is short thin thread like structure help in attachment and Reproduction.
- **Flagella –** Long thread like structure. Bacteria move with the help of flagella.

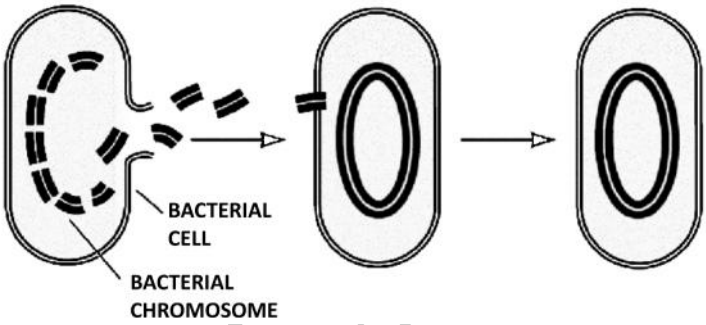
- **Genetic material -** Single circular naked DNA is present. Some extra chromosomal circular DNA is present called plasmid.
- **Nutrition in Bacteria –** Bacteria perform Autotrophic saprotrophic, symbiotic and parasitic mode of nutrition.
- **Respiration in Bacteria –** Mesosome help in respiration. Bacteria perform both anaerobic and aerobic respiration.
- **Reproduction in Bacteria –** Bacteria reproduces by following two way –

**(a) Asexual Reproduction -** By Binary fission (20 minutes)

**(b) Sexual Reproduction –** By conjugating - follow two step :

**(1)** Two conjugating bacteria are held together by pilli.

**(2)** A segment of DNA transferred from one bacterium to another bacterium or F- factor is transferred from male donor cell to female cell.




**Harmful Activities**

| | Name of Bacterium | Disease Caused |
|---|---|---|
| 1. | Vibrio cholera | Cholera |
| 2. | Salmonella typhi | Typhoid |
| 3. | Clostridium tetani | Tetanus |
| 4. | Corynebacterium diphtheriae | Diphtheria |
| 5. | Mycobacterium tuberculosis | Tuberculosis |

**Beneficial Activities of Bacteria**

| | Name of bacterium | Activities |
|---|---|---|
| **1.** | Rhizobium | Found in roots of legumes, like Peas, grams, Pulses Etc., where it fixes atmospheric nitrogen as ammonia, which is then converted into useful amino acid. |
| **2.** | Azotobacter | Makes the soil fertile. It fixes atmospheric nitrogen in the soil. |
| **3.** | Streptomyces | Produces Streptomycin antibiotic |
| **4.** | Lactobacillus | Ferments lactose (milk sugar) to lactic acid. This helps in setting of milk into curd. |
| **5.** | Methanogenic bacteria | Sewage treatment |

## KINGDOM – FUNGI

- ✓ It Includes without chlorophyll and Heterotrophic plant.
- ✓ Fungi exist as slender thread like filament called hyphae.
- ✓ Hyphae septate or aseptate.
- ✓ A Group of hyphae forming a network is called mycelium.
- ✓ Their cell wall are made of chitin.
- ✓ Food storage glycogen or fat drop.
- ✓ Reproduction asexual and sexual both

**Classification of Fungi**

Fungi included following five main kind -

1. **Myxomycetes –** Ex – Slime mould – Naked, Multinucleated fungi.
2. **Phycomycetes –** Ex. Rhizopus or Bread mauld., phytophthora – cause blight of potato.
3. **Ascomycetes –** Ex. Aspergillus and Yeast.
   Neurospora – Use in experiment of genetics.

   Penicillum notatum – Alexander Flemming, discovered penicillin antibiotic from this fungi.
4. **Basidiomycetes -** Ex. Puccinia graminis – cause wheat rust Agaricus (Mushroom) – edible fungi Toadstools
5. **Deuteromycetes –** Ex. Alternaria

**Lichen –** It Is symbiotic combination of fungi and algae or BGA. Algae form food and fungi absorbs water and minerals.

**Mycorrhiza –** It is symbiotic association of fungi and root of plant. Fungi get from plant and help in absorption of water and minerals.

**Cynobacteria –** It is also called Blue-green algae. They are photo auto trophic group of bacteria and released $O_2$.

- The do not contain flagellum. They are larger than Bacteria.
- They also involve in mitrogenfixation. Ex. Anabaena and Nostoc.

**Kingdom - Protista**

- It Includes unicellular eukaryotic organism.
- They have membrane bounded organelles such as mitochondria nucleus, chloroplast etc.
- Protist are photosynthetic, parasitic or saprophytic.
- In protest locomotion take place by – flagella, cilia or pseudopodia.
- They reproduces by both asexually and sexually.

## Classification of Protista

**Phylum-**

**Protozoa**

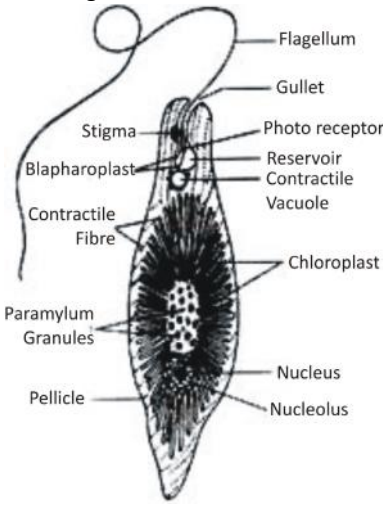
**Examples**

→ Amoeba – Fresh water

→ Entamoeba
It cause amoebic dysentery

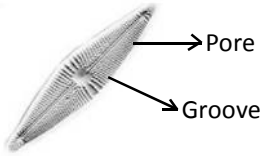
→ Plasmodium –
It Cause Malaria

→ Euglena – Fresh Water Flagellated




**Bacillariophyta**

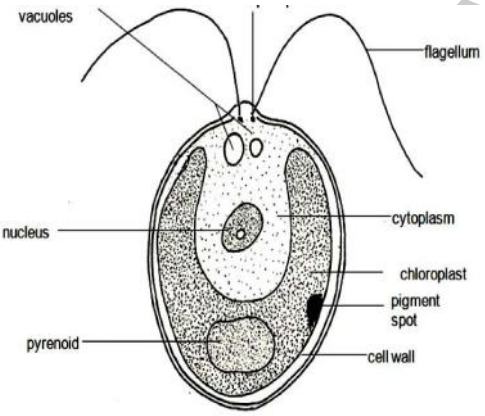
Ex- Diatoms

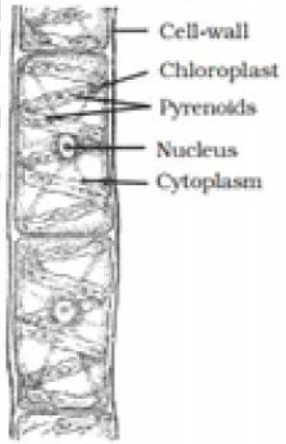



**Chlorophyta**

Examples

Chlamydomonas
Spirogyra




## EXERCISE

1. What is the main component of cell wall in Bacteria?
2. What is transfered during sexual reproduction in a bacteriaum?
3. Name the Bacteria that -
   (i) Cause tuberculosis
   (ii) Cause tetanus
4. Name the protozoa which cause :
   (i) Amoebic dysentry
   (ii) Malaria
5. Name the organelle responsible for regulating water content in amoeba.
6. Name the slender filament that form the body of fungus.
7. Draw two small figures to show asexual reproduction in yeast.
8. Write the name of uniclellular fungus.
9. Which fungus cause wheat rust?
10. Who discovered antibiotic properties of penicillium?

CHAPTER
02

# PLANT KINGDOM

**BRYOPYTA = "Amphibian of Plant Kingdom'**

It includes the simplest and primitive land plant. Bryophytes grow in moist and shady places. Most of member grow copper rich soil so called 'copper mosses'.

- The bryophytes are fundamentally terrestrial plant but require water to complete their life cycle. There for they are regarded as "the amphibian of the plant Kingdom".

The life cycle of bryophytes consist of two distinct phase-

*(i)*Gametophytic phase

*(ii)* Saprophytic phase.

***(i)* Gametophytic phase –** It is dominant phase of life cycle.

It is haploid, long-lived, green and independent.

***(ii)* Saprophytic phase –** If is diploid short lived and dependent upon the gametophyte.

The gametophyte are either thalloid or leaf short.

Roots are completely absent and they replaced by unicellular or multicellular thread like rhizoid.

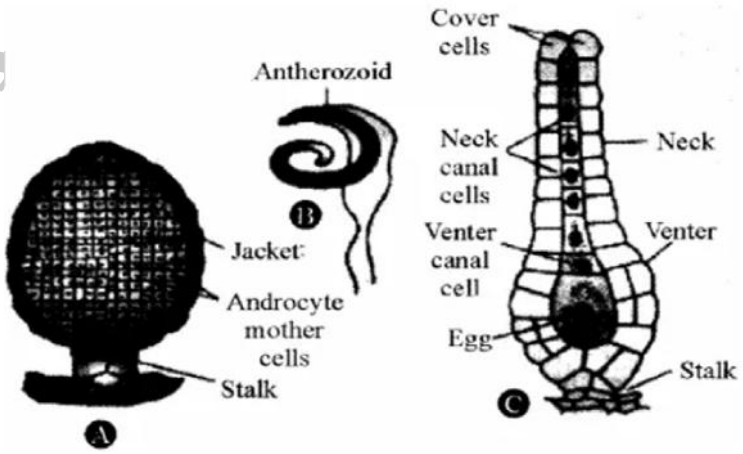
The vascular tissue are completely absent.

**Asexual reproduction** take place by fragmentation, adventitious branches and from gamma. Gemma are asexual multicellular green bud present in gemma cup.

**Sexual reproduction** is oogamous type. The sex organ is multicellular and jacketed with sterile jacket.

Male sex organ is antheridia and female sex organ is archegonia.

- Antheridia is differentiated into stalk and body. They produce male gamete flagellated coild antherozoid . Archegonia are flask shape and have neck and Venter. Venter have venter canal cell and a large egg.
- Male gametes are liberated from antheridia, with the help of water anthrezoid enter into archigonium and fertilized the egg, from zygote.



- The diploid fertilized egg is the first cell of saprophytic generation.
- Zygotes do not undergo meiosis immediately. They produce a multicellular saprophyte body. The saprophyte is not free-living but attached to gametophyte and derives nutrient from it.
- Saprophyte differentiated into foot, Seta and capsule. Some cells of capsule undergo meiosis and produces haploid spores.
- The spores germinate to from gametophyte.

**Classification of Bryophyte** – It classify into two main group. **(I)** Liverwort **(II)** Mosses

**(I) Liverwort** –

*(i)* Plant body of liverwort is thalloid. The thallus is dorsiventral and closely to the substrate.

*(ii)* Asexual reproduction in liverworts take place by Fragmention and by the formation of specialized structure called

gamma. Gemma are green, multicellular, asexual bud, which develop in small cup like structure called gemma cup.

*(iii)* Rhizoids are unicellular, unbranched.

*(iv)* During sexual reproduction male (antheridia) and female (archegonia) are produced either on same plant are different plant.

*(v)* The saprophyte is differentiated into foot, seta and capsule.

*(vi)* Spores produces in capsule by meiosis. Spores germinate to form gametophyte. Ex- Riccia, Marchantia and Pellia.

**(II) Mosses** –

(i) The gametophyte of mosses consist two stage. (a) Protonema (b) leafy stage.

(a) **Protonema –** It is first stage if life develops directly from a spore. It is creeping, green branched and filamentous stage.

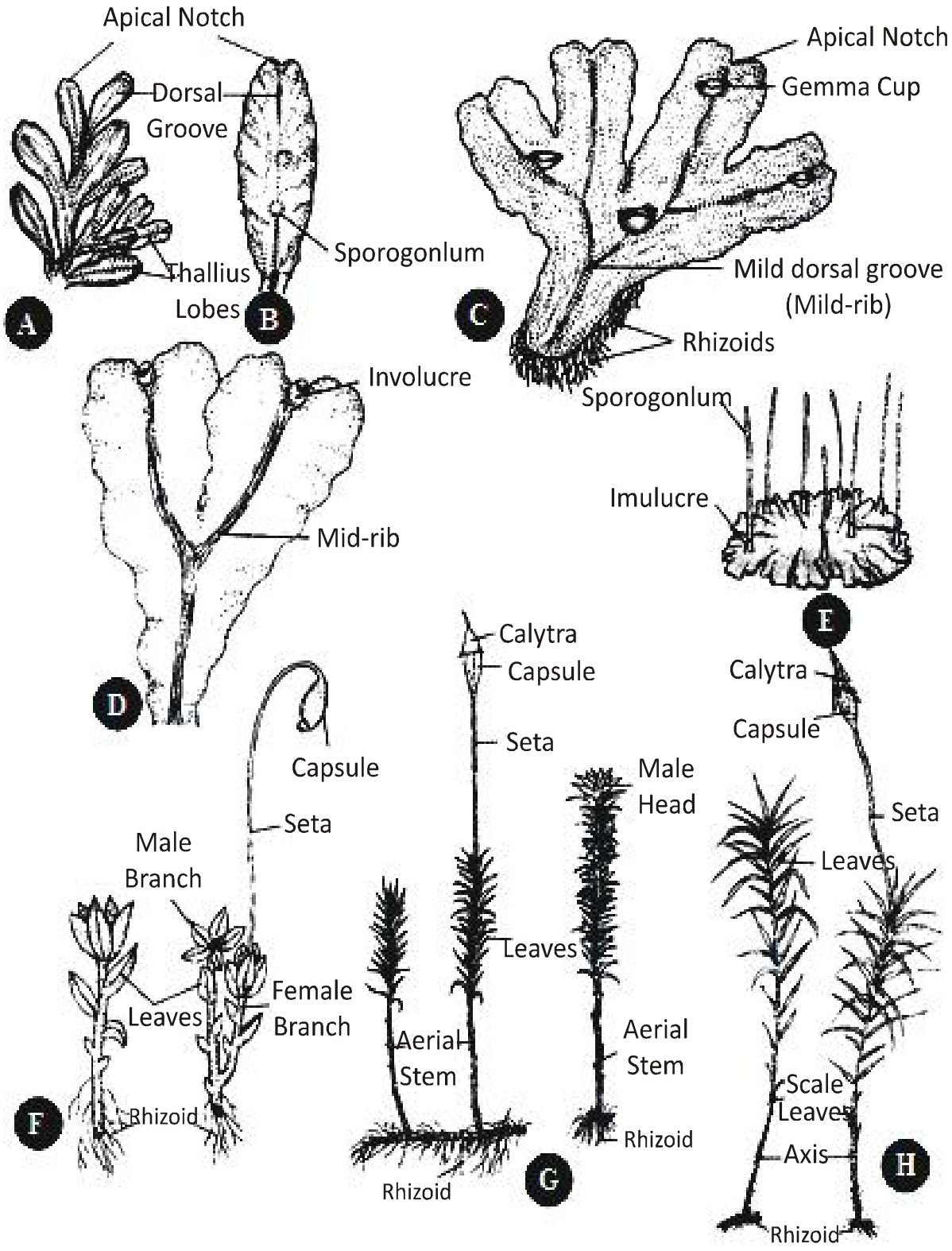
(b) **Leaf stage –** If is second stage of game tophyte, develops from the secondary protonema as a lateral buds. If consist upright, slender axis with spirally arranged leaf.

(c) Rhizoid is multicellular branched.

(d) Vegetative Reproduction by fragmentation and budding in secondary Protonema.

- In sexual reproduction, antheridia and archegonia devdops on shoot apex.
- After fertilization zygote develops to form saprophyte, saprophyte consist of foot, seta and capsule.
- Haploid spores are develops into capsule of saprophyte.
- Haploid spores germinated to form protonema than leafy gametophyte develops.

  **Ex.-** Funaria, Polytrichum, and sphagnum etc.
- Funaria – Common moss, have largest archegonia of plant Kingdom.
- Sphagnum – Peat moss or Bog moss.




**A- Bryophytes, B- Riccia, C- Marchantia, D- Pellia**
**E- Anthoceros, F- Funaria, G- Polytrichum, H- Pogonatum**

**PTRIDOPHYTES**

*(i)* Pteridophytes are first terrestrial plant which have vascular tissue.

*(ii)* The main independent plant body of pteridophytes is sporophyte.

*(iii)* They are differentiated into rest leaf e stem.

*(iv)* They are found in cool, damp, shady places.

*(v)* All the vegetative part possess vascular tissue.

*(vi)* The leaves may be small microphyllaus (e.g. Lycopodium, Equisetum) or large macrophyllaus (e.g. Pteridium, Pteris and other fem).

*(vii)* Reproduction occurs by spores produced inside the sporangia. The sporangia are borne on the ventral surface of fertile leaves, called sporophylls.

*(viii)* The sporangia either singly or in group called sori.

*(ix)* In some plant sporophylls may form compact structure called strobili or cone e.g. Selaginella and Equisetum.

*(x)* The plant may be homosporaus i.e. produced only one type of spores e.g. Lycopodium, Pteridium. He trosporaus i.e. produce two different type of spore e.g. selaginella e marsilea.

*(xi)* The spores germinate to produce haploid gametophyte called prothallus.

*(xii)* The prothollus is small multicellular, free living, photo, synthetic gametophyte.

*(xiii)* The Prothallus bear male and female sex organs called antheridia and archegonia which produces male & female gamete.

*(xiv)* The sexual reproduction is oogamous type. Fertilization occurs in the presence of water. Fusion of male gamete with female gamete to form zygote.

*(xv)* The zygote is developed into young embryo in female gametophyte. It is a important step in evolution of seed habit.

*(xvi)* The embryo germinated into new saprophyte plant.

Ex- Lycopodium – (club moss)

Selaginella – spike moss – (seed habitate), Resurrection plant.

Equisetum – Horsetail

Dryopteris – Fern

Adiantum – Walking fern or Maiden hair fern.

Azolla – Water fern.

**GYMNOSPERM**

The gymnosperm are plant in which the ovule are not enclosed by any ovary wall. The seed that developed post fertilization are not covered i.e. are naked e.g. cycas, pinus & ginco etc.

**General Character :-**

*(i)* The gymnosperms are widely distributed in the cold climate where snow rather than rain is the source of water. The only some gymnosperm are present in warmer areas like cylas.

*(ii)* The gymnosperms are mostly perennial, xerophytic, every reen and woody plant.

*(iii)* The plant body is saprophyte and differentiated into root, stem and leaf.

*(iv)* The gymnosperm include world's fullest free. Sequoia sempervirens (125 m height and 30 m in girth). This free is about too year old and found in Red-wood part of California. Smallest gymnosperm, Zamia pygmia (25 cm.).

*(v)* The plant possess well developed tap root system. In sum cases the roots are symbiotically associated with fungi (e.g. mycorrhizo in Pinus) and with cynobacteria or blue green algal e.g. coralloid root of cylas).

Plant possess vascular tissue xylem & phloem but vessel in xylem and companion cell in phloem are absent.

They are arranged in vascular bundle. V.B. are conjoint, collateral and open. Secondary growth present.

- Reproduction – Gymnosperm are hetrosporaus i.e. produces two different kind of spores – the male microspore and the female megaspores. Both spores are borne inside the sporangia.
- The two type of sporangia are borne on special leaf like structure called sporophyll . The male micro sporangia are borne on microsporophyll and the female mega sporangia (ovule) are borne on mega sporophyll.
- The sporophyll are usually aggregate in the form of compact structure called cones or strobili. The strobili or cones may be unisexual (e.g. cylas) or bisexual (e.g. pines)
- The microspore (pollen grain), are developed in microsporophyll from microspore mother cell by the meiosis division.
- In mega-sporangia (ovule) the megaspore mother cell under goes meiosis division and form four haploid megaspore megaspores are developed into archegonia which contain megaspore or egg.
- The pollen grain is rebased from the micro sporangia. They are carried in air currents and came in content with archegonia which are present in ovule.
- Each pollen grain germinated inside ovule and give out a pollen tube which carry male gamete. The pollen tube reaches upto the egg cell and releases the male gamete
- Egg fuse with male gamete from zygote during fertilization water is not necessary.
- The zygote develops into an embryo and ovule become seed. The wall of ovule become the seed coat. These seed are not covered.

**ECONOMICS IMPORTANT**

*(i)* Ornamental uses →cycas revolute used.

*(ii)* Source of food – cycas → Sago' have starch.

Pinus gerardians → chilgoza use as dry fruit.

*(iii)* Medical use - Ephedra→ ephedrine used in treatment of cough, asthma, bronchitis.

*(iv)* Resins (Semi fluid only content) – Use in formation of varnishes, waterproof paints, sealing wax, etc.

**ANGIOSEPERMS**

It constitute the most dominant vascular plant. In angiosperm, the pollen grain and ovule developed into a special structure called flower. The term angiosperm means 'enclosed seed' because the ovule or seed are enclosed with in a hollow ovary.

- Smallest angiospermic plant – Wolfia
- Tallest angiospermic plant – Eucalyptus

**Type of Angiosperm :** On the basis of cotyledon of seed angiosperm is two type. (a) Monocot (b) Dicot.

**(a) Monocot plant have following character –**

*(i)* In monocot tap root system is short lived and replaced by adventitious root.

*(ii)* Vascular bundle are scattered and vascular cambium is absent

*(iii)* Leaves show parallel venation pattern.

*(iv)* The seed have only single cotyledon.

*(v)* The number of flower part is three.

*(vi)* Secondary growth are absent.

*(vii)* Mostly annual.

**(b) Dicotyledon Plant -** The dicot plant have following characters –

*(i)* The plant have tap root system. Adventitilaus root also occurs in some cases.

*(ii)* Vascular bundle are arranged in ring vascular cambium is present.

*(iii)* The leaves have reticulate venation pattern.

*(iv)* The seed consist two cotyledon.

*(v)* The number of flower parts in four or five

*(vi)* Secondary growth is present.

*(vii)* Plant are annual, biennial or perennial

**Life cycle of flowering Plant**

In angiospermic plant the dominant phase is saprophyte plant. The plant produces their reproductive structure in flower.

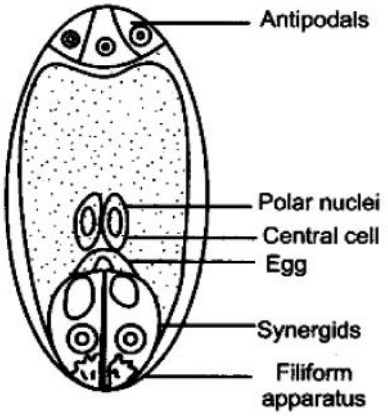
Androecium is group of stamen which represent the male reproductive organ. A stamen consist of an another at tip and filament. Anther are bilobed, each lobed consist two pollen sac which consist a number of pollen mother cell. Pollen mother cell (PMC) under goes meiosis an produces haploid pollen grain.

Gynoecium is a group of carpel or pistil with represent female sex organ. Carpel's are megasporophyll which bear megaspore (ovule). A single carpel consist three part (a) Stigma (b) styl (c) ovary.

**(a) Stigma –** It is top most part of style and lodged pollen grain.

**(b) Style –** It is long tubular filamentous structure connecting the stigma to ovary.

**(c) Ovary –** The basal swellen part of carpel is called ovary which contain one or more ovules. Inside the ovule female gametophyte is developed by the help of meiosis cell division is termed as Embryo sac. Each embryo sac has three ceiled egg apparatus – one egg and two synergids, three antipodal cell and two polar nuclei.



Mature Embryo sac of an angiosperm

**Pollination –** After dispersal from the another, pollen grain transpoted to the stigma by different agents, is known as pollination. If pollination is carried by

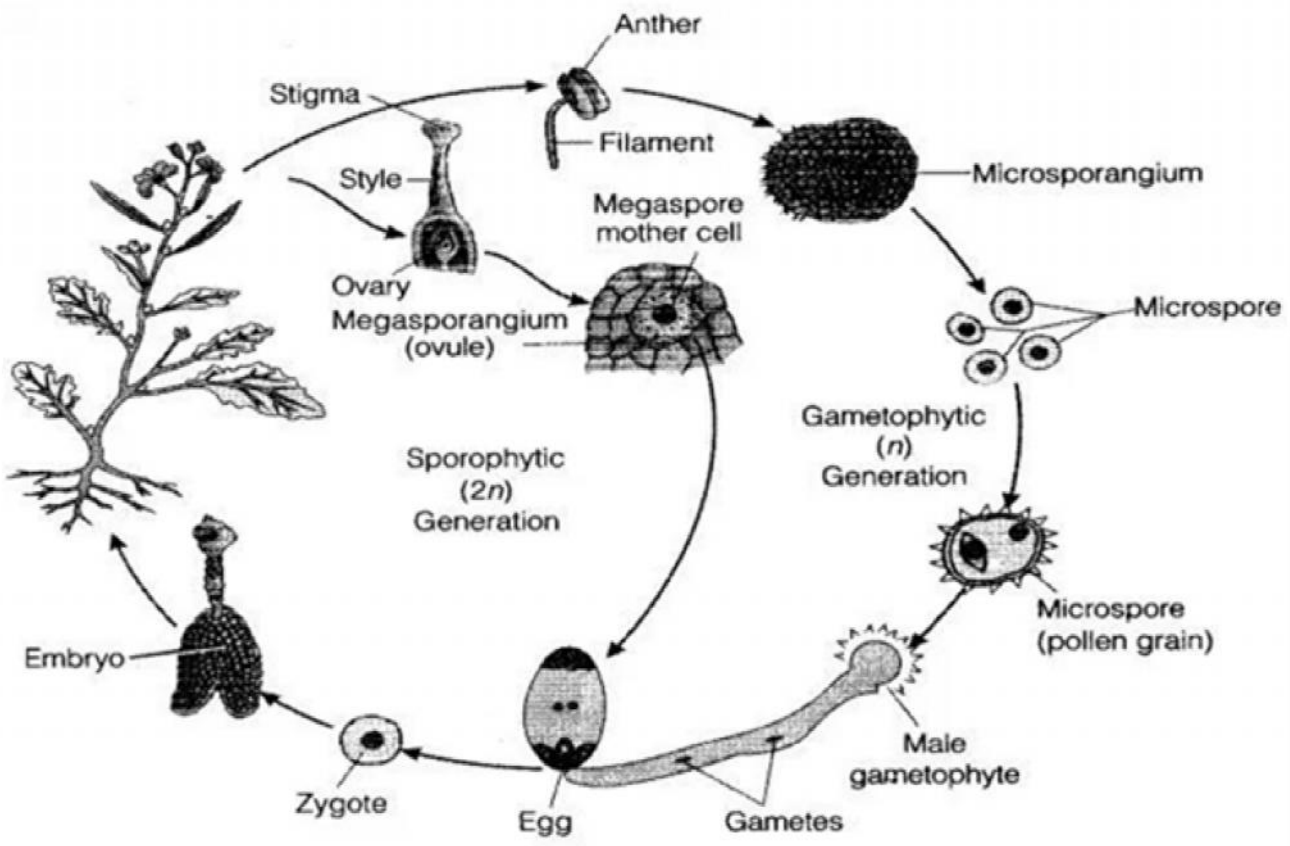
| | | |
|---|---|---|
| wind | - | Anemophily |
| Water | - | Hydrophilic |
| Insect | - | Entomophily |
| Bird | - | Ornithophily |

- When pollen grain are transferred to the stigma of same flower it is known as seif pollination, different flower is known as cross pollination.

After pollination pollen grain (which have two male gamete) germinated on the stigma and pollen tube reach to embryo ac through style. The pollen tube enter into there two male gamete are discharged.

**Fertilization –** In embryo sac the one male gamete fuse with egg to farm zygote, is known fertilization. The second male gamete fuse with diploid polar nuclei to form triploid primary endosperm nucleus, is known as triple fusion. Due to involment of two fusion, this event is known as double fertilization.

After fertilization zygote develops into an embryo and the PEN develops into endosperm which provides nourishment to the developing embryo. The synergids and antipodal degenerate after fertilization. Ovules develops into seed and ovary develops into fruit.



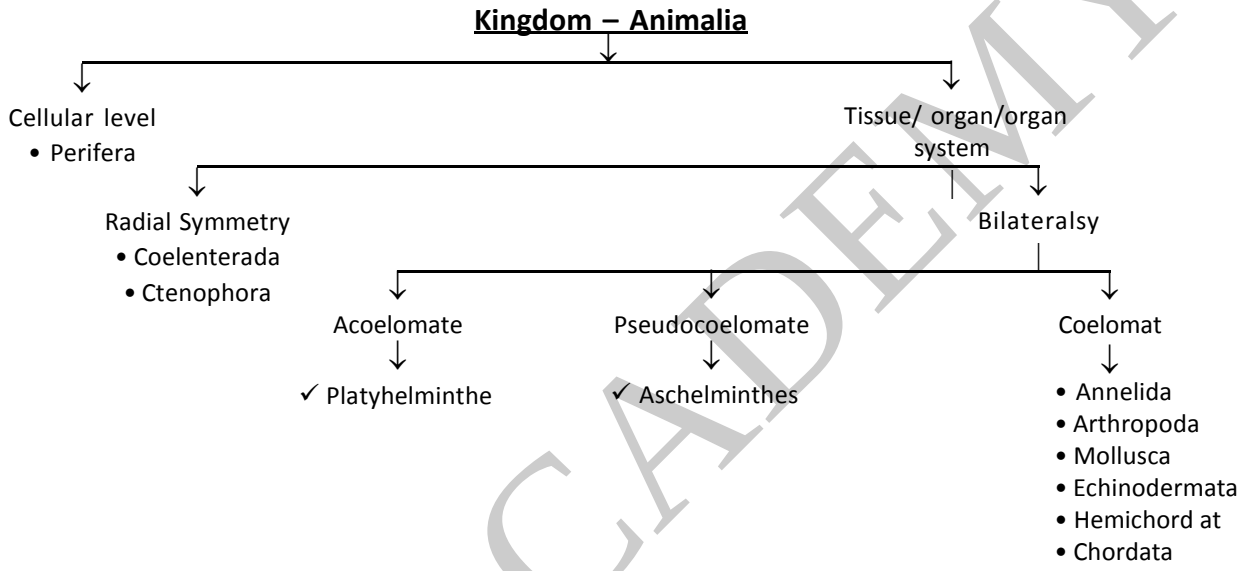

Life cycle of an angiosperm

## KINGDOM ANIMALIA

- It includes multicellular eukaryotic animals.
- Animals have the power of locomotion.
- They show sensitivity through nervous system.

**Classification of Animals :** On the basis of following property animals are classify into different group.

✓Body organization ✓Body cavity or coelom ✓Symmetry
✓ Embryonic ✓Notochord




- **Phylum – Porifera (Sponges)** ì
  - ✓ Sponges have canal system
  - ✓ Canal system open outside by osculum
  - ✓ Body encloses a large cavity spongocoel
  - ✓ Cellular level of body organization
  - ✓ All are marine some are fresh water.
  - ✓ Spicule and sponging form endoskeleton
  - ✓ Ex. – Sycon, Euplectella, Euspongia
- **Phylum Cnidaria (Includes hydroids, jelly fishes, sea anemone and corals)**

  **Main Characters:**
  - Body with no head and no segmentation.
  - Body wall two layered: external epidermis and inner gastrodermis, jelly – like, non-cellular mesogoea in between.
  - Cnidoblasts (stinging cells) present, help to catch prey (carnivorous)
  - Skeleton calcareous, horny or none.

• Asexual reproduction by budding in the sessile (polyp) stage, and sexual reproduction in free swimming (medusa) stage.

• Radial symmetry

• All marine, except Hydra (found in fresh water).

**Ex –** Hydra, Ielly fish, Sea Anemone

**3. <u>Phylum</u>** – <u>Platyhelminthes</u> = (Flat worm) –

• Elongated, dorsoventrally flatted worm without segmentation

• Suckers or hooks or both for attachment to the body of the host.

• Sexes usually united, mostly sexual reproduction, with asexual reproduction in some.

• Alimentary canal has only one opening-the mouth. In some forms (e.g. tapeworms) there is no alimentary canal at all.

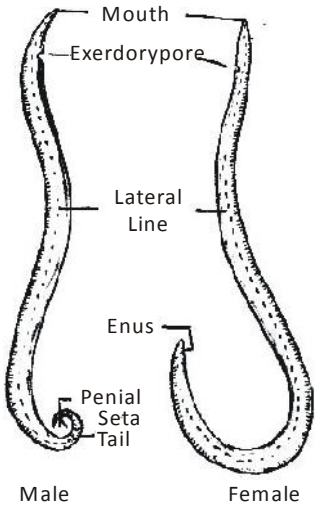
• A few are free-living but mostly parasites.

**Examples**: *Planaria* (free living),

*Fasciola* (liver-fluke) is a parasite of sheep liver, *Taenia* (tapeworm) is a parasite of the human intestine.

**4. Phylum Aschehelminthes (Class Nematoda) –**

(Roundwordms, thread worms)




**Main characters:**

• Elongated cylindrical round body

• Body cavity is a pseudocoelom (false body cavity)

• Alimentary canal opens at the two ends, mouth and anus.

• Sexes separate, males smaller than females (Fig 3.10).

• Mostly parasitic in animals but some live freely in the soil.

• Ascaris is a common roundworm, parasitic in the intestine of humans.

• Pinworm and *Wucheria* (Filariaworm) are some other examples.

**5. Phylum Annelida (Includes earthworms)**

**Main characters:**

• Elongated, segmented, coelomate (true body cavity) worm-like animals.

• Body provided with setae or parapodia for locomotion.

• Well developed digestive system with the alimentary canal open at both the ends.

• Excretory organs called nephridia.

• Sexes united (as in earthworm) or separate (as in *Nereis*).

• Regeneration quite frequent.

• Aquatic, some terrestrial animals some living in tubes and some even parasitic.

**Examples:** *Nereis*, Earthworms like *Pheretima* (free-living in soil), *Hirudinaria*

**6. Phylum Arthropoda (includes Crab, scorpion, insect, spiders etc.)**

**Main characters:**

• Segmented body, can be differentiated into head, thorax and abdomen.

- Head and thorax often fused to form **cephalothorax**.
- Jointed legs for locomotion, one paid each on some or all body segments.
- Exoskeleton of chitinous cuticle, shed at intervals (moulting).
- Sexes usually separate.

Arthropods are further divided into classes.

(i) Crustacea (ii) Myriapoda (iii) Insecta (iv) Arachnida

**Ex-** Scorpion, Prawn, cockroach

**7. Phylum Mollusca (includes squids, snails and oysters)**

**Mollusca**

These animals have a soft, unsegmented body, with a hard, calcareous shell to protect the soft body. They have a muscular foot to help in locomotion and also to act as a weapon in some cases. Examples: snails, slugs, oysters, mussels, clams, squids, and octopuses (Fig. 3.13).

**Main Characters.**

- Unsegmented soft-bodied animals terrestrial or aquatic,
- Exoskeleton in the form of a shell. When present shell is usually univalved or bivalve; internal shell present in some.
- Sexes separate or united.
- Have a muscular foot for locomotion.

**8.** Phylum Echinodermata (Includes starfishes, brittle stars, sea urchins, sea cucumbers).

**Main Characters.**

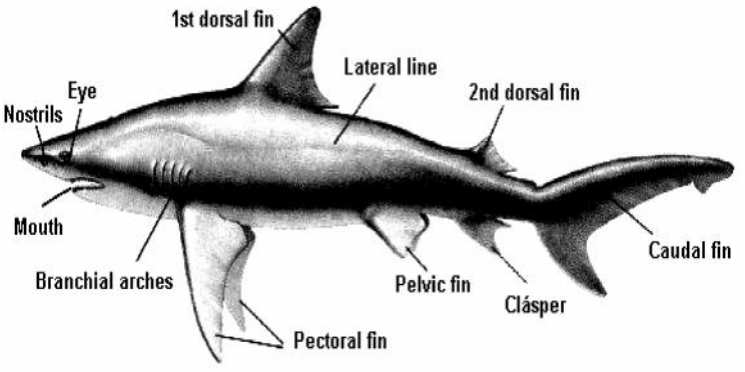
- Marine animals, with unsegmented body.
- Head absent, body surface marked with 5 radiating areas.
- Radial symmetry.
- Endoskeleton of dermal calcareous ossicles with spines.
- Movement by tube feet.
- Sexes usually separate.
- Regeneration of lost parts a peculiarity.
- Adults are radially symmetrical, but the larvae are bilaterally symmetrical.

**9. Phylum – Chordata** ì

- Notochord present at some stages of life.
- Dorsal tubular nerve cord.
- Gill slit present at some stage of life.
- Body with a head and trunk.

Phylum chordate included following six classes –

- ✓ Chondrichthyes
- ✓ Osteichthyes
- ✓ Amphibia
- ✓ Reptilia
- ✓ Aves
- ✓ Mammalia

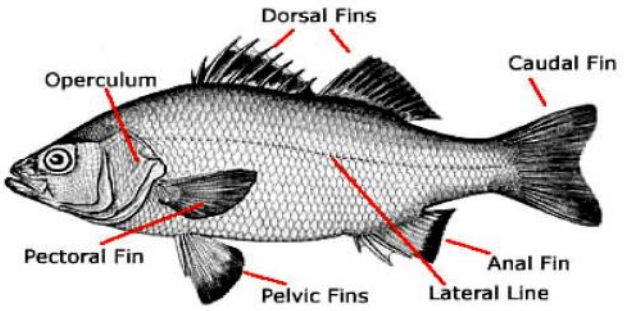



**Class 1. Chondrichthyes**

(GK, Chondro = cartilage; ichtyes = fish)

- Mouth ventral
- Tail heterocercal
- Skeleton cartilaginous
- Five to seven pairs of gills
- Operculum (gill cover) absent

**Example:** *Scoliodon (dog-fish)* Fig 3.16a)




**Class 2. Osteichthyes**

(os = bone; ichthyes = fish)

- Mouth terminal
- Tail homocercal
- Skeleton bony
- Four pairs of gills
- Operculum present

**Example:** *Labeo (*Rohu*)* Fig 3.16b)

**Class 3. Amphibia (amphi: double or both, "bios" : life referring to life on land as well as in water)**

**Main characters:**

- The animal partly live in water and partly on land.
- Skin smooth or rough, rich in glands.
- Two pairs of limbs; pentadactyl (five-fingered), digits without claws.
- Body with distinct head and trunk, no neck.
- Two nostrils opening into the buccal cavity.
- Tympanum present on surface of body wall.
- Eggs are laid in water.
- In the early stage of life (larvae), they breathe by means of gills, but adults breathe by lungs.

**Example:** Salamandra, Proteus, Rana, Bafo, Ichthyophis.

**Class 4. Class Reptilia (reptere: to crawl) : are four-legged or legless crawling animals whose body is covered by scales, they lay eggs on land.**

**Characteristic Features:**

- Terrestrial (live on land), or some are aquatic (live in water).
- Body covered with horny scales.
- Skin is dry.
- Paired pentadactyl limbs (absent in snakes) with clawed digits.
- Tympanum small and depressed (absent in snakes).
- Respiration by lungs.
- Heart three-chambered but with a partially divided ventricle (4- chambered in crocodiles).
- Their eggs have leathery shell.

**Example :** Tortoise, turtles, garden lizard (*calotes*) wall lizard (Hemidactylus), cobra (*Naja naja*) and crocodile (Crocodile (*Crocodilus*) and Gharial (*Gravialis*)

**Class (5) Class : Aves (avis = Bird)**

**Characteristic Features:**

- Warm-blooded (homoiothermal, also called endothermal i.e. body temperature remains constant).
- Body covered with feathers, scales are present only on hind-limbs
- Body is divisible into three parts: head, neck and truck.

- Jaws with horny beak, no teeth.
- Hind-limbs with four digits adapted for perching, walking or swimming
- Bones with air spaces to make the skeleton light (pneumatic bones).
- Forelimbs modified into wings for flight.
- Heart 4-chambered, lungs for respiration connected with air-sacs.
- Voice box or syrinx (present at the junction of trachea and bronchi).
- Only left ovary and oviduct present in the females (economy in body weight.)
- All oviparous (lay eggs), egg with much yolk and calcareous shell.

**Example**: *Struthio (*Ostrich*), Abteryx* (Kiwi)*, Pavo* (Peacock) *Columba,* (Pigeon),

**Class (6) Mammalia (Mamma – Breast)**

- Body covered by hair, presence of mammary gland.
- Sweat and oil gland present in skin.
- Dentition the codont and hetrodont.
- Seven neck vertebrae, worm blooded, heart fear chambered.
- Testies are extra abdominal.
- Viviparous, give birth to the young EX - Prototheria.
- Duck bill platypus (viviparous), Kangaroo, Bat, Tiger Human, Rat, Whale etc.

## EXERCISE

**1.** Explain few properties of Bryophyta.
**2.** Name the male & female sex organ of bryophyta.
**3.** Define the term alternation of generations.
**4.** Name the dominant generation of pteridophytes.
**5.** Explain the habitate of pteriodphyte.
**6.** Give any two common examples of gymnosperm.
**7.** List two commercial product of gymnosperm.
**8.** Write the name of some families of angiosperm.
**9.** Explain parasitic property of platyhelminthes.
**10.** Member of which phylam possesses the cnidoblast?
**11.** Explain property of the phylum Arthropoda with few examples.
**12.** Give some examples of bony fishes and cartilagenaus fishes.
**13.** Name one failles amphibian.
**14.** What is the voice box in bird called.?
**15.** Name the group of mammals which includes :
(i) Egg- laying mammals
(ii) Pouched mammals.

CHAPTER 03

# TISSUES AND OTHER LEVELS OF ORGANISATION

**Tissue –** A tissue is a group of cells with a common origin, structure and function. The study of tissue is called histology.

**The Plant tissue –** Plant tissue is two type – **(1)** Meristem **(2)** Permanent.

**(1) Meristem –** Composed of living, than-walled, Prominent nucleus cell which have division capacity. It s following three type –

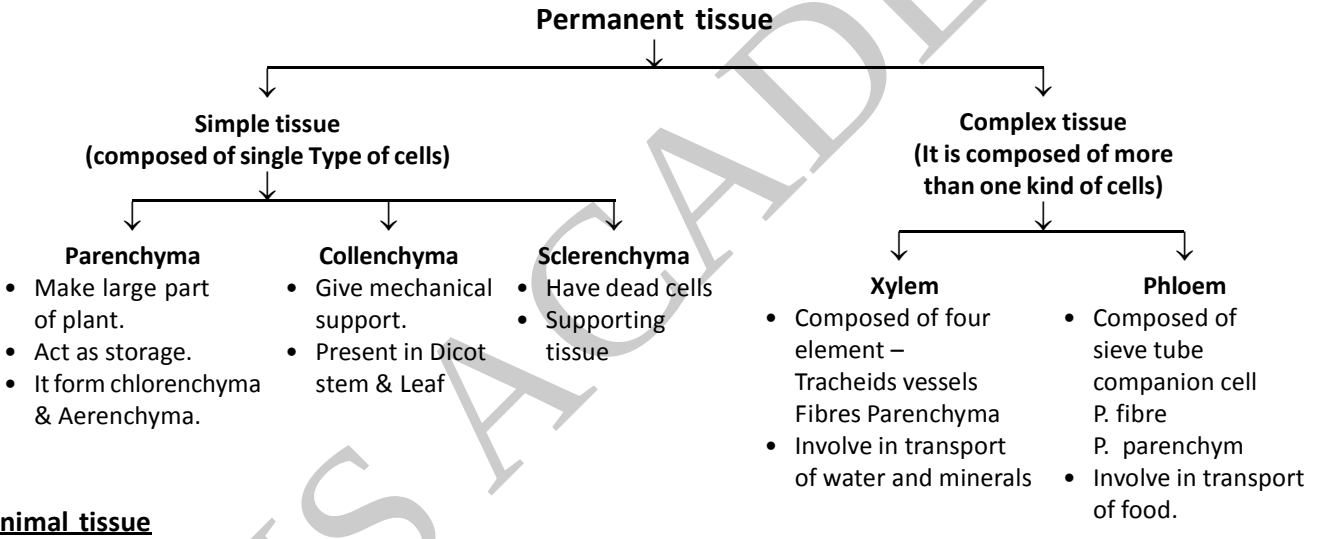
**(a) Apical meristem –** Present at root and shoot tip involve in increase length of plant.

**(b) Intercalary Meristem –** Present at node involve in growth of Internode.

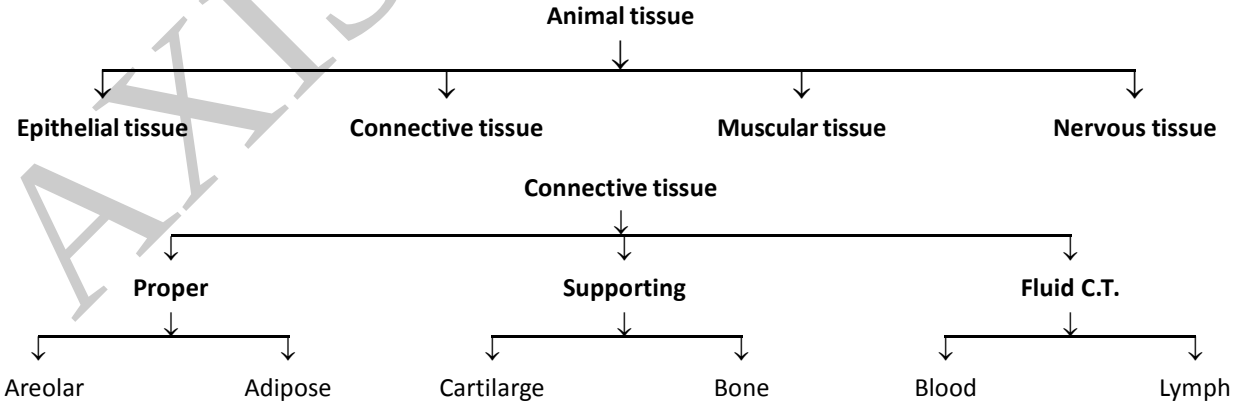
**(c) Lateral Meristem –** It is cambium and cork cambium involve in secondary growth.

**(2) Permanent tissue –** It is composed of living or dead cells.

They have thick wall cells. Permanent tissue loss their division properity.




**Animal tissue**




- **Squamous Epithelium –** Irregular flattened cell, Present in Lungs, blood capillaries etc. It help in exchange of gases, materials.

• **Cubodial Epithelium** – Have cub like cells, Present in lining of ducts, It involve absorption and secretion.

• **Columnar Epi** – Have long column like cells, present in stomach and intestine. It involve in secretion and absorption.

• **Ciliated Epithelium** – Have cilia of free surface. Present in kidney tubules. It help in flow of materials.

• **Connective tissue** – Composed of matrix and cells. It involve in Binding support and transport.

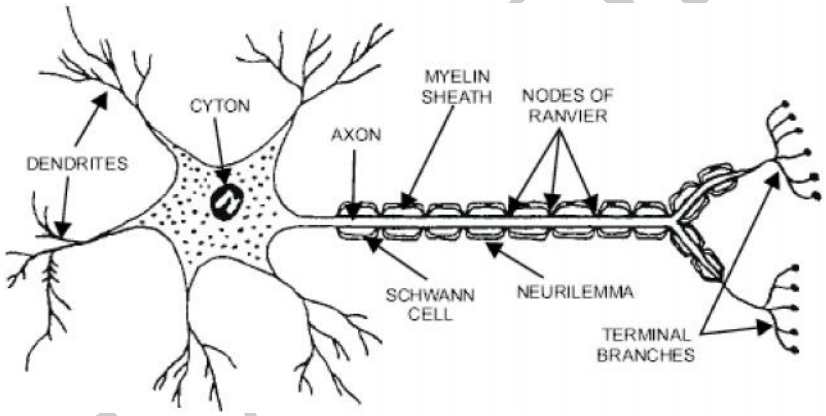
➢ **Muscular tissue –** Composed of long excitable cells containing parallel microfilament of contractile protein, as in actin, myosin, troponin and tropomyosin. It is following three type –

**(1) Striated Muscle –** It is attached with skeleton. Have elongated multinuckated myofibrils. Voluntary in function.

**(2) Unstriated Muscle –** It is located in body organs. Have spindle shape, single nucleated myofibres. Involuntary in function.

**(3) Cardiac Muscle –** It is located in heart walls. Have Elongated, cylindrical, branched myofibres. Involuntary in function.

**(4) Nervous Tissue –** It is composed two kind of cells – neuron and neuroglia cells. It constitute the brain, spinal cord, nerves and sense organ.




**Level of organization :** Animals have following type of organization.

***(i)*** **Cellular level** – Composed of single cell. Ex – Protozoan.

***(ii)*** **Tissue Level** – Composed of tissue – Parenchyma, Epithelium.

***(iii)*** **Tissue system** – Vascular tissue, Organ level – Tissue form organ – Ex. Liver, leaf

***(iv)*** **Organ System** – Respiratory system, shoot system.

## EXERCISE

**1.** Define tissue. What is a complex tissue?
**2.** Mention any two special feature of the meristematic in plant.
**3.** Write the function of xylem and pheom
**4.** Write the location of cilinated epithelium & cuboidal epithelium in human.
**5.** Explain muscular tissue.
**6.** Draw structure of Nerve Cell.
**7.** Differentiate the parenchyma & sclerenchyma.
**8.** Which type of body organisation present in Protozoa.

CHAPTER
04

# SHOOT SYSTEM

Shoot system is an aerial part of plant body. It consist of stem, leaves, flower, fruit etc.

**STEM**

***(i)*** Stem is the ascending part of plant which is formed by the prolongation of the plumule of embryo.

***(ii)*** It is positively phototropic and negatively geotropic and hydrotropic.

***(iii)*** It bears nodes and internodes.

***(iv)*** Leaf bearing part of stem is called shoot.

**Modification of Stems**

**1. Underground Stems**

**(a) Rhizome :** It grows parallel or horizontal to soil surface. It bears nodes, internodes, buds and scaly leaves, e.g., Ginger, Turmeric, Ferms.

**(b) Tuber :** It is the terminal portion of underground stem branches which are swollen on account of accumulation of food, e.g., Potato

**(c) Corm :** It grows vertically to soil surface. It bears nodes, internodes, buds and scaly leaves, e.g., Colocasia, Gladiolus, Colchicum, Crocus, Amorphophallus (Zaminkand).

**(d) Bulb :** Stem is reduced and disc shaped. The bud is surrounded by many concentric leaves. The leaf bases are fleshy and edible, e.g., Onion, Lily, Garlic.

**(2) Sub-aerial Stems**

**(a) Runner :** It is elongated, prostrate branch with long internodes and roots at nodes, e.g., grass.

**(b) Sucker :** It arises by auxiliary bud of underground part of stem. The branch creeps below the soil surface and grows obliquely upward and produces new shoot, e.g., Chrysanthemum, Pineapple and Banana.

**(c) Offset :** Short horizontal branch producing a cluster of leaves above and cluster of roots below, e.g., Pistia, Eichhornia.

**(3) Special modifications of stem**

**(a) Phylloclade :** It is green flattened or cylindrical succulent stem with leave modified into spine, e.g., Opuntia Euphorbia.

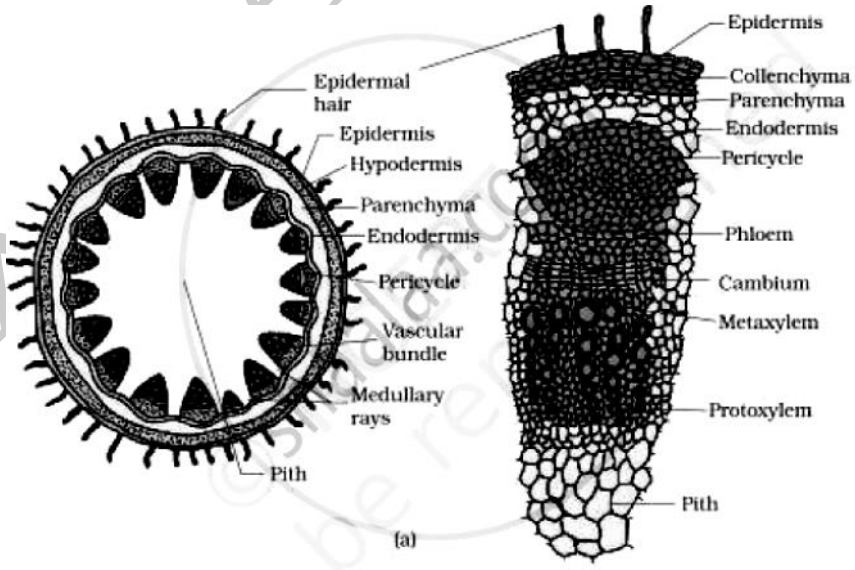
**(b) Cladode :** Phylloclade with one internode is called cladode, e.g., Asparagus, Ruscus.

**(c) Thorn :** It is modification of axillary bud, e.g., Bougainvillea and Citrus.

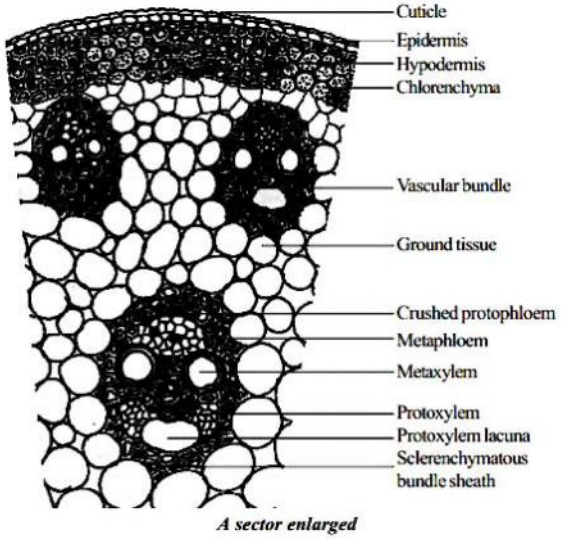
**(d) Stem tendril :** Selender and spirally coiled structure that help plant to climb, e.g., Cucumber, Pumpkin, Watermelon and Grapevines.

## (c) Anatomy of Stem ì

| Differences between dicot and monocot stem | | |
|---|---|---|
| **Characters** | **Dicot Stem** | **Monocot Stem** |
| 1. Epidermis | Single layered with hair (trichome). | Single layered without hair. |
| 2. Hypodermis | Collenchymatous. | Sclerenchymatous. |
| 3. Cortex | Made up of several layers of parenchymatous tissue. | Absent but parenchymatous ground tissue present from hypodermis to centre of stem. |
| 4. Endodermis | Single layered which is usually not well differentiated. | Absent |
| 5. Pericycle | Made up of one or more layers of parenchymatous or sclerenchymatous cells. | Absent |
| 6. Medullary rays | Found between the vascular bundles. | Absent |
| 7. Pith | Made up of parenchymatous cells situated in the centre of stem. | Absent (Pith cavity is present in stems). |
| 8. Vascular bundles | **(a)** Vascular bundles arranged in ring. | (a) Scattered, throughout the ground tissue. |
| | **(b)** Conjoint, collateral or bicollateral, end arch and open. | (b) Conjoint, collateral, end arch and closed. |
| | **(c)** Almost all of them are uniform in size. | (c) Larger towards centre and smaller towards outer side. |
| | **(d)** Wedge shaped | (d) Oval in shape. |
| | **(e)** Bundle sheath absent. | (e) Bundle sheath present. |
| | **(f)** Vessels arranged in rows (radial). | (f) Vessels arranged in V or Y shaped manner. |
| | **(g)** Phloem parenchyma present. | (g) It is absent |
| | **(h)** Schizolysigenous cavity absent. | (h) Schizolysigenbous water canal or cavity resent (formed by disintegration of protoxylem) |




**T.S. of stem (a) Dicot – Sun flower**




**Monocot stem (Maize)**

**Secondary growth in dicot stem** completes in following steps :

**1. Formation of vascular cambium ring :**

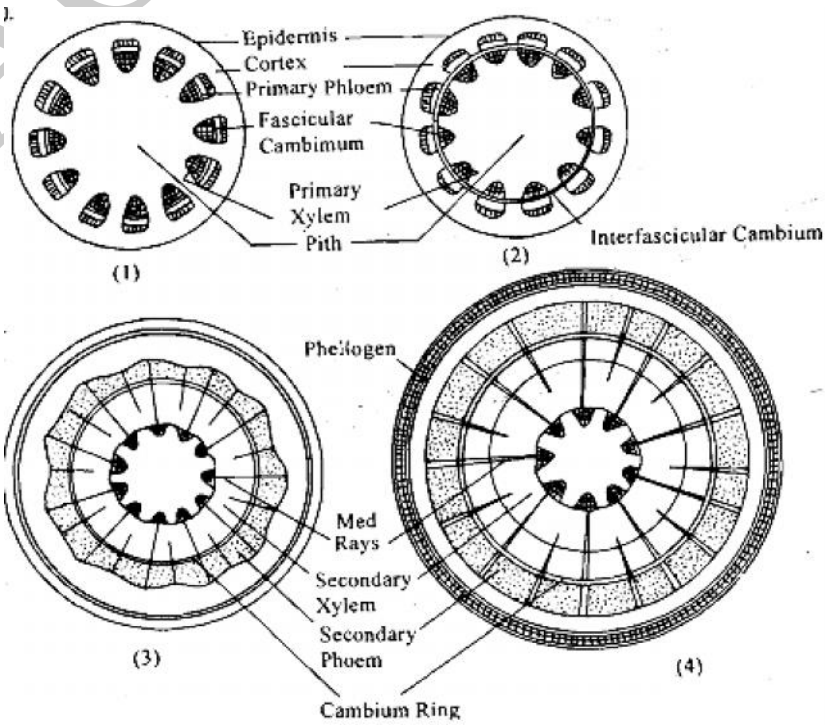
***(i)* Intrafasclicular cambium :** It is primary in origin, present in between primary phloem and primary xylem.

***(ii)* Interfasclcular cambium :** It is true secondary meristem. It originates from parenchyma cells of medullary rays regions. It lies in between the vascular bundles.

***(iii)* Vascular cambium ring :** Both intrafascicular and interfascicular cambia join each other and forms cambium ring.

**Activity of cambial ring:**

The cambial ring becomes active and begins to cut off new cells, both towards the inner and the outer sides. The cells cut off towards pith, mature into **secondary xylem** and the cells cut off towards periphery mature into secondary phloem. The cambium is generally more active on the inner side than on the outer. As a result, the amount of secondary xylem produced is more than secondary phloem and soon forms a compact mass. The primary and secondary phloem's get gradually crushed due to the continued



formation and accumulation of secondary xylem. The primary xylem however remains more or less intact, in or around the centre. At some places, the cambium forms a narrow band of parenchyma, which passes through the secondary xylem and the secondary phloem in the radial directions. These are the secondary medullary rays.

**Figure** : Secondary growth in a dicot stem (diagrammatic) – stages in transverse views

**Annual rings** : These are formed by the seasonal activity of vascular cambium. Cambium is not uniformly active throughout the year. In spring or summer, cambium is more active and forms large sized xylem elements (vessels) which constitute spring or early wood. In autumn or winter, cambium is less active and cut off small sized xylem elements (vessels) and constitute autumn wood or late wood. Both autumn and spring wood constitute an annual ring. In one year only one annual ring is formed. In successive years numerous growth rings are formed. Thus by counting the number of annual rings in the main stem at the base we can determine the age of a tree. This branch of science is known as dendrochronology.

Growth rings are distinct or sharply demarcated in the plants of temperate climate, e.g., Shimla, Nainital Mussourie due to presence of contrasting seasonal variations. Growth rings are not distinct or sharply demarcated in the trees of tropical climate (near equator), e.g., Calcutta Bombay, Madras due to absence of contrasting seasonal variations.

**Heart wood and Sap wood**

| | Heart wood | Sap wood |
|---|---|---|
| **1.** | Forms the central major portion. | Forms the peripheral portion. |
| **2.** | It is darker in colour. | It is lighter. |
| **3.** | It has deposition of organic compounds like tannins, resins, oils, gums, aromatic substances and essential oil. | These depositions are absent. |
| **4.** | It is more hard durable and resistant to the attack of microorganisms and insects. | These features are absent. |
| **5.** | It provides mechanical support. | It is involved in conduction of water and minerals from root to leaf. |

**Formation of cork cambium:**

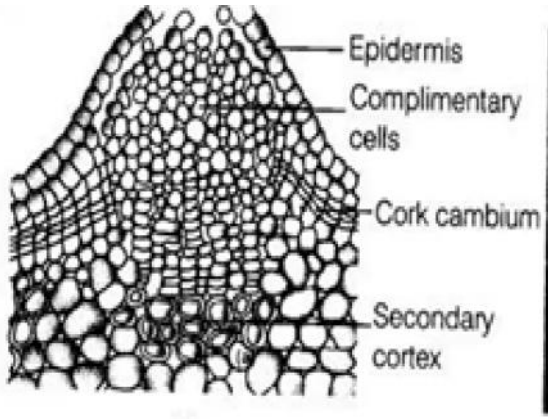
- It is formed by dedifferentiation of cortical cells. It is also called as phellogen. It is made of narrow, thin-walled and nearly rectangular cells.
- Phellogen cuts cells on both sides. Towards inner side if forms secondary cortex or phelloderm which is living and paranchymatous. Towards outer side it forms cork or phellem. It has suberin deposition and hence is impervious to water.
- Phellem + Phellogen + Phelloderm $\rightarrow$ Periderm.

  **Bank :** It is a non-technical term that refers to all tissues lying outside the vascular cambium. It includes periderm and secondary phloem.
- Bark formed early in the season is called early or soft bark.
- Towards the end of the season late or hard bark is formed.

  **Lenticels :** At some place phellogen cut off closely arranged parenchymatous cells on the outer side instead of cork cells. These parenchymatous cells soon rupture the epidermis forming lens-shaped opening called lenticels.

  It helps in exchange of gases.

It is generally present in woody stem.




**LEAF**

Leaves are laterals, flat green and expanded part of plant which arise from the nodes on the stem or branches. Leaves originate from shoot apical meristems and are arranged in an acropetal order. Usually leaf a bud in its axil. The auxiliary bud later develops into a branch. The chief function of leaf is photosynthesis and transpiration.

**Part of a Leaf : A leaf consists of following three parts:**

**(i) Leaf base (Hypopodium):** Leave are attached to stem by leaf base. In some plats, leaf base becomes swollen and is called **pulvinus** which is responsible for sleep movement, e.g. Mimosa. In some plants, leaf base expands into **sheath** (Sheathing leaf base), e.g., Grasses, Banana (monocots).

**Stipules –** are minute appendages arising from the leaf base.

***(i)*** **Petiole (Mesopodium) :** The stalk of leaf is called potiole.

***(ii)*** **Lamina (Epipodium) :** The broad flat part of the leaf is the lamina (leaf blade). It has veins and veinlets.

**Venation : Arrangement of veins in the lamina is called venation. It is of following types:**

**(a) Reticulate venation :** The branches of veins form a network, e.g., dicots. However there are some dicots which show parallel venation, e.g., Calophyllum, Erygium, Corymbium.

**(b) Parallel venation :** The veins and veinlets remain parallel to each other, e.g., monocots. Some monocots which show reticulate venation are, e.g., Smilax, Dioscorea, Alocasia.

**Type of Leaf**

**(a) Simple leaf :** Leaf which may be entire or incised and the incisions do not touch the midrib, e.g., Mango, Banyan.

**(b) Compound leaf :** Leaf blade is incised upto midrib or petiole thus, divides it into two or more leaflets. They are to two types:

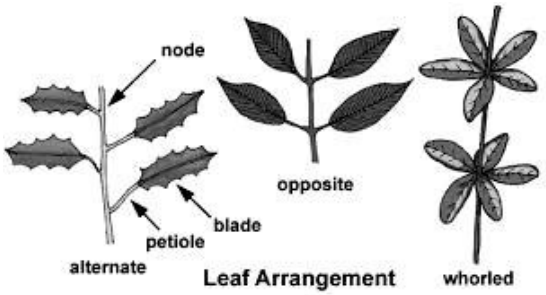
**1. Palmately compound leaves :** It has no rechis and all the leaflets are joined to a common point at the tip of petiole, e.g., Silk cotton.

**2. Pinnately compound leave:** Rachis bears a number of leaflects, e.g., Neem.

**Phyllotaxy**

It is mode of arrange of leaves on the stem or its branches. T is of following types:

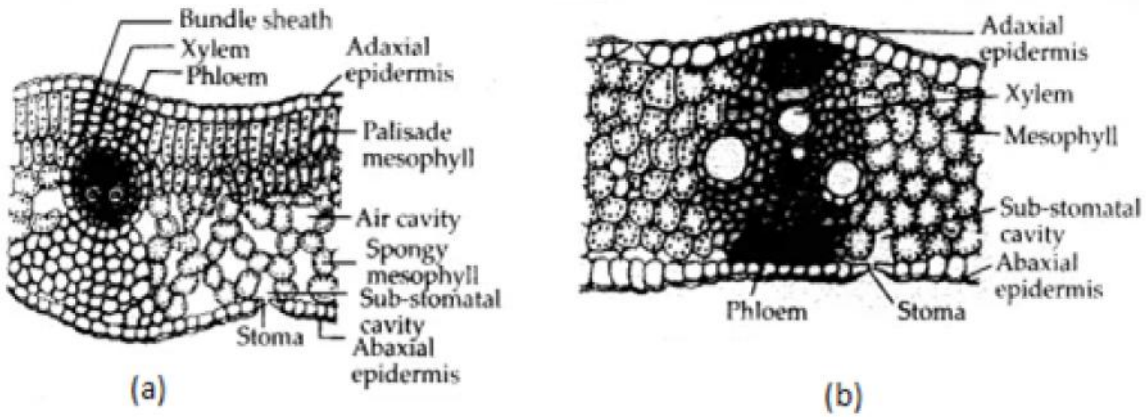
1. **Alternate or spiral :** Single leaf arising at each node, e.g., Mustard, China rose and Sunflower.
2. **Opposite :** Leaves occurring in pairs at the node. E.g., Calotropis and Guava.
3. **Whorled :** More than two leaves at each node, e.g., Nerium, Alstonia.




**Different types of phyllotaxy : (a) Alternate (b) Opposite (c) Whorled**

**Anatomy of Leaf**

| Major Anatomical Difference between Dorsiventral and Isobilateral Leaf | | |
|---|---|---|
| **Features** | **Dorsiventral leaf** | **Isobilateral leaf** |
| Cuticle | Thick at upper or ad axial epidermis and thin at lower or abaxial epidermis. | Uniform cuticle |
| Stomata | More on lower surface. | Equal number of stomata on either side |
| Mesophyll | Differentiated in to palisade and spongy parenchyma. | Not differentiated into palisade and spongy parenchyma |




**T.S. leaf : (a) Dicot ; (b) Monocot**

**FLOWER**

Flower is defined as a highly condensed and modified reproductive shoot. Following points can be mentioned to justify that flower is a modified shoot.

- A typical flower has four different kinds of whorls arranged successively on the swollen end of the stalk or pedicel, called thalamus.

**Position of floral parts on thalamus**

**(i) Hypogyny :** Ovary is at the top and separable from thalamus. Flowers are hypogynous and ovary is superior, e.g., Mustard, China rose Brinjal.

**(ii) Perigyny :** Ovary is half syperior, half inferior, e.g., Rose, Plum and Peach.

**(iii) Epigyny :** Calyx and corolla arise from upper side of ovary. Ovary is completely surrounded by and fused with thalamus. Ovary is inferior and flower is epigynous, e.g., Guava. Cucuber and the rayflorets of sunflower.

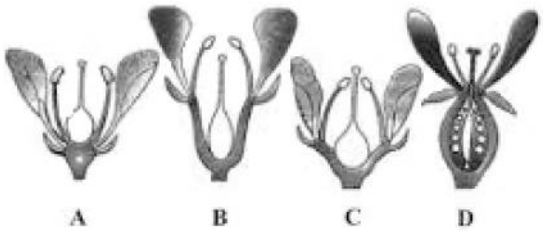



**Figure :** Position of floral parts of thalamus : **(a)** Hypogynous ; **(b)** & **(c)** Perigynous ; **(d)** Epigunous

**INFLORESCENCE**

The arrangement of flowers on floral axis is called inflorescence.

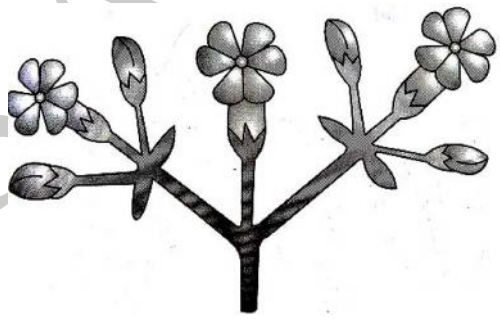
**Types**

**(A) Racemose (Indefinite)**

Main axis of inflorescence does not end in a flower but continues to grow. The development of flowers is acropetal. The opening of flowers is centripetal, e.g., Radish, Wheat, Cauliflower, Sunflower

**(B) Cymose (Definite)**

Main axis ends in a flower. The development of flowers is **basipetal** and opening of flowers **is centrifugal**, e.g., *Solanum*.



**Cymose inflorescence**

**(C) Special Inflorescence**

These are of following types:

**(i) Verticillaster :** A cluster of sessile or subsessile flowers borne on a dichasial cyme ending in monochasial cyme (scorpioid) in the form of condensed whorl on either side of the node, e.g., Ocimum (Tulsi), Salvia (Lamiaceae).

**(ii) Cyathium :** It looks like a single flower, Where a cup shaped involucre encloses a single female flower and a number of male flowers. Each male flower is represented by single stamen, e.g., Poinsettia (Euphorbia pulcherrima).

**(iii) Hypanthodium :** Faeshy receptacle forming a narrow cavity with an apical opening. The flowers are developed on inner wall of the hollow cavity. The male flowers are situated at the top near the opening, below them are situated the female flowers with long styles and at the bottom are situated short styled gall flowers which are sterile, e.g., Ficus (Banyan, Fig. Gular).

**Part of Flower**

**(1) Calyx :** Lowermost whorl of a flower is called calyx. It is the non-essential whorl and consists of sepals. Sepals may be free (polysepalous) or fused (gamosepalous).

**(2) Corolla :** It is second whorlof flower and consists of a number of petals which are usually brightly **coloured.** The petalsmay be gamopetalous (fused) or polypetalous (free) Various forms of petals are

**(a) Cruciform :** Four petals arranged like a cross, e.g., members of Brassicaceae.

**(b) Papilionaceous :** Number of petals is five with largest petal **standard** or vexillum enclosed two lateral wings which are free and in turn enclose the nnermst fused petals, **keel**, e.g., Pea.

**Aestivation** : Arrangement of flora parts in a floral bud is known as aestivation. It may be of following types :

**(i) Valvate :** When sepals or petals lie very close to each other without overlapping, e.g., Mustard, Calotropis.

**(ii) Twisted or contorted:** When one margin of the sepal or petal overlaps the margin of next and other margin is overlapped by the third one, e.g., China rose, Lady's finger and cotton.

**(iii) Imbricate :** When both margins of one of the petals are covered by other and both margins of another one are external and of the remaining partly internal, partly external, e.g., Cassia and Gulmohur.

**(iv) Quincuncial :** When two are inner, two are outer and one is partly outer and partly inner, e.g., Ranunculus.

**(v) Vexillary :** The posterior one is largest and almost covers the two lateral petals and the latter in turn nearly overlap the two anterior petals, e.g., Pea and beans (Fabaceae).

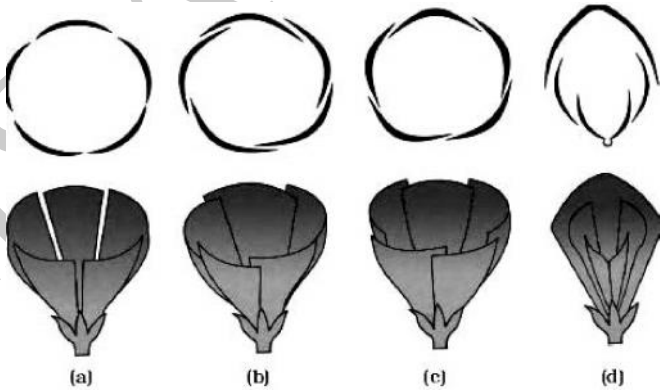



**Figure :** Types of aestivation in corolla : **(a)** Valvate **(b)** Twisted **(c)** Imbricate **(d)** Vexillary

**(3) Androecium :** Androecium is the third and male whorl of the flower and is made up of one or more stamens (microsporophylls). Each stamen consists of **filament** and **another**. The two lobed another is called **bithecous** another, e.g., Pea. The another with one lobe is called **monothecous** another, e.g., members of **Malvaceae**. A sterile stamen is called staminode.

**(a) Cohesion of Stamens :** Fusion among themselves.

(i) **Polyandrous :** Stamens free (no cohesion), e.g., Lily, Mustard.

(ii) **Monoadelphous :** Stamens may be united by means of their filaments in bundle, e.g., China rose, (Malvaceae).

(iii) **Diadelphous :** When the filaments are united into two bundles, the remain free e.g., Pea, (Fabaceae).

(iv) **Polyadelphous :** When the filaments are united into more than two bundle but anthers are free, e.g., Citrus.

(v) **Syngenesious :** When anthers are united but the filaments are free, e.g., Sunflower, (Compositae).

(vi) **Synandrous :** When anthers as well as filaments of stamens are united throughout their whole lengh, e.g., members of Cucurbitaceae.

**(b) Adhesion of Stamens :** Fusion with other floral parts.

**(i) Epipetalous :** When stamens are united to the petals, e.g., China rose, Brinjal, Sunflower.

**(ii) Epiphyllous (Epitepalous) :** When stamens are united to perianth (tepal), e.g., members of Liliaceae.

**(c) Length of Stamens**

**(i) Didynamous :** Four stamens, two outer long and two inner small, e.g., Ocimum, Salvia.

**(ii) Tetradynamous :** Six stamens, two outer small and four inner long, e.g., Mustard.

**(4) Gynoecium :** It is the female part of flower comprising of carpels bearing ovules. It consist of ovary, style and stigma. The gynoecium may be monocarpellary or polycarpellary.

**(a) Cohesion of Carpels**

**(i) Apocarpous :** Carpels are free (no cohension), e.g., Lotus and Rose.

**(ii) Syncarpous :** Carpels more than two and fused, e.g., Mustard and Tomato.

**(b) Number of locules :** Ovary has locules or chambers and may be unilocular, bilocular, trilocular tetralocular or pentalocular (multilocular).

**(c) Placentation :** The arrangement of ovules on placenta within the ovary is called placentation. It is of following types:

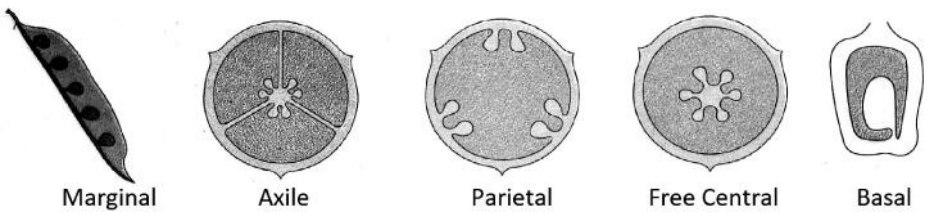
**(i) Marginal :** Placenta developing along the junction of the two margins of the carpel in one chambered ovary. It is characteristic feature of family Leguminosae, e.g., Pea, Gram.

**(ii) Axile :** The ovary is two to many chambered and placenta bearing ovules develop from the central axis e.g., Tomato, China rose, and Lemon.

**(iii) Parietal :** Ovary is one chambered and the placenta bearing the ovules develop on the inner wall of the ovary. The number of placenta corresponds to the number of carpels, e.g., Mustard and Argemone.

**(iv) Free central :** Ovary is one chambered and the placenta bearing the ovules develops all round the central axis, e.g., Dianthus and Primrose.

**(v) Basal :** Ovary is unilocular and the placenta develops at the base of ovary on thalamus and bears a single ovule, e.g., Marigold and Sunflower. It is most advanced.



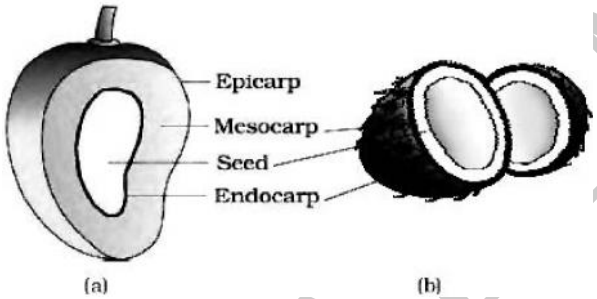
**FRUITS**

Fertilized and ripened ovary is fruit. A fruit consists (i) Pericarp (fruit wall)-developed from wall of ovary and may be differentiated into epicarp, mesocarp and endocarp (ii) Seeds-deelop from ovules.

In some plants ovary grows into fruit without fertilization, such fruits are called parthenocarpic fruits. They are seedless, e.g. Banana, Grapes.

The fruit which develops from vary is called true fruit. Most of the fruits are true fruit. If any other floral part taken part in fruit formation, it is called false fruit (pseudo carp), e.g., Apple, Pear.

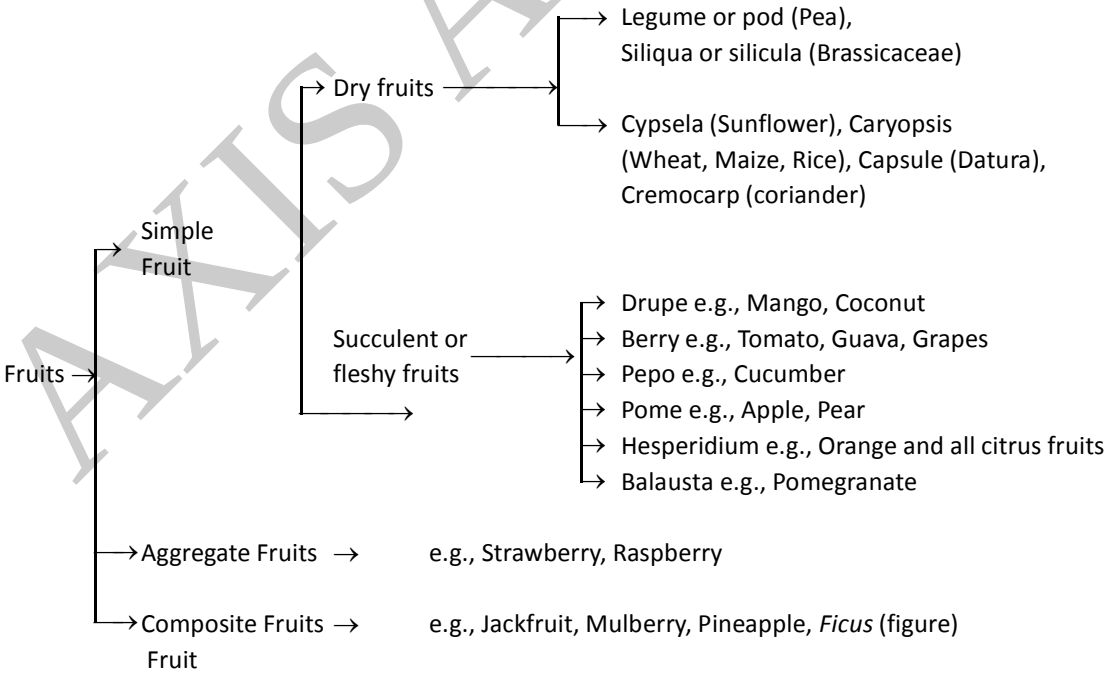
Simple fruit develops from the syncarpous ovary of the single flower with or without accessory parts. Aggregate fruits are formed polycarpellary, apocarpous ovary. Each carpel develops into a fruitlet and all fruitlets together form an aggregate fruit. The multiple fruit develops from the entire inflorescence.




In mango and coconut, fruit is known as drupe. The develop from monocarpellary superior ovaries and are single seeded.

Edible part in mango is middle fleshy mesocarp. In coconut endosperm is edible.

**Classification of different kinds of fruits**



## EXERCISE

**1.** Name the modification to which Runner, Stolen and offset belong.

**2.** Give Primary function of Stem.

**3.** Match the following in column A with column B.

| | **A** | | **B** |
|---|---|---|---|
| (a) | opuntia | - | storage of food |
| (b) | Ginger | - | Perennation |
| (c) | Potato | - | Photosynthesis |
| (d) | Datura | - | Protection |

**4.** Differentiate between monocot and dicot stem.

**5.** Where will you find radially arranged vascular bundles?

**6.** Explain activity of cambium ring in dicot plant during secondary growth.

**7.** How many layers involve in the fomation of periderm? Name the each layer.

**8.** How can you determine the age of tree?

**9.** Give two examples of insectivores plant.

**10.** Define placentation? Write examples of Axile and marginal placentation.

**11.** Define infolorescence . What is a cymose inflorescence?

**12.** Define fruit. Give two examples of false fruits.

# CHAPTER 05 ABSORPTION, TRANSPORT AND WATER LOSS (TRANSPIRATION IN PLANTS)

Water is one of the most important constituent of the protoplasm. It makes up 80-90% of the fresh weight of most herbaceous plants and over 50% of the fresh weight of woody plants. It acts as solvent in which the gases, minerals and other solutes enter the plant cells and move from cell to cell and from organ to organ. Water is a reactant or reagent or reagent in many important processes such as the hydrolysis of starch to sugar. Water maintains the turgidity which is essential for cell enlargement, growth and for maintaining the firm if herbaceous plants. Turgidity is also important in the opening and closing of stomata, movement of leaves, flower petals and various specialized plant structures.

**CELL TO CELL TRANSPORT**

**1. Diffusion :** It is "the movement of particles (or molecules or ions) of a substance from a region of its higher concentration to the region of its lower concentration down the concentration gradient until the molecules are evenly distributed throughout the available space".

Rate and direction of a diffusing substance depends upon the concentration of that substance at different sports, and is independent of the presence of other diffusing substances. It is the only means of gaseous movement within the plant body. Rate of diffusion is affected by many factors *e.g.,*

**2. OSMOSIS :** It may be defined as "the passage of solvent molecules from a region of their higher concentration to a region of their lower concentration through a semi permeable membrane". In all biological systems, the solvent is water.

**Osmotic Pressure**

It is the "actual pressure which is developed in a solution when it is separated from pure water by a differentially permeable membrane". It is also defined as "the pressure needed to prevent the passage of pure water into an aqueous solution through a semi permeable membrane thereby preventing an increase in the volume of the solution". The osmotic pressure depends upon (i) the **concentration of solute particles,** (ii) **ionization of solute particles,** (iii) **hydration of solute particles and** (iv) **temperature.**

**Water potential (Slatyer and Taylor 1960) :** Currently, the term water potential is used by biologists to describe the tendency of water molecules to move from one place to another. It is denoted by the symbol 'Ψ' (the Greek letter, psi).

$\Psi_w = \Psi_s + \Psi_p$ (where $\Psi_s$ = Solute potential, $\Psi_p$ = Pressure potential)

**Solute potential ($\nu_s$) :** Also called osmotic potential. It is defined as the amount of solute particles by which $\Psi_w$ is reduced. It is always negative.

**Pressure potential ($\nu_p$):** It is equal to TP and is positive except in plasmolysed cell and in xylem vessel where it is negative.

**Turgidity and Turg or Pressure :** If a plant cell is placed in hypotonic solution or pure water (*i.e.,* a solution of higher water potential), water starts moving into the cell by endosmosis. As the volume of the protoplast increases, it begins to exert pressure against the cell wall and stretches it. The pressure exerted by the protoplast against the cell wall is called turgor pressure (TP). The cell wall, being rigid, exerts an equal and opposite pressure on the protoplast, which is called wall pressure (WP). The two pressures are equal and opposite in direction. As the turgor pressure of the cell increases, the cell becomes turgid.

However, a stage is reached when this tendency of water to enter a cell i.e., osmotic potential is exactly balanced by turgor pressure. At this point the amount of water leaving the cell equals that exactly balanced by turgor pressure. At this point, the amount of water leaving the cell equals that entering the cell. Hence, there is not further net movement of water and cell is said to be in equilibrium with the exterior solution.

**3. Plasmolysis :** When a cell is placed in hypertonic solution, exosmosis occurs. Due to loss of water to external solution, T.P. of cell decreases, hence shape of the cell slightly changes. This stage is called as Limiting plasmolysis. If cell continues to be in hypertonic solution, more and more water is lost, therefore protoplast starts shrinking. It first leaves the corners of cell, stage is called as Incipient plasmolysis. If more water is lost protoplast shrinks and remains in contact with wall at one or two places. Space between cell wall and protoplast is occupied by outer solution. This stage is called as Evident plasmolysis. Turgor pressure of the cell at limiting plasmolysis is equal to 0, whereas at incipient plasmolysis and evident plasmolysis, T.P. of the cell is negative.

**4. Imbibitions :** Adsorption as well as absorption of a liquid by a solid without forming a solution is called as imbibition. The solid substance is called **imbibant,** whereas liquid is called as **imbibate**. The liquid particles are held in between the particles of solid by **adsorption and capillarity**. The phenomenon depends upon the affinity of imbibant to imbibate. As a result of imbibition (i) volume of imbibant increases (ii) heat is released which is called as **heat of wetting** (iii) develops a pressure which is called as imbibition pressure or **matric potential**

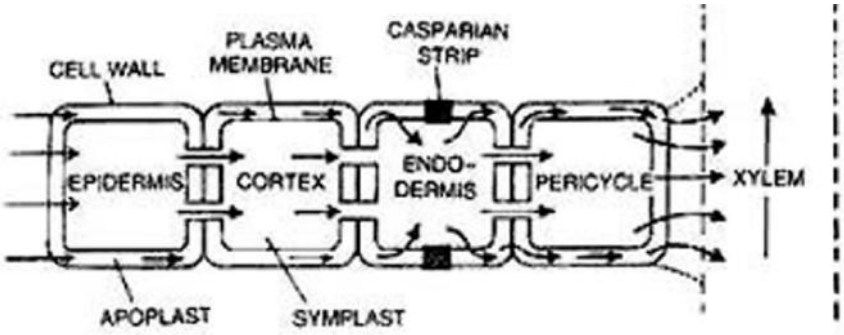
**Imbibants** present in plants are generally hydrophilic in nature. Among plant imbibants, Phycocolloids (e.g. Algin, Agar etc.) are the best imbibants followed by proteins, starch and cellulose. Lignin and suberin do not show imbibition.

Imbibition is affected by a number of factors like temperature, pressure against imbibant, surface texture of imbibant, electrolytes and pH.

**Long distance transport of water :** Special long distance transport systems are required to move substances across long distances and at much faster rate. Water and minerals and food are generally moved by a mass or bulk flow system. Bulk flow can be achieved either though a +ve hydrostatic pressure gradient (e.g., a graden hose) or a negative hydrostatic pressure gradient (e.g., suction through a straw)

**Absorption of water and Pathway of water across the root :** Water is mainly absorbed by root hair zone. Root hairs are elongation of epiblema cells. They have a vacuole filled with salt, sugars and organic acid, hence OP of the root hair cell is high cells. Due to entry of water, $\Psi_w$ of root hair cell become less negative. Movement of water from root hair cell to xylem may occur by two methods.

**1. Apoplast Pathway :** In this method, water passes from root hair cell to xylem through the walls of intervening cells without crossing any membrane or cytoplasm. The apoplastic movement of water beyond



cortex is blocked sue to the presence of casparian strips in the endodermal cells. Major movement of water through cortical cells occurs by this method, as cortical cells offer least resistance.

**2. Symplast Pathway :** In this method water passes from cell to cell by crossing plasma membrane, therefore it is also known as transmembrane pathway. This may occur by two methods:

**Machanism of Water Absorption:** Water is absorbed by two different mechanism:

(a) Passive (Water is absorbed through the roots)

(b) Active (Water is absorbed by the roots)

Water absorption by rapidly transpiring plants are called passive because forces responsible for water uptake develop in shoots and is transmitted to roots through which water enters. Active absorption depends on forces developing in roots and is found in low transpiring plants.

**Difference between Passive absorption and Active absorption**

| | Passive absorption | | Active absorption |
|---|---|---|---|
| **1.** | Roots are non-essential. | **1.** | Essential. |
| **2.** | Transpiration pull pay a role. | **2.** | Osmosis and energy play a role. |
| **3.** | Creates a negative pressure in xylem sap. | **3.** | Creates a positive root pressure. |
| **4.** | Responsible for 96% of total water uptake. | **4.** | Meets only 4% of water uptake. |
| **5.** | Water is absorbed due to process of transpiration. | **5.** | Water is absorbed by the osmotic and non-osmotic mechanisms. |
| **6.** | It is apoplastic. | **6.** | It is symplastic. |

**ASCENT OF SAP**

The water absorbed by roots has to be conducted upwards so as to meet the needs of tissues there. This vertical conduction of water from root to aerial parts of plat is called **ascent of water or ascent of sap.**

Theories explaining ascent of sap are :

**(1) Root Pressure Theory :** Due to movement of water from the soil into the root hairs and from there to cells of the xylem, a hydrostatic pressure of water develops inside root xylem. This is called **root pressure**. This pressure pushes the water up in the xylem vessels. The root pressure can be easily observed and measured when a freshly cut stump continues to exude water (bleeding) from its xylem vessels. This development of root pressure is an **active process**. It depends upon the active secretion of salts or other solutes into the xylem sap, thereby lowering its osmotic potential. This involves the utilization of metabolically produced energy and is inhibited by respiratory inhibitors such as cyanide, lack of oxygen and low temperatures. But, the positive hydrostatic pressure generated by root pressure (maximum 2 atmospheres) is not sufficient to push up water to more than a few meters. It cannot account for water movement up the xylem in tall trees. Also, actively transpiring plants and tall trees, especially conifers, do not generate root pressure. But it is a contributing factor in many plants. It may be sufficient for the transport of water in slowly transpiring herbaceous plants.

**Guttation (term by Bergerstein)**

Plants growing under humid conditions in a moist warm soil often exhibit droplets of water along the margins of their leaves. Phenomenon is commonly seen in Oat, tomato, cucumber etc. The loss of water in the form of liquid is called guttation. In moist and humid conditions, the rate of absorption of water greatly exceeds transpiration. The root pressure is built up which pushes the water up in the xylem ducts, from where it comes out on the leaf surface through special structures called hydathodes.

Hydathodes are present at the tips of veins in leaves. A hydathode consists of a pore in the epidermis followed by large intercellular spaces, loosely arranged parenchyma canned epithem which lie over the tip of vascular strands or xylem elements. Guttated water contains salts and it not pure.

**(2) Cohesion-tension or transpiration pull theory :** This is the most widely accepted theory proposed by **Dixon and Jolly** (1894). The main features of the theory are :

(a) Right from the root hairs to the leaves on top, water forms a continuous column in the plants.

(b) Water molecules have high cohesive forces between them i.e., these tend to stick to each other, because, being polar, these are electrically attracted to each other, by hydrogen bonds. The high cohesive force means that a relatively large tension is required to break column. In other words, the water column has a great tensile strength. The magnitude is generally 10-30 MPa.

(c) The ligno-cellulosic cell walls of xylem vessels have a strong affinity (adhesion) for water molecules. Therefore, a strong adhesive force exits between the walls of the xylem vessels and water, i.e., water tends to 'stick' to the vessel wall.

(d) As the water is lost from the leaf surface by transpiration, osmotic pressure of the leaf cells increases. As a result, the cells develop low water potential and water from the leaf veins (xylem) moves into leaf cells. The xylem vessels, in turn draw water from xylem of main stem. A negative (pulling) pressure is thus, exerted by all the leaves on the stem. The combined pressure, called transpiration pull, is strong enough to pull up the column of water to great heights. Rate of ascent of sap is 15 m/hr.

The whole column of water moves. Water potential as low as – 30 bars has been measured in the leaved borne on tree tops. Such a low water potential is sufficient to create pulling pressure which can overcome the gravitational pull and resistance offered by the capillaries of xylem vessels.

**Transpiration**

The loss of water in the form of vapour from the exposed parts of a plant is called transpiration.

**Types of Transpiration.**

**(1) Cuticular :** Loss of water vapour from general surface through cuticle. Commonly it is 3-10% of total but in herbs and ferns it may be 50%.

**(2) Lenticular :** Loss of water vapour from lenticels r aerating pores in bark of tree of fruits etc. It is hardly 0.1% of total.

**(3) Bark :** It is approximately 1% of total.

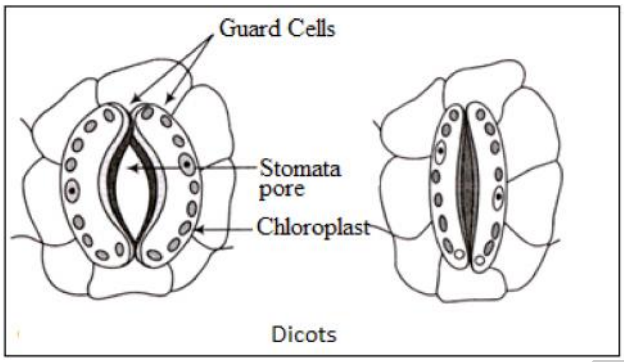
**(4) Stomatal :** Major form of transpiration constituting 50-97% of total.

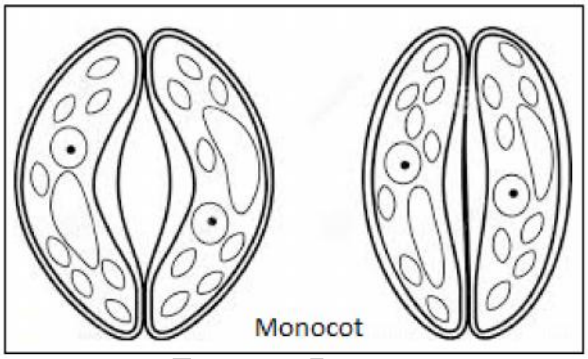
**Mechanism of Opening and Closing of Stomata :** Stomata function as turgor operated valves. When osmotic concentration of guard cells increases, water comes in, guard cells become turgid and stomata are open. Whenever, osmatic concentration of guard cell decreases water moves out, guard cells become flaccid and stomata get closed. In guard cells, cellulosic micro fibrils are oriented radially marking it easier for the stoma to open.

**Most accepted theory explaining opening and closing of stomata is—**

**Active $K^+$ ion Uptake Theory (Levitt) :** According to this theory pH of guard cells rises in day due to assimilation of $CO_2$ in photosynthesis and uptake of $H^+$ ions by chloroplast and mitochondria from cytoplasm. At this higher pH, starch is converted into PEP and then into malic acid, which dissociates into malate and $H^+$ ions. There occurs an efflux of $H^+$ ions and influx $K^+$ ions, which forms potassium malate; (a highly osmotically active substance) which is stored in vacuoles. This raises osmotic concentration of guard cells, water moves in, becomes turgid and stomata get open. In night, the process is reversed.

➢ **Ati – transpirant = The chemicals reduces transpiration rate is called anti – transpirant. e.g. – PMA, abscisic acid (ABA)**




**Structure of Dicot and monocot stomata**

## EXERCISE

1. Define following term : (a) Diffusion, (b) Osmosis
2. Name the phenomenon which make it difficult to close a wooden door after monsoon?
3. How does translocation occurs in plant?
4. Write difference between apoplast and symplast pathwaty.
5. Explain process of ascent of sap.
6. Draw structure of dicot stomata.
7. Differentiate between turger pressure and wall pressure.
8. Explain any four factor affect transpiration in plant.

CHAPTER 06

# NUTRITION IN PLANT
# MINERAL NUTRITION

The sum total of various processes by which an organism withdraws and utilizes the substances required for development and sustaining life related processes is called nutrition and these substances are called **nutrients.**

The absorption, distribution and metabolism of various mineral elements by plants is called mineral nutrition. About 60 elements have been reported from plant ash. Out of these, 30 are present in all the plants.

The inorganic nutrients are classified as essential elements and non-essential elements. 17 elements have been placed in essential elements. These are the elements without which the reproduction and life cycle of a plant cannot be completed. The essential elements are : C, H, O, N, P, K, S, Mg, Ca, Fe, Mo, Mn, Ni, Zn, B, Cl, Cu.

**ELEMENTARY IDEA OF HYDROPONICS AS A METHOD TO STUDY MINERAL NITRUTION**

Commercial technique of soil less culture is called **Hydroponics**, which was first developed by **Goerick** (1940). In 1860, Julius von Sachs, a German botanist, demonstrated for the first time, that plants could be grown to maturity in a defined nutrient solution in complete absence of soil. Culture is performed in large tanks of metal or Reinforced Cement Concrete (RCC) Tanks are covered with wire mech. Tanks are provided with aerating and circulating techniques. Seeds are suspended in solution from the wire mesh with the help of threads. As plant grows up additional support is provided.

Depending upon the quantity in which these elements are present in cell, they are classified as:

**(a) Macronutrients** are the elements which are present in a quantity of more than 10 mmole $kg^{-1}$ of dry matter. They are C, H, O, N, P, S, K, Mg, Ca.

**(b) Micronutrients** are the elements which are needed in a quantity of less than 10 mmole $kg^{-1}$ of dry matter. They are Fe, Mn, Mo, Ni, Zn, B, Cl, Cu.

**MACRO AND MICRO NUTRIENTS AND THEIR ROLE**

The concentration of the element below which plant growth is retarted is termed as critical concentration.

The element is said to be deficient when present blow the critical concentration.

The deficiency brings about certain morphological changes called deficiency symptoms. The common deficiency symptoms are chlorosis, necrosis, stunting, premature fall of organs and inhibition of cell division.

**Functions of Mineral Elements**

| | Mineral Element | Principal Functions |
|---|---|---|
| **1.** | Nitrogen<br>$NO_2^-$, $NO_3^-$ | (a) All living matter<br>(b) Amino acids, proteins<br>(c) Purines, pyrimidines<br>(d) NAD, NADP, FMN, FAD |

| | | |
|---|---|---|
| | | (e) Chlorophyll, cytochromes |
| **2.** | Phosphorus<br>$H_2PO_4^-$ | (a) Nucleic acids<br>(b) Nucleoproteins,<br>(c) Phospholipids<br>(d) AMP, ADP, ATP<br>(e) NAD, NADP<br>(f) Indispensible role in energy metabolism |
| **3.** | Potassium<br>$K^+$ | (a) Permeability<br>(b) Osmotic regulation<br>(c) Maintenance of cell organization<br>(d) Stomatal movements<br>(e) Translocation of sugars<br>(f) enzymes concerned with photosynthesis, nitrate reduction, protein biosynthesis, respiration, etc. |
| **4.** | Calcium<br>$Ca^{++}$ | (a) Cell wall structure<br>(b) Membrane structure<br>(c) Required by meristematic and differentiating tissues<br>(d) In cell elongation and spindle formation<br>(e) Activators of amylases, ATPase, etc. |
| **5.** | Magnesium<br>$Mg^{2+}$ | (a) Component of chlorophyll<br>(b) Activators of Pepco and Rubisco<br>(c) Combines the subunits of ribosome's<br>(d) Synthesis and hydrolysis of ATP |
| **6.** | Sulphur<br>$SO_4^{--}$ | Part of CoA, Ferredoxin, Thiamine, Lipoic acid, cysteine, methionine |
| **7.** | Iron<br>$Fe^{3+}$ | (a) Structural component of porphyrin molecules, cytochromes, leghaemoglobin<br>(b) Activates catalase enzyme |
| **8.** | Molybdenum<br>$Ma^2O^+_2$ | (a) Component of nitrate reductase<br>(b) $N_2^-$ fixation |
| **9.** | Boron<br>$BO_3^{-3}$ | (a) Translocation of sugars<br>(b) For seed, pollen and spore germination<br>(c) Flowering and fruiting |
| **10.** | Copper<br>$Cu^{++}$ | (a) Plastocyanin, cytochrome oxidase<br>(b) Terminal oxidation by cytochrome oxidase |
| **11.** | Manganese<br>$Mn^{++}$ | (a) In chlorophyll synthesis<br>(b) Photolysis of water (best defined function) |
| **12.** | Zinc<br>$Zn^{2+}$ | (a) Tryptophan synthesis (precursor of auxin)<br>(b) Activator of alcohol dehydrogenase enzyme<br>(c) Carbonic anhydrase |
| **13.** | Chlorine | (a) In the transfer of electron from water to PS II |

**DEFICIENCY SYMPTOMS OF ESSENTIAL ELEMENTS**

1. **Chlorosis** is caused by the deficiency of elements N, K, Mg, S, Fe, Mn, Zn and Mo.
2. **Necrosis** is due to the deficiency of Ca, Mg, Cu, K.
3. Lack or low level of N, K, S, Mo causes **an inhibition f cell division.**
4. N, S, Mo elements **delay flowering** if their concentration in plants is low.

**Hetrotrophic plants –** They categorized into two group-

1. **Saprophytes –** It grow an dead organic matter.
   **Eg.** Monotropa found in Khasi hills.
2. **Parasitic Plant –** It grow on other plants and take the nutrient.
   **Eg.** Dodder (Cuscuta).
3. **Insectivores plant –** They are autotrophic but trap insect to supplement of nitrogen.
   **Eg.** Pitcher plant (Nepenthes), Sundew (Drosera), Venus flytrap (Dionaea), Bladderwort (Utricularia).

## EXRCISE

1. What are the criteria of essentiality of element?
2. Differentiate between micro and macro nutrient.
3. Explain term hydroponics.
4. Give the deficiency symptoms of nitrogen, phosphorus and potassium.
5. What is meant by 'passive absorption' of minerals by plant.
6. Define following term : (i) Chlorosis, (ii) Necrosis
7. State any two function of $Ca^{++}$ in plant?

CHAPTER
07

# NITROGEN METABOLISM

**NITROGEN METABOLISM**

Nitrogen is the most prevalent element in living organism. The atmosphere contain near about 78% of $N_2$ by volume. Plants complete with microbes for the limited nitrogen that is available in soil.

Nitrogen Fixation by Free living organism and Symbiotic organism Examples of free living microbes which fix nitrogen-

*(i)* Clostridium **–** Anaerobic bacteria
*(ii)* Azotobactor –Aerobic Bacteria
*(iii)* Rhodospirillum – Purple, non-sulphur bacteria
*(iv)* Anabaena – Cynabacteria

**Examples of Symbiotic nitrogen fixation organism -**

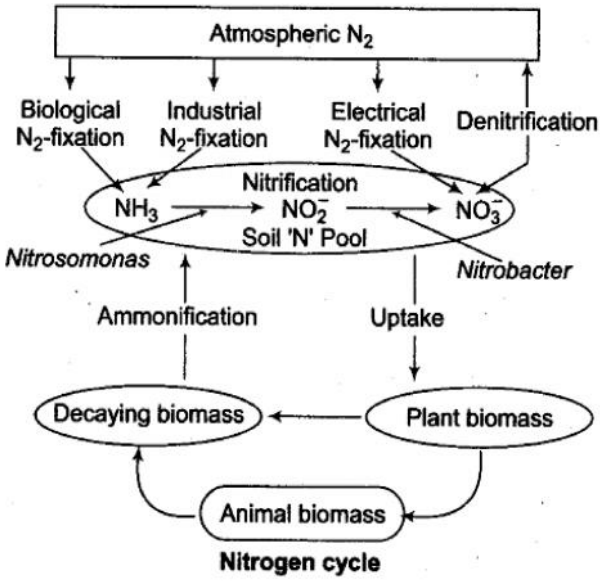
***(i)*** Lichen – Algae + fungi
***(ii)*** Bryophyte – Cynobacteria + Anthoceros
***(iii)*** Pteridophyta – Cynobacteria + Azolla
***(iv)*** Gymnosperm – Cynobacteria + Cycas
***(v)*** Angiosperm – Legume plant + Rhizobium

**(a) Nitrogen Cycle :**

Nitrogen is the most prevalent element in living organisms. The atmosphere contain near about 78% of $N_2$ by volume. Plants complete with microbes for the limited nitrogen that is available in soil. Thus, it is a limiting nutrient for both natural and agricultural ecosystems.

$N_2$ cycle can be conveniently discussed under the following steps:

*(i)* $N_2$ fixation *(ii)* Ammonification *(iii)* Nitrification *(iv)* Denitrification



Nitrogen cycle

**(b) Biological nitrogen fixation:**

Atmosphere is the ultimate source of nitrogen. Nitrogen is a highly inert gas. It cannot be used directly but has to be combined with C, H, N, O to form compounds before being used. Higher plants utilize nitrogen in the oxidized forms such as nitrate ($NO_3$É) and nitrite ($NO_2$É); or in the reduced form ($NH_4$+) made available to plants by the nitrogen fixers. The best known nitrogen fixing symbiotic bacterium is *Rhizobium*. This bacterium lives in the soil to form root nodules in plants belonging to the family **Leguminosae** such as beans, gram, groundnut and soyabean. Root nodules are little outgrowths on roots. When a section of the root nodule is examined, it appears pinkish due to the presence of a pigment called Leg hemoglobin. Like hemoglobin, leghemoglobin is an **oxygen scavenger**. The enzyme that catalyses the fixation of nitrogen is nitrogenase which functions under anaerobic conditions. Leghemoglobin combines with oxygen and protects *nitrogenase*. Free living microorganisms such as the cyanobacteria can also fix nitrogen. Some cyanobacteria also have symbiotic association with plants. They are found in lichens, *Anthoceros*, *Azolla* and coralloid roots of *Cycas*. In the process of biological nitrogen fixation, the **dinitrogen** molecule is progressively reduced by the addition of pairs of hydrogen atoms so that, the three bonds between the two nitrogen atoms are cleaved and ammonia is formed. These reactions occur only in the presence of a single enzyme **nitrogenase**. The process of nitrogen fixation is energy intensive.

**Requirements of $N_2$ Fixation:**

1. **Nitrogenase enzyme complex, (synthesized by nif genes of bacteria):** It is seat of nitrogen reduction and containsMo, Fe and S.
2. **Strong reducing agent.** *e.g.* $NASPH_2$, $FMNH_2$, Ferredoxin.
3. **Anaerobic conditions.**
4. **Energy source (ATP)**
5. **Cofactors** like TPP, CoA, $Mg^{+2}$
6. **Electron and $H^+$ donor** (generally glucose-6-phosphate)

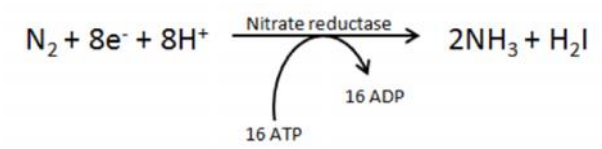
**<u>Process of Nodule Formation</u>**

Nodules are little outgrowths on the roots. When a root hair of a legume comes in contact with Rhizobium there occur an exchange of plant and bacterial signals. Bacteria secrete nod factors which result in curling of tip of root hairs. Plant responds by forming an infection thread which grows inward and carry the bacteria to cortical cells of root hairs. Some of bacteria enlarge to become membrane bound structures called bacteroids. Plant flacons act as inducers of nod genes which specify early events of nodulation.

Cortical cells are stimulated to divide rapidly. It is due to auxin secreted by plant and cytokinin contributed by bacteria.

Nodules are pink in colour due to leg-hemoglobin which is oxygen scavenger and protect nitrogenase. Its heme comes from bacteria and globin from legumes.

Process of $N_2$ fixation can be summarized as :




Ammonium ions can be taken up by higher plants but plants are more adapted to absorb nitrate ($NO_3$É) than ammonium ions ($NH_4$+) from the soil. Soil bacteria like *Nitrosomonas* and *Nitrococcus* convert

ammonia to nitrite (NO2É) ions. Nitrobacter oxidizes nitrite to nitrate. This process of converting ammonia into nitrate, a from of nitrogen more available to plants, is called **nitrification**.

$$4NH_3 + 7O_2 + 4e^- \xrightarrow{\text{Nitrosomonas Nitrococous}} 4NO^-_2 + 6H_2O \xrightarrow{\text{Nitrobacter, Nitrocystis}} 4NO^-_3$$

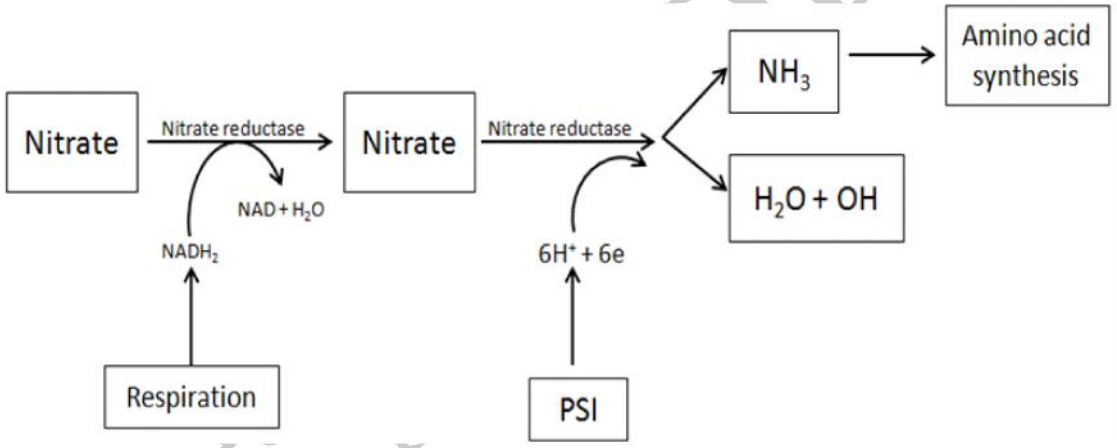
This process is an oxidation and releases energy which is used by nitrifying microbes in chemosynthesis.

**NITRATE ASSISMILATION**

The process of nitrate reduction o ammonia is called nitrate assimilation and is accomplished in two steps and contains molybdenum.

(a) First, the nitrate is reduced to nitrite by an enzyme called nitrate reductase. This enzyme is a flavoprotein and contains molybdenum.

The nitrite ions are then reduced to ammonia by an enzyme called nitrite reductase, Ferredoxin is the most direct source of electrons for nitrite reduction and it occurs specifically is leaves. Therefore, nitrite ions formed in other parts of the plant are transported to leaves and further reduced to ammonia. Nitrite reductase does not require molybdenum but contains copper and iron.




## EXERCISE

**1.** Define nitrogen fixation. Write name some bacteria involve in this process.

**2.** How does human haemoglobin differ from leghaemoglobin?

**3.** Match the following :

| | A | | B |
|---|---|---|---|
| (a) | Azotobacter | - | anaerobic nitrogen fixer |
| (b) | Clostridium | - | aerobic nitrogen fixer |
| (c) | Lichen | - | cynobacteria |
| (d) | Anabaena | - | symbiotic nitrogen fixer |

**4.** Differentiate between biological and abiological nitrogen fixation.

**5.** Write the name of enzyme which catylise the process of nitrogen fixation.

**6.** What is the function of leghemoglobin?

**7.** Name two name of biomolecule which contain nitrogen.

CHAPTER
# 08 PHOTOSYNTHESIS

**Photosynthesis**

Photosynthesis is "the synthesis of carbohydrates by green plants in the presence of light by utilizing $CO_2$ and $H_2O$. By this process, solar energy (ultimate source of energy for all living beings) is trapped by autotrophic organisms and is stored in the form of chemical energy.

$$6CO_2 + 12H_2O \xrightarrow[\text{chlorophyll}]{\text{light}} C_6H_{12}O_6 + 6H_2O + 6O_2$$

**Contributions of Some Scientists**

- Joseph Priestley : Vegetation purifies air (Phlogiston $\rightarrow$Dephiogiston)
- Jan lngen-Housz : Discovered photosynthesis
- Juliues Von Sachs : Glucose is produced during photosynthesis
- Engelmann : First action spectrum of photosynthesis
- Cornelius Van : Demonstrated that photosynthesis is essentially a light-dependent reaction in which hydrogen from a suitable oxidisable compound reduces carbon dioxide to carbohydrates
- Ruben, Kamen : Using $O^{18}$ ($H_2O$), found that $O_2$ evolved in photosynthesis comes from $H_2O$
- and Hassid : (in *Chlorella*)

**Site of Photosynthesis : Chlotoplast**

Chloroplast consists of membranous system consisting of grana, the stroma lamellae and the fluid stroma. These is a clear division of labour.

- Membrane system is concerned with light reaction i.e. synthesis of ATP and NADPH+ $H^+$
- The stroma is concerned with dark reaction i.e. reduction of $CO_2$

**Mechanism of Photosynthesis**

Photosynthesis occurs in two phases:

**A. Light reaction :** Solar energy is trapped by chlorophyll, and is stored in the form of chemical energy (ATP) and as reducing power (NADPH).

**B. Dark reaction :** Reducing capacity of NADPH and the energy of ATP are utilized in the conversionof $CO_2$ to carbohydrates.

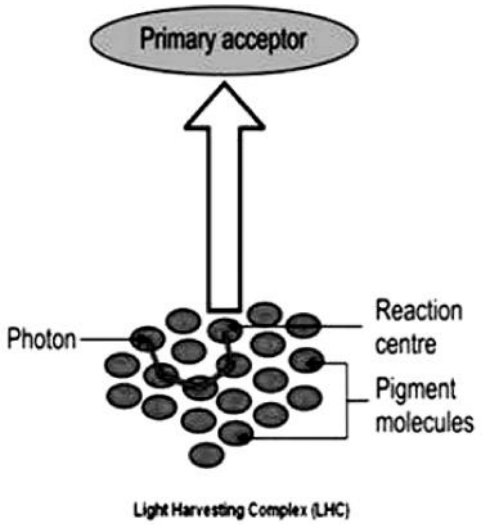
**Warburg** and others, using reaction inhibitors proved that light and dark reactions occur independently.

**A. Light Reaction or Photochemical phase and Biosynthetic phase :** Occurs in the thylakoids of grana. All those events which require light are included in this phase.

The pigments are organized into two discrete photochemical light harvesting complexes (LHC) within Photo system I and II. Pigment systems are composed of a reaction centre (Chl-a) and light harvesting molecules (Antenna molecules) bound to proteins. Light harvesting molecules absorb solar light and

| Photo system I / Pigment system I | Photo system II / Pigment system II |
|---|---|
| 1. The reaction centre is $P_{700}$ | 1. The reaction centre is $P_{680.}$ |
| 2. PS I lies on the outer surface of the thylakoids | 2. PS II occurs on the inner surface of the thylakoids. |
| 3. Found in both grana and stroma lamellae | 3. Found in grana lamellae only. |

transfer this energy to reaction centre where primary photochemical reaction occurs i.e. absorption of light quanta and release of an electron.

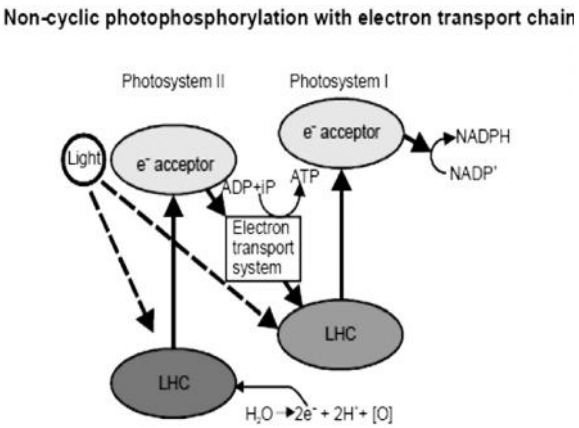


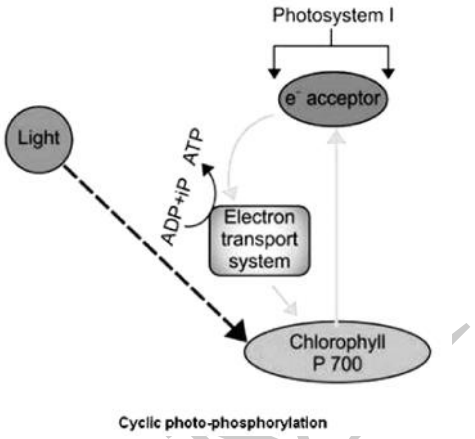

Non-Cyclic and Cyclic Photophosphorylation : In PS-II the reaction centre chlorophyll-a absorbs 680 nm wavelength of red light causing excitation of electron. These electrons are then picked by electron acceptor, which passes them to electron transport system consisting of cytochromes. This movement is down hill in terms of an oxidation-reduction or redox potential scale. Then these electron are passed to PS-I. Similarly PS-I is also excited by red light and electrons move down hill and are accepted by $NADP^+$. $NADP^+$ is then reduced to NADPH + $II^+$. When all the carriers are placed in a sequence on a redox potential scale the Z shape is obtained. Due to its characteristic shape it is known as z-scheme. This electron transfer is called **non cyclic – ETS.** The electrons that were moved from PS-II must be replaced. This is achieved by splitting of $H_2O$ done by water splitting complex associated with PS-II on the inner side of thylakoid membrane

$$2H_2O \xrightarrow[Ca^{+2}]{Mn^{-2},\ Cl^-} 4H^+ + 4e^- + O_2$$

In the stroma lamellaePS-II as well as NADP reductase enzyme are absent. Under such conditions only PS-I is functional, the electron is circulated within the photo system. Thus representing cyclic ETS. It also occurs when wavelength of light beyond 680 nm is available for excitation.

ETC along-with NADPH is also associated with ATP formation. The ATP formation from ADP and Pi in the presence of light is called photophosphorylation. When the two photo systems work together, then it is called non-cyclic photophosphorylation. When only PS-I works then it is cyclic photophosphyorylation.

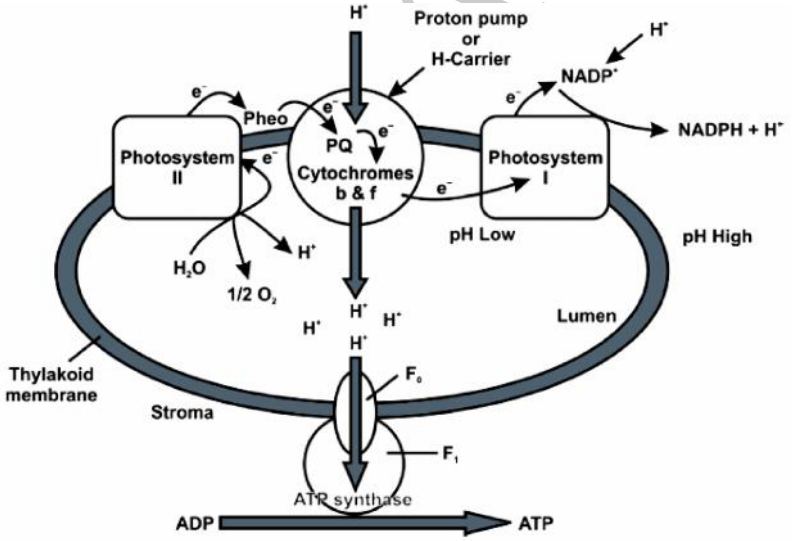



Cyclic photo-phosphorylation

**Chemi-Osmotic theory**

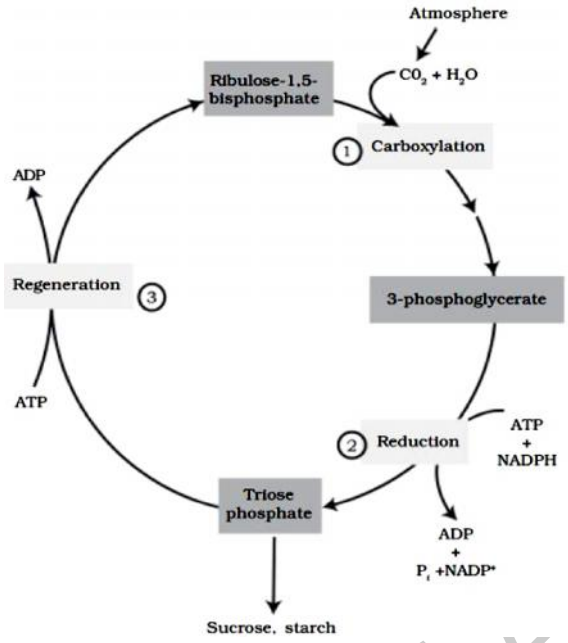
Chemiosmotic hypothesis was first explained by P. Mitchell to explain the mechanism of synthesis of ATP. As a result of (a) Photolysis of $H_2O$ towards thylakoid lumen, (b) Quinone pump, which takes $H^+$ from stroma to lumen, and (c) $NADP^+$ reductase eaction towards stroma; $H^+$ concentration in thylakoid lumen increased by 1000-2000 times and as a result a proton motive force develops. This force is responsible for ATP synthesis on the head of $CF_0$ – CF, particles. Movement of $3H^+$ is involved in the synthesis of 1 ATP.




ATP synthesis through chemiosmosis (in noncyclic photophosphorylation)

**B. Dark Reaction : Biosynthetic phase** is so called because it is independent of light. The ATP and NADPH produced by the light reactions are utilized in the dark reaction to reduce carbon dioxide to carbohydrate by a process called carbon fixation. It occurs in the **stroma**. The process comprises a series of reactions controlled by enzymes. The sequence of these reactions was determined in *Chlorella* and *Scenedesmus* by Calvin, Benson and Bassham using radioactive carbon $^{14}C$, and techniques like chromatography and autoradiography. Therefore, it is also known as **Calvin cycle or Calvin-Benson or $C_3$ cycle**. The dark reaction is also known as **Blackman's reaction**. The whole reaction can be studied in three parts :

**(i) Carboxylation** (Acceptance of $CO_2$ by RuBP – $CO_2$ acceptor),
(ii) **Glycolytic reversal,**
**Regeneration of RuBP**. 18 ATP and 12 NADPH + $H^+$ are used for the formation of a molecule of glucose.




| In | Out |
|---|---|
| Six $CO_2$ | One Glucose |
| 18 ATP | 18 ADP |
| 12 NADPH | 12 NADP |

**Cycle or Calvin Cycle**

**$C_4$ Plants**

**H.P. Kortschak and C.E. Hartt** (1965) found that in sugarcane (a tropical plant), leaves removed $CO_2$ more efficiently from the atmosphere and the first products of photosynthesis were acids containing 4-carbon atoms (e.g. malic, oxaloacetic and aspartic acid), rather than the 3C-acid PGA. Since then, the same has been foundtrue for many important tropical plants including monocots (like maize, Sorghum and Eleusine) as well as dicots (like Amaranthus and Euphorbia sp.) These plants are called $C_4$ plants. On the other hand, the plants in which the first product for photosynthesis is $C_3$ acid-PGA, are called C3 plants. Calvin cycle, infact, is $C_3$ pathway.

In 1966, two Autralian scientists, Hatch and Slack showed that $C_4$ plants were much more efficient in Co2 utilization than $C_3$ plants. Such plants do not show photorespiration. In 1967, Hatch and Slack explained the manner of $CO_2$ fixation and reduction in such plants. The new carbon pathway in $C_4$ plants is called **Hatch-Slack Pathway.**

The C4 plants possess a characteristic leaf anatomy. Thei r vascular bundles are surrounded by two rings of cells. The inner ring, called bundle sheath cells, contains starch-rich chloroplasts lacking grana which differ from those in the mesophyll cells which makes the outer ring. The chloroplasts in these plants are, therefore, called dimorphic. This peculiar anatomy is called Kranz anatomy because Kranz means crown or wreath, which refers to two distinct rings of cells.

The net result of $C_4$ pathway is the use of two high-energy phosphate bonds to transport $CO_2$ and hydrogen from the mesophyll cells to the chloroplasts of the bundle sheath cells.

Since every $CO_2$ molecule has to be fixed twice so $C_4$ pathway is more energy-consuming than the $C_3$ pathway. The $C_3$ pathway requires 18 ATP for the synthesis of one molecule of glucose. On the other

hand, the $C_4$ pathway requires 30 ATP. However tropical plants lose more than half of photosynthetic carbon in photorespiration, thus the $C_4$ pathway is an adaptive mechanism for minimizing this loss.

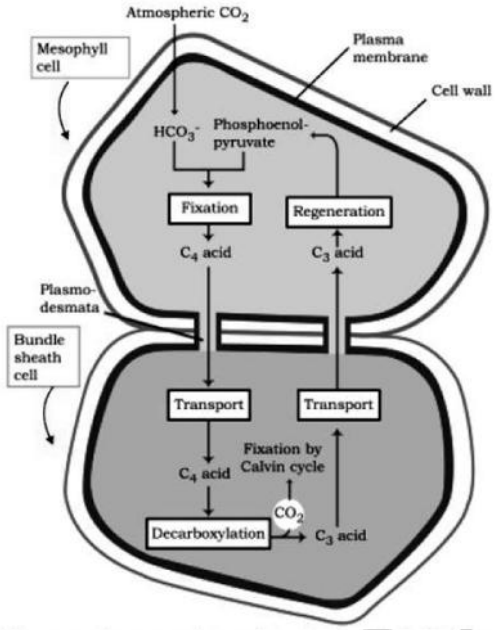



**Figure :** Diagrammatic representation of the Hatch and Slack Pathway ***Or*** $C^4$ – Cycle

**Factors Affecting Photosynthesis**

**Blackman** (1905) proposed law of limiting factor which states that "When a biological process is conditioned as to its rapidity by a number of separate factors, the rate of the process is limited by the pace of the slowest factor".

Photosynthesis is regulated by many factors. These factors are broadly classified into two categories:

**(a) External factors affecting photosynthesis**

**(1) Light** : It is an essential factor for photosynthesis. It affects the rate of photosynthesis in three ways:

light intensities. At higher light intensities gradually the rate does not show further increase as other factors become limiting. Light saturation occurs at 10% of full sunlight. Hence, except for plants ins shade or dense forest, light is rarely a limiting factor.

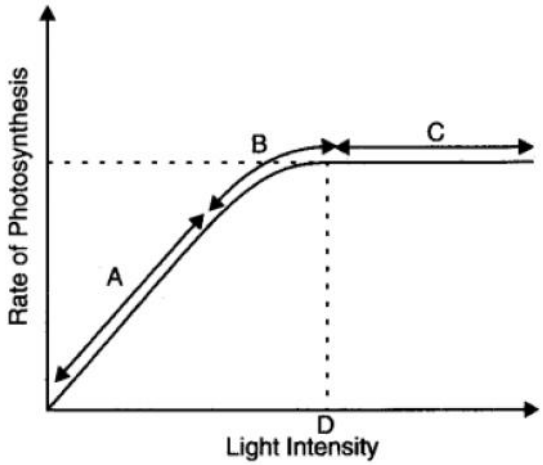



**Figure :** Graph of light intensity on the rate of photosynthesis

**(I) Light quality :** Light between 400-700nm wavelength constitute the photo synthetically active radiation or PAR. Maximum photo synthesis takes place when whole white light is available to the plant. Maximum photosynthesis takes place in red and blue light and minimum photosynthesis takes place in green light.

**(II) Duration of light :** Light duration does not affect the rate of photosynthesis, but it affects the total photosynthesis.

**(1) Carbon dioxide :** Carbon dioxide concentration is the major factor influencing the rate of photosynthesis. The $CO_2$ concentrationis very low in the atmosphere (between 0.03 and 0.04 percent). This level of $CO_2$ is far below the requirement for optimum photosynthesis. Thus, the rate of photosynthesis could be increased several times by increasing $CO_2$ concentration to about 0.25%. $C_4$ plants show saturation at about 360 ppm, while $C_3$ plants shows this beyond 450 ppm. Thus current $CO_2$ concentration is limiting for $C_3$ plants.

**(2) Temperature :** The dark reactions are controlled enzymatically in stroma, hence are temperature regulated, Optimum value of temperature for photosynthesis in $C_3$ plant is 20-250C and for $C_4$ plants is 300 – 450C. In $C_4$ plants, pyruvate phosphate dikinase enzyme is sensitive to low temperature, while in $C_3$ plants affinity of RuBisCo for $CO_2$ decreases at high temperature.

**(3) Water :** Photosynthetic process utilizes less than 1% of the water absorbed by a plant, hence, it is rarely a limiting factor in photosynthesis. But water scarcity affects photosynthesis indirectly. It water supply is withheld for sometime. Water stress can cause stomatal closing, wilting of leaves and reduced metabolic activities in leaves.

**Internal factors** (chlorophyll, photosynthetic products).

## EXERCISE

**1.** What is photosynthesis? Give the overall general chemical equation of photosynthesis.

**2.** In which colour of light, rate of photosynthesis is minimum and which colour of light it is maximum?

**3.** Which molecule is the source of evolution of oxygen in photosynthesis?

**4.** What is the role of enzyme :

(i) Rubisco

(ii) PEPCO and where are they present?

**5.** Explain Kranz antotomy.

**6.** Differentiate between $C_3$ and $C_4$ plants.

**7.** Explain calvin cycle.

**8.** Write external factors which affect the rate of photosynthesis.

**9.** What are the products of light reaction?

**10.** Differentiate between PSI and PSII.

CHAPTER 09

# RESPIRATION AND ELIMINATION OF NITROGENOUS WASTE

**Respiration –** Respiration is the stepwise oxidation of glucose or other nutrient which result in release of energy that store in the form of ATP. Respiration is complete in following two steps –

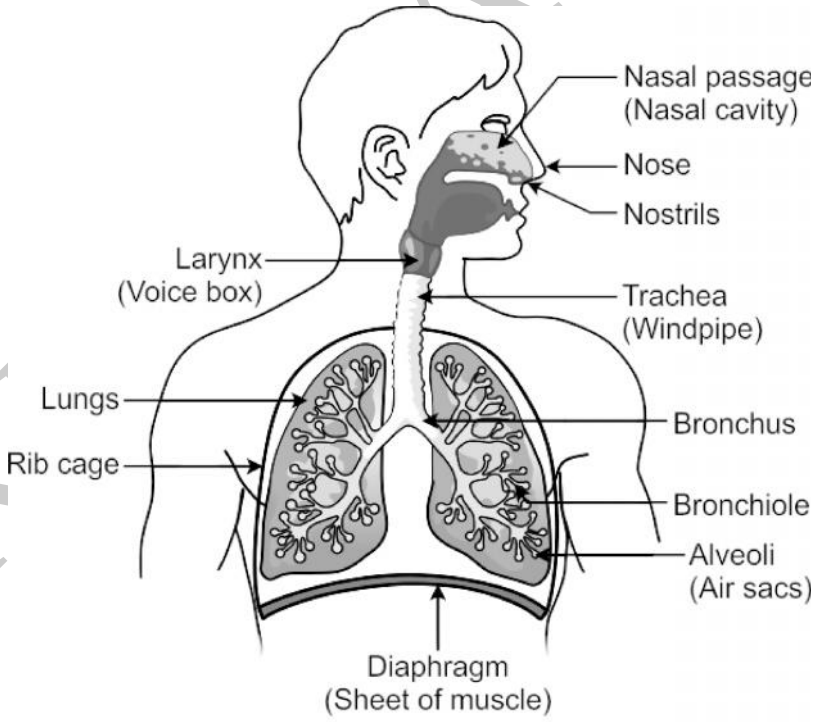
**1.** Gaseous exchange

**2.** Cellular respiration

**Respiratory Exchange in different animals –** All animals exchange gases with their surrounding by the mechanism of diffusion.

**Eg.-** Cutaneous respiration – Earthworm
Tracheal system in Cockroach.
Gills in fishes
Pulmonary respiration in Human.

**Respiration System of Human –** Human respiratory system consist of Nostril, nasal cavity, pharynx, Larynx, trachea, bronchi and lungs.



The human respiratory system

**Human respiratory System**
**Respiratory organs of human body**

| Organ | Structure | Function |
|---|---|---|
| Nostril | Opening of Nose | Filtration of unwanted particles. |
| Nasal Cavity | Covered with mucous membrane and cilia | Traps dust, bacteria; warms and moistens the air in the pharynx. |
| Pharynx (Throat) | Muscular Tube | The common passage for both respiratory gases and food moving into digestive passage, separated by epiglottis. Epiglottis is a flap like structure that closes the tracheal opening (opening of the wind pipe) called glottis when food is swallowed. |
| Larynx/Voice Box) | A small cartilaginous organ with vocal cords : lined by ciliated epithelium | Connects pharynx to the trachea; helps in sound production. |
| Trachea (Wind pipe) | Supported by C-shaped cartilaginous rings to prevent it from collapsing. Trachea divides into two bronchi and enters the two lungs | Passage for air upto bronchi. |
| Bronchus (Plural : Bronchi) | Elastic, ciliated and covered with mucous epithelium | Enters the lungs and divides to form secondary bronchi, tertiary bronchioles and ultimately terminal bronchioles. Together they form bronchial tree. |

**Differences between breathing and respiration**

| Breathing | Respiration |
|---|---|
| 1. Physical process | 1. Bio-chemical process involving enzymes |
| 2. Takes place only in reptiles, birds and mammals | 2. Occurs in all organisms |
| 3. It is a rhythmic process | 3. It is a continuous process |
| 4. It is an extracellular process | 4. It is an intracellular process |
| 5. It involves gaseous exchange between the animal and its external environment | 5. It involves enzymatic breakdown of glucose in the presence or absence of Oxygen to release energy |

**1. Mechanism of Pulmonary Respiration –** It complete following steps – 1. Breathing

**2.** Exchange of gases a the alveolar surface

**3.** Transport and Exchange of gases in the tissue.

**4.** Cellular respiration.

(i) **Breathing –** It is involuntary process. It complete in following two step – (i) Inspiration (ii) Expiration

(ii) **Inspiration –** It is process of intaking of atmospheric air into lungs.

(iii) **Expiration –** It is process of forcing air out from lungs.

**2. Exchange of gases at the alveolar surface -** Blood is medium for transport of oxygen from the lungs to different tissue and $CO_2$ from tissue to the lungs. Alveoli involve into exchange of $O_2$ into blood and $CO_2$ into lungs due difference in partial pressure of these gases.

| Air volume exchanged during breathing | | |
|---|---|---|
| Tidal volume (TV) | Volume of air inhaled and exhaled without any noticeable effort (normal breathing). | 500mL |
| Vital capacity (VC) | Volume of air that can be maximally breathed out after a maximum inspiration (VC = RV+TV+ERV). | 3400-4800mL |
| Inspiratory reserve volume (IRV) | Volume of air that can be taken in by forced inspiration over and above the normal inspiration. | 2000-3000mL |
| Expiratory reserve volume (ERV) | Volume of air that can be expelled by forced expiration over and above the normal expiration. | 1000mL |
| Residual volume (RV) | Volume of air that cannot be forced out even on forced expiration. This is the air that remains in the lungs and in the air passage. | 1000-150mL |
| Total lung capacity | Sum of all lung volumes (maximum air that remains in the lungs after a maximum inhalation). | 5500-6000mL |

Vital capacity may be highly reduced in smokers and people suffering from tuberculosis. Athletes and singers on the other hand have higher vital capacity.

**3. Transport of oxygen by blood from lungs to tissue –** About 97% O2 is transported from lungs to the tissue in combination of haemoglobin 3% O2transported into plod plasma.

$$Hb + 4O_2 \underset{\text{Tissue}}{\overset{\text{Alveoli}}{\rightleftharpoons}} Hb(4O_2)$$

**Transport of $CO_2$ –** 5-7% - dissolve in plasma.
21-23% - Carbaminohaemoglobin.
75% - 80% - Bicarbonate ($H_2CO_3$).

$$Hb + 4O_2 \underset{\text{Carbonic anhydrase}}{\rightleftharpoons} H_2CO_3 \longrightarrow HCO_3^- + H^+$$

| Respiratory disorders and their prevention | | | |
|---|---|---|---|
| **Disease** | **Cause** | **Symptoms** | **Prevention** |
| Bronchial asthma | It is an allergic disease caused due to certain foreign substance in the air. | Causes difficulty in breathing and coughing because excess mucous secretion may narrow down (clog) the bronchioles. | Avoiding exposure to the foreign substance is the best preventive measure. |
| Bronchitis | Inflammation of bronchi caused by infection. It can also be caused by smoking and by exposure to air pollution. | Regular coughing with greenish blue sputum. | Avoiding exposure to smoke and dust prevents bronchitis. |
| Pneumonia | Acute inflammation caused by diploccus infection in the alveoli of the lung. | It causes fever, pain and severe cough. Most of the air space is occupied by fluid and dead W.B.C. | Avoid crowded places where infection is prevalent. |

| | | | |
|---|---|---|---|
| Tuberculosis | It is a bacterial infection that spreads through droplets of infected persons | It can affect many other organs but pulmonary T.B. is most common. Weight loss and cough are common symptoms. It is accompanied by low fever. It extreme cases blood may come out while coughing. B C G vaccine can prevent T.B. Well – ventilated dwellings and protein rich diet is also essential for T.B. patients. | BCG vaccine can prevent T.B. Well – ventilated dwellings and protein rich diet is also essential for T.B. patients. |

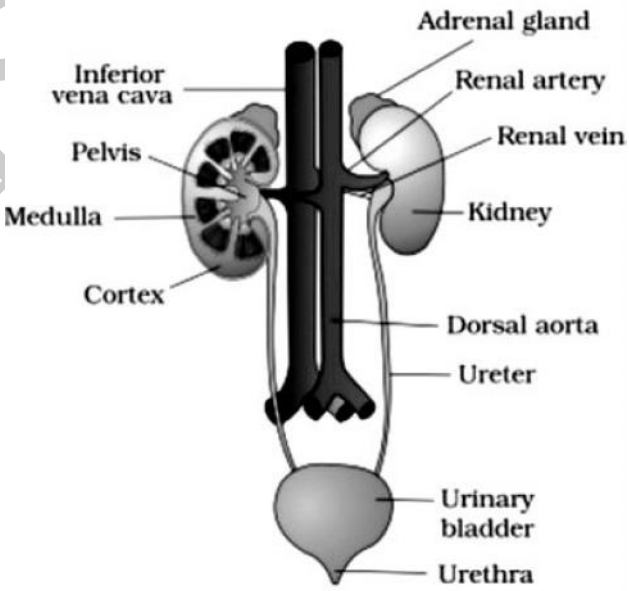
**Excretion –** Removal of all harmful, unwanted product (specially nitrogenous waste) from the body is called excretion/ Urea is the main nitrogenous waste in our body.

**Categories of animals on the basis of nitrogenous waste produced**

| Category | Product formed | Solubility in water | Examples |
|---|---|---|---|
| Ammonotelic | Ammonia (highly toxic) | Highly soluble, therefore needs plenty of water for its excretion. | Fresh water aquatic animals e.g., bony fish, *Amoeba* |
| Ureotelic | Urea (less toxic) | Less soluble, thus needs less water for excretion | Mammals like humans, dog etc, marine fishes and amphibians like frog and toad birds, reptiles and insects. |
| Uricotelic | Uric acid (least toxic) | Insoluble solids or semi solid. Needs very little water just to flush out the uric acid. | |

**Excretory organ in cockroach –** Malpighian tubules.

**Human Excretory organ –** Human Excretory system consist of a pair kidneys, a pair of ureters, a urinary bladder and Urethra.



**Excretary organs of humans**

**Formation of Urine –** Nephron is functional unit of kidney. Nephrons carry out Excretory and osnoregulatory function in following steps –

**(a)** Ultrafiltration **(b)** Selective reabsorption **(c)** Tubular secretion.

**(a) Ultra – filtration –** Each glomerular capillaries receives blood flowing under high pressure through a branch of rehal artery. There is continuous process of ultra filtration. Due to high pressure protein free filtrate is collected in the lumen of Bowman's capsule.

**(b) Selective reabdorption –** The useful substances such as glucose, amino acid, and minerals are reabsorbed through the wall of the renal tubules. About 65% - 85% of filtrate reabsorp in PCT. 5% water reabsorb in Henle loop. DCT absorb Na+ and water under influence of the hormones Aldosterone and ADH.

**(c) Tubular Secretion –** Cells of the renal tubulas also secrete some unwanted substance from the blood into the filtrate. These includes uric acid, K+ ions and ammonia.

**Urine Composition**

| **Component** | **Amount /day** |
|---|---|
| Water | 1200 / 1500mL |
| Urea | 25-30 gram |
| Uric acid | 0.7 gram |
| Creatin | 1.2 gram |
| Ammonia | 0.6 gram |
| Nacl | 10-15 gram |

**Regulation of Kidney –**

**1. Renin –** angiotensin mechanism

GFR decrease ⟶ JGA activated ⟶ Renin ⟶ angiotensinogen

⇩

Angiotensin – II

⇩

Increase B.P. which increase filtration rate.

**2. Antinatriuretic factor -** It is powerful vasodilator and it released from Heart wall. It decrease B.P. and control homeostasis of water, sodium, potassium and fat in body.

**3. Haemodialysis –** The blood urea level rise abnormally in patients suffering from kidney failures. In such patient an artificial kidney is used for removing excess urea from the blood by a process called Haemodialysis.

## EXERCISE

**1.** What is breathing? Write capacity of tidal volume.

**2.** Name the blood vessel that takes oxyganated blood from the lungs to the heart.

**3.** Name the vaccine used for prevention of T.B.?

**4.** What is difference between bronchitis and asthma?

**5.** Which is most toxic form of nitrogenous wates? Name an organism that excretes it.

**6.** Name the functional unit of Kidney nd its parts.

**7.** Name the harmones which maintain GFR rate in Nephron.

**8.** Differentiate between - Inspiration and expiration.

**9.** Draw the excretory system of human and label the parts.

**10.** What is the role of liver in excretion?

CHAPTER
# 10 BODY FLUID AND CIRCULATION

For the constant supply of materials the Nutrient, oxygen and other essentials substances, multicellular animals possess well developed circulatory system.

Main Role of circulatory system.

- Nutrient and waste product transport.
- Oxygen and $co_2$ transport.
- Carries metabolic intermediates.
- Hormones transport to target tissue.
- Uniform distribution of water, Ht, chemical and body heat.

→ Circulatory system discovered by William Harvey in 1628.

→ On the basis of body fluid circulatory system is two type.

Circulatory System → Blood circulatory system
Circulatory System → Lymphatic System.

→ The circulatory system is develops from mesoderm and internally lines with simple squamous epithelium called endothelium.

→ On the basis of blood vessels —

Circulatory System → Open e.g. arthropods – prawn, crab, Insert, Snail.
Circulatory System → Closed. E.g. – Some annelids – Earth – Sepia (Cattle fish) & all vertebrates.

**(1) Open circulatory system :** The main blood vessels arising from the heart pour the blood into tissue space called sinuses. RBCs is absent. Blood flow s very slow. There is no distinction b/w blood and tissue fluid in animals with open circulatory system. Therefore the blood or general body fluid is more correctly called haemolymph, and the tissue spaces through which it flow are referred to as the haemocoal.

- Animal are generally small with open circulatory system.

**Function -**

*(i)* Keep the tissue moist
*(ii)* transport of nutrient.
*(i)* Transport of toxic material
*(ii)* Carries defensive phagocyte to place of infection
*(iii)* Transport of Hormones of gland.
*(iv)* Camer $CO_2$ near the body wall.

**(2) Closed circulatory system :** In this system blood remains in blood vessels during its entire trip round the body never coming in the direct contact with the tissue cell.

**Advantages –** *(i)* The blood completes its circulation round the body in a much shorter time. It help in quick supply of useful materials.

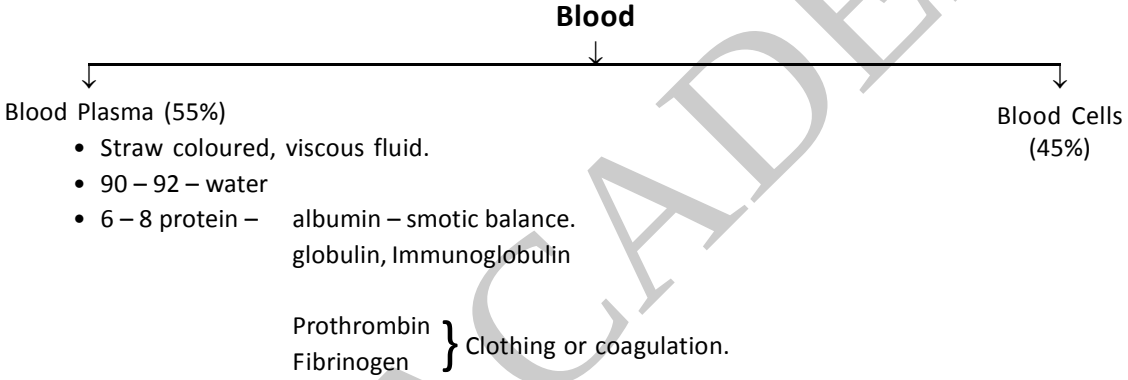
**(3)** Regulation of blood flow. Arterial musculature and precapillary sphincter in the closed circulatory system regulate the flow of the blood to organs according to their need.

- **Blood circulatory system** → It consist following part —

**(i)** Blood **(ii)** B. vessels **(iii)** Heart

**(1) Blood :** An average adult person has about 4 – 6*l* of blood or 6 – 10% of body weight. Study of blood hematology. Mesodermal origin.

- Blood is Salty in taste, heavier than water, and temperature – $38^0$C ($100^0$ 4 $^0$F).
- PH = 7.4, alkaline.
- PH of blood is maintained by ratio of sodium bicarbonate and carbonic acid.
- PH of blood in arteries is more than in vein.




- Inorganic salt→ $Na^+$, $Ca^{++}$, $Mg^{++}$, $HCO_3$, etc.
- Nutrient and Respiratory gases.
- Anticoagulant – Heparin.
- Antibodies, etc.

• Serum → Blood plasma – clotting factor.

**Blood Cells** → (i) RBCs or Erythrocyte.

→ Formation of blood is called haemopoiesis.

→ Formation of RBCs is called erythropoiesis.

→ Number – 5 – 5.5 million/$mm^3$ of blood.

→ Amphibian RBCs are largest RBCs of vertebrate.

→ RBCs of Frog are oval and nucleated.

→ Musk dear has the smallest RBCs.

→ RBCs of mammalian are round, biconcave and non-nucleated. Mitochondria also absent in RBCs.

→ Camel has oval and nucleated RBCs.

→ Life span – 120 days.

→ RBCs consist red pigment Hemoglobin. Hemoglobin constitute about 33% of RBCs.

Hemoglobin → Globin (conjugated protein)

Hemoglobin → Heme – $Fe^{2+}$ – porphyry complex. (4Fe)

→ Haemoglobin consist - 2∝ chain (141 amino acid) & 2 – B chain (146 amino acid).

→ A healthy individual has 12-16 gm of Hemoglobin per 100 mL blood. It play important role in transport of respiratory gases.

→ If a person has insufficient RBCs or Hemoglobin called Anemic

- Microcytic anemia — Deficiency of Iron.
- Megablastic anemia — Deficiency of folic acid And $B_{12}$
- Pernicious anemia Deficiency of Vit. $B_{12}$.
- Hemolytic anemic — Haemolysis (Rupture of RBCs)

Sickle cell sthalassemia anemia — gene mutation.

→ Erythropoietin is a hormones secreted by Kidney cells. It stimulates the RBCs production in bone marrow.

→ Non functional RBCs destroyed in spleen, liver and bone marrow. The most important site of RBCs disposal is spleen, so it is called their 'graveyard'.

→ The breakdown product of hemoglobin is bilirubin, bilirubin oxidize into biliverdin in bile.

- Polycythemia – High RBCs Number.
- Erythrocytopenia – Decrease in RBCs number.

**(2) Leucocytes (WBCs)** ì

✓ Shape – Rounded or irregular cells. WBCs capable to change their shape an show amoeboid movement. This property help to squeeze out of capillaries into tissues. Called dispedesis.

✓ Number – 6000 – 8000/ $mm^3$

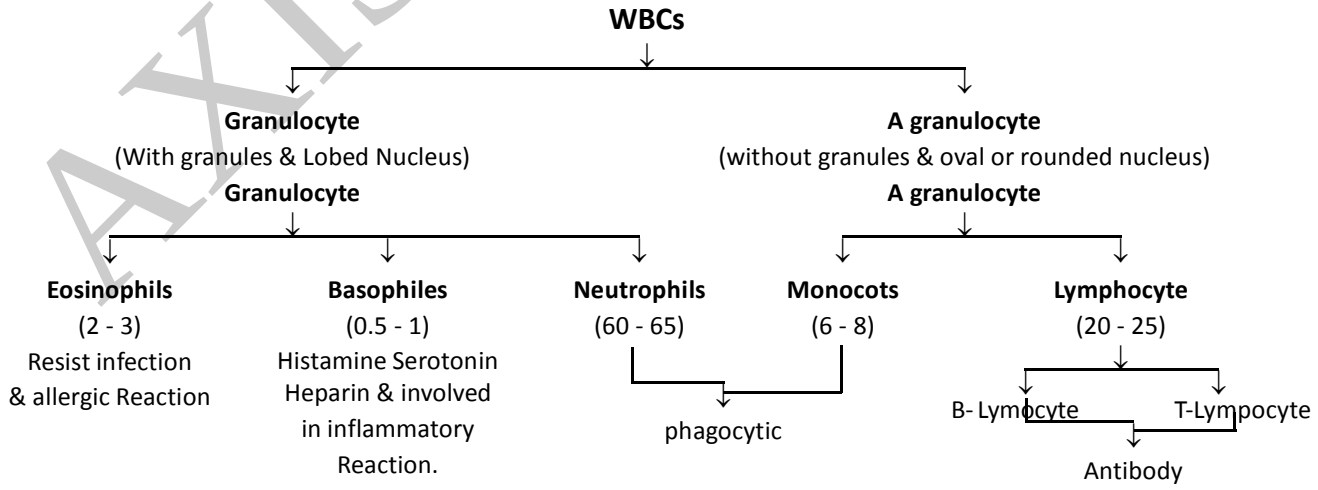
✓ Ratio of RBCs' WBCs = 600: 1

✓ Leucocutosis = Ruse in Leucocyte count.

✓ Leucopenia = Fall in Leucocyte count.

✓ Leukemia = Uncontrolled production of Leucocyte **"<u>Blood Cancer</u>"**

✓ Life span = 3-4 days.



**(3) Platelets' or Thromocyte :** Cell fragment produced from megakaryocytes of bone marrow.

Number = 1.5 – 3.5 Lakh or lacs / $mm^{-3}$

Life span – 3 – 7 days.

✓ It release thromboplastin which is necessary for blood clotting.

## Blood Group

Karl Landsteiner (1900) recognized four type of Blood group know as ABO blood group.

| Blood group | Antigen | Antibody | Transfusion |
|---|---|---|---|
| A | A | Ant – B | |
| B | B | Ant – A | |
| AB | AB | – – | Universal Recipient |
| O | – – | Ant - AB | U. donar. |

• **Rh: factor** Ĝ Rh factor discovered in 1940 by Landsteiner and Wiener in Rhesus monkey. 80% Human population have Rh. Factor – $Rh^+$ & other $Rh^-$

Male X Female

$Rh^+$ $Rh^-$

*(ii)* $\frac{\text{Factus}}{death}$ (erythroblastsis foetillis)

**Coagulation of Blood** Ĝ Clotting of Blood.

✓ Serotonin vasoconiricfor.

✓ Vitamin K is necessary for the synthesis of Prothrombin is liver.

Injured tissue

↓

Platelets gather

- Break & Release

↓ Serotonin

Thrromboplastin which

(I) Forms enzyme prothrombinase or Thrombokinase.

↓

(II) Prothrombin $\xrightarrow{Ca^{++}}$ Thrombin

(III) Fibrinogen $\longrightarrow$ Fiberin

↓ Polymersise

Fibrin thread

+

RBCs

↓

Blood clot.

(3.5 minutes)

## HUMAN HEART

It is myogenic. Their origin is mesodermal, is situated in thoracic cavity, in b/w lungs. slightly titled to the left. It has the size of a clenched first (12 x 9 cm.). Its average weight is about 300g. It broad base upward and narrow apex downward.

The heart is enclosed in double walled membrane called pericardium. B/w two layer pericardial cavity is present which contain 50 mL pericardial fluid.

**Internal structure of Heart.**

The entire heart is made up of cardiac muscle. The wall of ventricle are thicker than atria. In heart two specialized cardiac musculature present. First sino-atrial node (S-A node) present in the right upper corner of the right atrium. Second atrio-ventricular node (AVN). AV node continue into Bunde of his which divided into purkinje filorers.

Nodal musculature has the ability to generate action potential without any external stimuli i.e. it is auto-exit able.

The SA-node can generate the maximum number of action potential i.e., 70-75 $min^{-1}$. It is responsible for initiating and maintaining the rhythmic contractile activity of the heart. Therefor, SA-node is called pace maker.

- Inferior vena-cava – Eustuchius valve.
- Coronary sinus (vein) – Thebesius valve.

Work in Mechanism of Heart - (Cardiac Cycle) – The sequential event of heart which follow alternate contraction and relaxation i.e. systole and diastole is called cardiac cycle. Cardiac cycle follow three events:

**1.** Atrial systole – 0.1 second

**2.** Ventricular systole – 0.3 second

**3.** Joint diastole – 0.4 second

During a cardiac cycle each ventricle pump out approximately 70 mL of blood which is called the **stroke volume**.

The stroke volume multiplied by the heart rate (no. of heart beats per minute) give the **cardiac output**.

**Heart sound (stethoscope).**

**Two sound**
- 'lub' – clouser sound of tri, & bicuspid valve. Low pitched not loud, long duration.
- 'dub' – clouser of semilunar valve. Higher pitched, louder, short duration.

**Pulse –** It is alternate expantion and elastic recoil of artery with each systole.

**Double circulation :-**

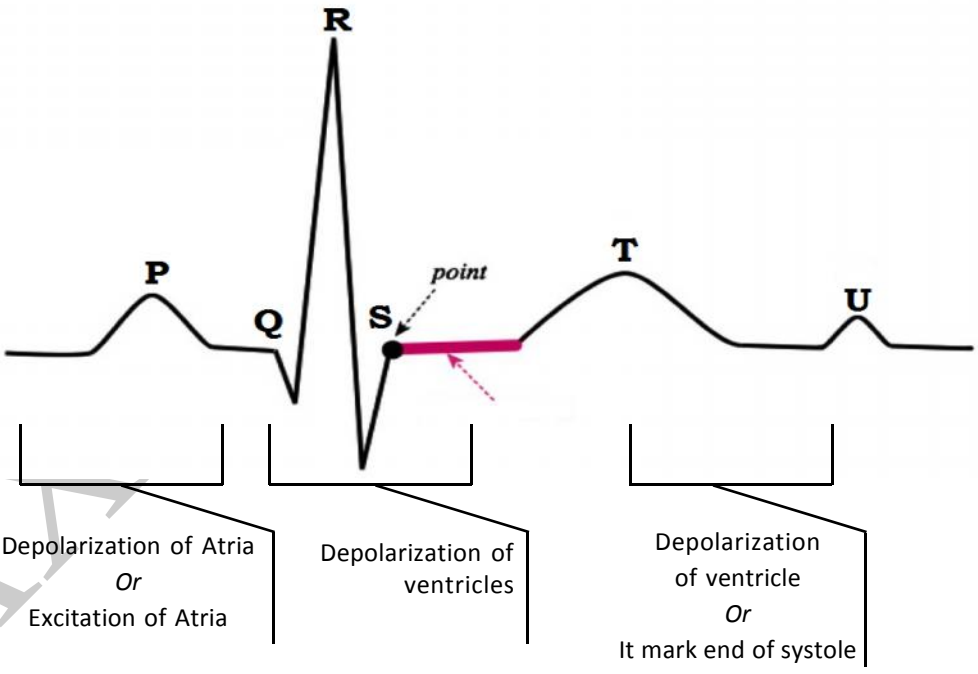
- Pulmonary circulation – RV – Lung – L.A.
- Systemic circulation LA – Body – R.A.

**Portal circulation :-** The flow of blood through the portal vein to certain specific organ other than the heart is called portal circulation. It is following type.

**(1) Hepatic portal System :** It present in all vertebrate, including man. It carries the venous blood from the alimentary canal, pan crease and spleen to liver.

**(2) Renal Portal system :** It is present in fishes and amphibian is reduced in reptiles and birds, and absent in mammals. It supplies blood from the posterior region of the body to the Kidney.

**Electrocardiograph (ECG) :-** ECG is a graphical representation of the electrical activity of the heart during a cardiac cycle. It obtain by Electro-cardiograph machine. A standard ECG is shown below.




**Regulation of Heart :** Human heart is mynogenic *i.e.* auto regulated by nodal tissue. Medulla oblongata moderate the cardiac function. Sympathic nerve of ANS can increase the rate of heart beat.

Parasympathic nerve of ANS cane decrease the rate of heart beat.

Adrenal medullary hormones increase the cardiac output.

**Disorder of Circulatory system.**

1. **High Blood Pressure** (Hypertension)

(B.P.) Blood Pressure is a measure of the force blood exerts against blood vessel wall. B.P. normally a trial blood pressure. The instrument used to measure B.P. is sphygmomanometer.

✓ Normal B.P. = 120/80 mm. Hg.

✓ Hypertension = 140/90 or over.

2. **Coronary Artery disease** (CAD). (Atherose lerosis) – It Affect the vessels that supply blood to heart muscle. It is caused by deposition of calcium fat, cholesterol and fibrous tissue in coronary vessels.

3. **Angina** (Angina pectoris) – Acute chest pain appears when no enough oxygen is reaching the heart muscle. It accurs due to condition that affect the blood flow.

4. **Heart failure** – It means the state of heart which not pumping blood enough to meat the need of the body. It cause due (some time) congestion of lung.

- Cordiac arrest – when the heart stop beating.
- Heart attack – When the heart muscle is suddenly damaged by an inadequate blood supply.

## EXERCISE

**1.** Differentiate open and closed circulatory system with examples.

**2.** Name the structure where the wave of contraction originates in heart to begin heart beat.

**3.** Write the name of the three protein present in the blood plasma.

**4.** Write the function of blood elements :

(i) RBCs (ii) WBCs (iii) Platelets

**5.** With the help of a flow chart describe the step involved in the coagulation of blood.

**6.** What is an ECG and what is its function?

**7.** Why is a person with blood group O called universal donar?

**8.** Explain cardiac cycle in hman.

**9.** Write the name of pigment present in human RBCs.

**10.** Write the function of Blood.

CHAPTER
# 11 LOCOMOTION AND MOVEMENT

Locomotion is the displacement of the entire body from one place to another. It is characteristic of all animals and zoogametes of plants.

**Type of Movements for Locomotion** - It is following two type.

***(i)* Clilary Movement** – 'Cilia' are minute hair like processes which are motile and extend from cell surface. Ex. Ciliate Protozoa. Cilia help to propel fluid and materials.

***(ii)* Flagellar Movement –** A flagellum is a long, whip like structure, flagellum is mostly present single or few in number. Ex- Euglena, Chlamydonas.

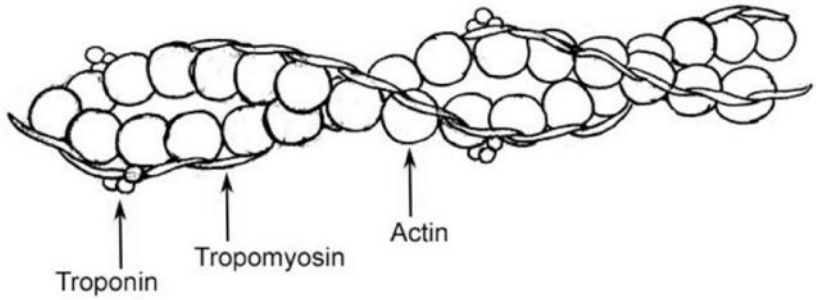
**Muscular Movement in Animnals :** Skeletal muscle or striated Muscle are attached to bone to bone and are responsible for movement of the limbs. Every skeletal muscle is also enclosed in a thin connective tissue.

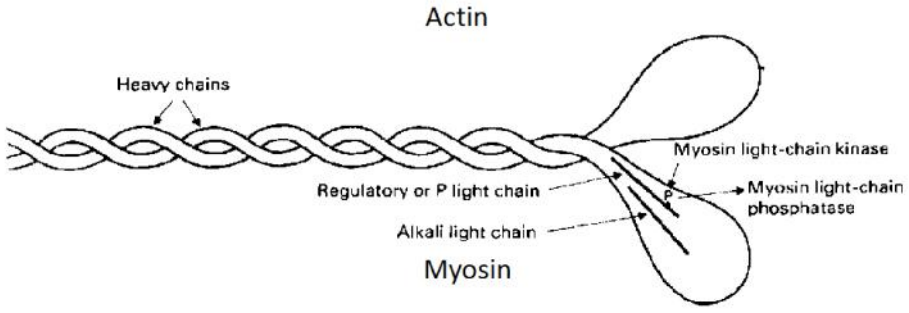
**Myo-filaments -** The muscle cell also called muscle fibre.

Myofilament are muscle protein which are two type –

*(i)* Thick filament made of myosin protein.

*(ii)* Thin filament made of actin protein.




→ Stimulation of muscle contraction and events of muscle contraction (Sliding Filament Theory) – Muscle contraction stimulated by neural stimulation Nerve branch on muscle and this area of muscle is called myo-neural function.

Impulse at nerve ending of muscle fibre

↓

Muscle fibre stimulated

↓

Ca++ released from muscle fibre

↓

Binding site of action filament released

↓

Cross bridges flex & reattach to new site

↓

(ATP release energy)

↓

Actin and myosin slide over each other

↓

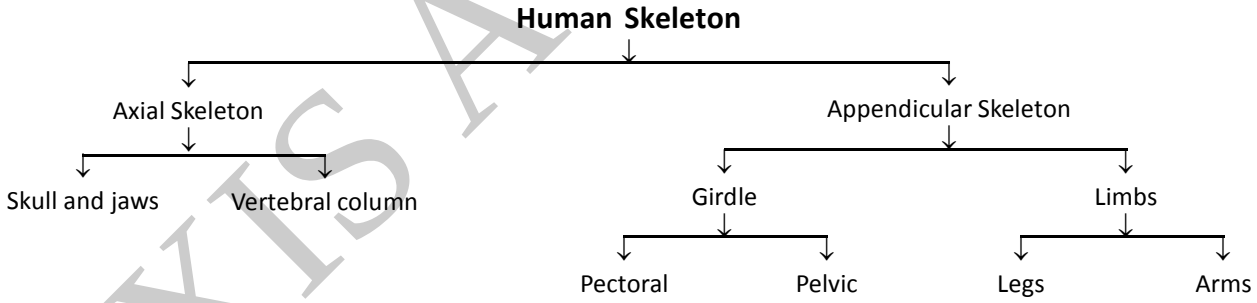
Muscle cell shorten

↓

As a result the muscle contract.

The skeletal system – Skeleton support the body, gives rigidity to body, provides surface for attachment of muscles and protect soft internal organ like the brain, heart, Lungs etc. – skeleton is made of bone and cartilage.

**Human Skeleton**




**Muscular and Skeletal Disorders -**

- **Myaesthenia gravis –** X-chromosomal disorder. In this disorder muscle slowly waste away and the patient gradually become immobile at last stage saw muscle do not work.
- **Muscular dystrophy –** Autosomal dominant disorder. Muscle waste away and person become immobile.
- **Arthritis and Rheumatoid arthritis –** Constant joint pain. Hand and feet become crooked due to inflammation in the joint.
- **Osteoporosis –** It is the softening of bones due to calcium deficiency.
- **Gout –** It is painful inflammation of joint due to elevated level of uric acid in blood.

**Movement in plant -**

Plants show following two type of movement.

*(i)*Tropic movement – Plant show directional movement in response to external stimuli like light, water, gravity called tropic movement. It is following type -

| | | |
|---|---|---|
| Touch/contach | - | Thigmotropism |
| Gravity | - | Geotropism |
| Water | - | Hydrotropism |

*(ii)* Nastic Movements – In nastic movement the plant do not move in the direction of stimulus. Ex-

→ Mimosa pudica called 'chhui mui', droops when touched.

→ Leaf closes in the insectivores plant. (venus fly trap)

→ Flower of porfulaca bloom in the day.

## EXERCISE

**1.** Distinguish between :

(i) tendon and ligament

(ii) tropic and nastic movement

**2.** How does paramecium swim in water?

**3.** Give an examples of each of geotropsim and phototropism.

**4.** Draw flow chart of muscle contraction.

**5.** What causes osteoporesis and gout?

**6.** Name main part of skeleton and mention their function.

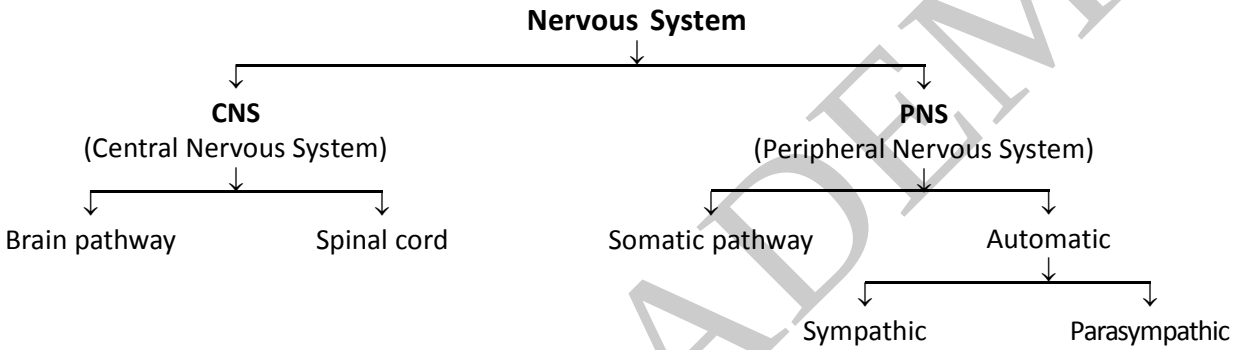
**7.** Write the examples of ciliary and flgellar movement.

CHAPTER 12

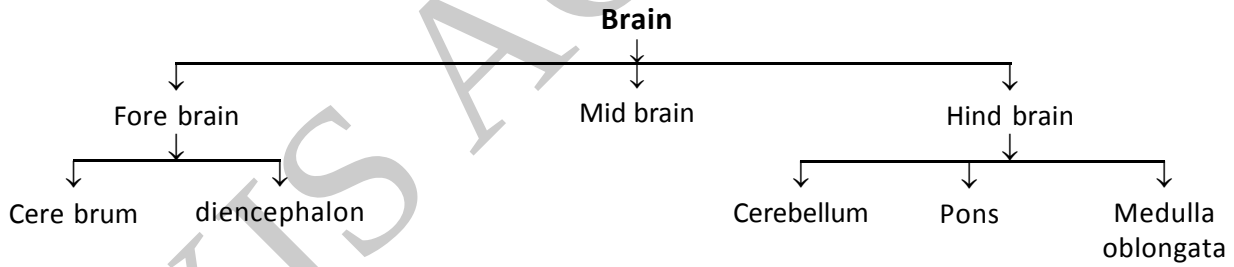
# COORDINATION AND CONTROL
# THE NERVOUS SYSTEM

**Major function of Nervous system –**

1. It keep us informed about the outside world through the sense organs.
2. It enable us to remember, think and to reason out.
3. It control all voluntary muscular activities like running, speaking etc.
4. It also regulate several involuntary activities such as breathing, breathing of the heart, etc.




**Central Nervous System –** The Brain – It is highly coordinated organ present inside cranium of skull. It is cover by meninges. It is composed of following Part -




**Function of different part of Brain –**

**1. Cerebrum (cerebral Cortex)** – It control voluntary muscle contraction. It receive information of sense organ. It carried out metal activities of thinking, planning, memory etc.

**2. Diencephalon – (a) Thalamus –** It is relay center for sensory impulses, going to the cerebrum.

**(b) Hypothalamus –** It control body temperature. It also control motivated behaviour such as eating, drinking & sex.

**3. Cerebellum –** It maintain the balance of the body.

**4. Medulla oblongata –** It is the center for breathing, coughing, swallowing etc.
It control heart beat, the movement of alimentary canal.

**The spinal cord –** (i) It carry out reflexes below the neck.
(ii) Conduct sensory impulse from skin and muscle to brain.

| Effects of autonomic nervous system | | | |
|---|---|---|---|
| | **Organ** | **Effect of Sympathetic Activity** | **Effect of Parasympathetic activity** |
| **1** | Eye Pupil | Dilated | Constricted |
| **2** | Heart beat | Speeded up | Slowed down |
| **3** | Blood vessels<br>**a.** on skin<br>**b.** on muscles | <br>Constricted<br>Dilated | <br>Dilated<br>No effect |
| **4** | Bronchioles | Dilated | Constricted |
| **5** | Urinary bladder | Muscles relaxed<br><br>Sphincter contracted | Muscles contract<br>(feeling of urination)<br>Sphincter relaxed |
| **6** | Sweat secretion | Increased | No effect |

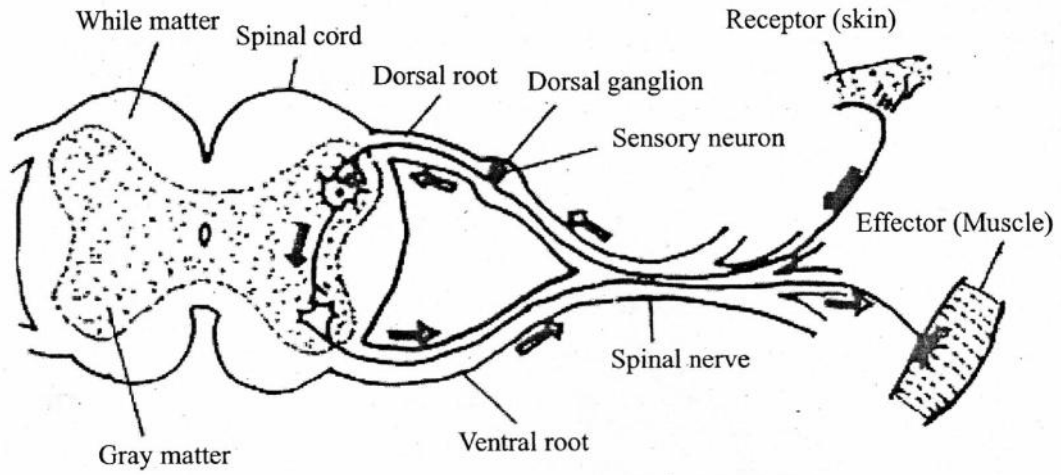
**Reflex Action –** It is an automatic, quick and involuntary action in the body brought about by a stimulus. It is controlled by spinal cord.

Types of Reflex Action – It is two type –

1. **Simple Reflex -** – Quick closing of eyelids.
   – Caughing
   – Narrowing of the eye pupil in strong light.
2. **Conditioned Reflex –** –Applying brakes in your vehicle.
   – Tying shoe laces
   – A dog runs aways

**Mechanism of Reflex Action**

Some reflexes are brought about through the brain (cerebral reflexes) such as the closing of the eyelids due to approaching objects while other are brought about through the spinal cord (spinal reflexes). The parthway in a simple spinal reflex action is represented in the diagram below.




Nerve pathways in a simple reflex action

In this, there are five necessary parts :

The stimulus (prick, heat etc.) → receptor in the sensory organ → the afferent (sensory) nerve fibre running through the dorsal root of the spinal nerve bringing the impulse into the spinal cord → a (motor) neuron sending out the command through its efferent fibre in the ventral root of the spinal nerve → muscle or the gland.

**Sensory Receptor (The Sense Organ)**

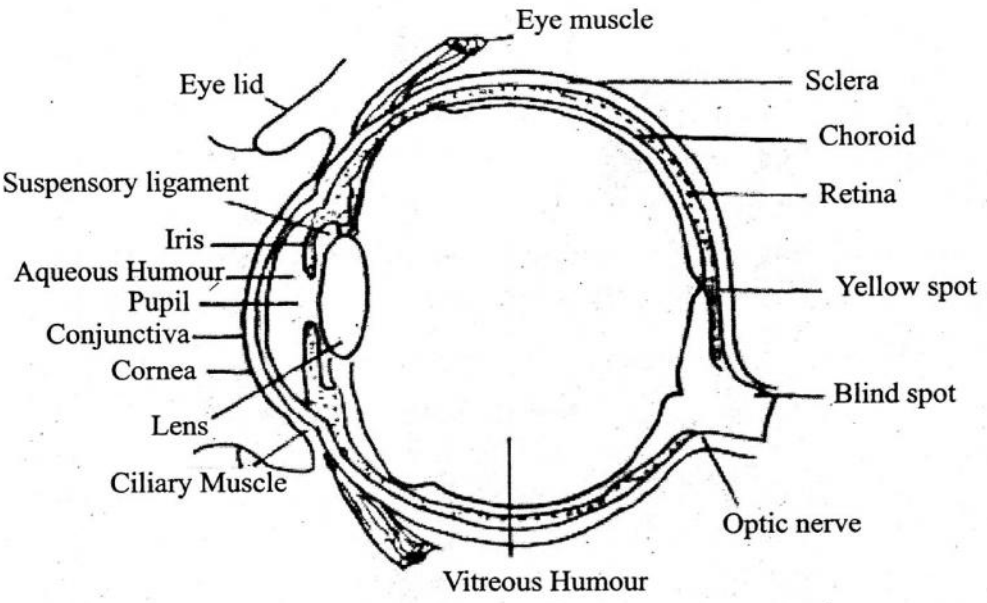
Those organ by which we detect or sense changes in the external environment called sense organ.

In human there are five sense receptor, - eye for seeing, ear for hearing, nose for smelling, tongu for taste and skin for sensing touch, pain, heat, etc.

**(i) The Eye :** The eye is nearly spherical in shape, able to rotate freely in the bony socket.

**Part of Eye :**

- The wall of the eyeball is made up of three layers; the sclera, choroid and retina.
  - Sclera is the outermost tough white layer. In front it is continued as the transparent cornea.
  - Choroid is the middle layer. It is composed of connective tissue having a dense network of blood vessels. Its inner surface is dark brown or black. This prevents reflection, which otherwise interfere with the clarity of the image.




Vertical section of the human eye

- **Retina :** It is innermost layer. It contain two kinds of sensory cells - the rod (sensitive to dim light) and cone (sensitive to bright light and colours).
- **Lens -** It is biconvex in shape and semi-solid. It is composed of soft gelatinaus tissue. It is held in position by syspensory ligament called ciliary body.

• **Iris -** It is sort of circular curtain in front of the lens. It is black, brown or blue. The colour of the eye is the colour of its iris.

Aqueous chamber is front part containing a watery fluid. It keeps the lens moist and protect it from physical shocks. Vitreous chamber is back part containing a thick jelly like glassy susbtance. It helps in maintaining the shape of the eyeball and protects the retina.

**Mechanism of Vision :** The light rays in visible wavelength focused in rod and cones. Potential differences are generated in the photoreceptor cells. This produces a sighal that generate action potential in bipolar cells. These action potential are transmitted by the optic nerve to the visual cortex area of brain.

The brain interpret the image in many ways i.e. its sees the object vertical although the actual image formed is inverted.

• **Accomodation :** Focusing the image on retina is called accommodation.

**The common eye defect**

**(i) Near Sightedness (Myopia) :** Nearby object are clearly seen but not the distant. This can be corrected by using concave lens.

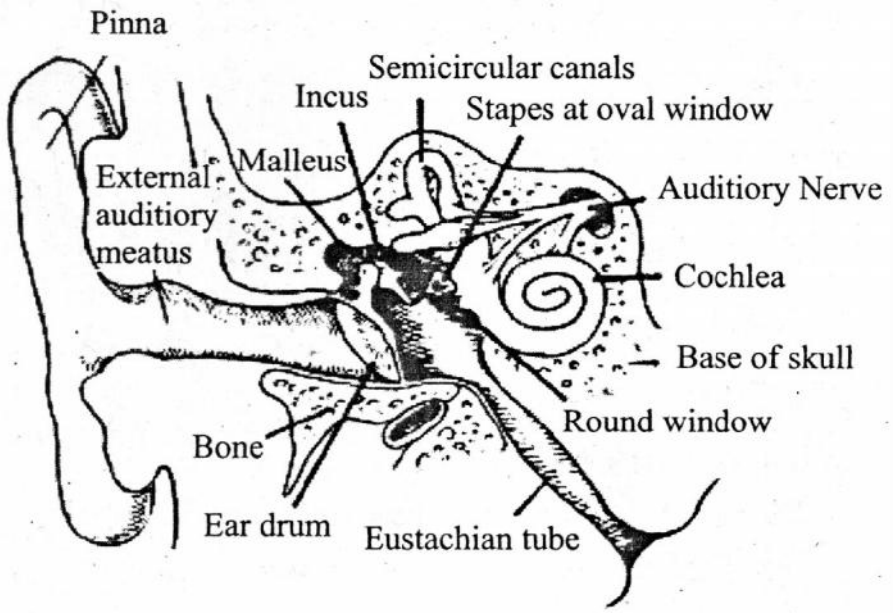
**(ii) Long sightedness (Hypermetropia) :** Distant object are clearly seen but not the nearby because the image of the object is formed behind the retina corrected by convex lens.

**(iii) Cataract (opacity of the lens) :** The lens usually loses its transparency and turns opaque with age. Such a lens can be surgically removed and replaced by an intracular lens.

**The Ear-Sense of Hearing and Balance**

The ear serves two sensory functions; hearing and maintaining balance of the body.

The ear has three man parts - external ear, middle ear, and internal ear.




The human ear.

The external ear consists of the following :

• an outwardly projected ear to be called pinna supported by cartilate. It directs the sound waves inwards.

• The auditory canal through which the sound waves travel up to the ear drum (tympanic membrane)

The middle ear consists of the following :

• An air-filled tympanic cavity

• The tympanum or ear drum

• Three tiny bones-malleus (hammer) connected to the ear drum, incus (anvil) in between and stapes (stirrup) forming a contact with the oval window of the internal ear.

• Eustachian tube connects the tympanic cavity with pharynx. It equalizes the pressure on both sides of the eardrum or tympanum :

The internal ear contains two main parts :

**(a) Cochlea :** It is a long coiled structure which looks like the coils of the shell of a snail. It has two and a half turns. The inner winding cavity of the cochlea is divided into three parallel tubes of canals separated by membranes. The canals are filled with a fluid called endolymph. The middle canal possesses sensory cells (organ of corti) for hearing.

**(b) Vestibule :** It is concerned with physical balance of the body. It is consists of three semicircular canal arranged at right angles to each other and a part join with cochela.

**Mechanism of hearing :**

- The sound wave enter into auditory canal and cause eardrum to vibrate.
- The vibration of eardrum transfer to oval window into the cochela through middle ear.
- These vibration move the fluid in the cochlea. The organ or carti catches the movement of the fluid and transfers it to the auditory nerve that carries the impulse to the brain.

**Chemical Coordination and Integration**

- Hormones (Gr. Hormoein = to exite) – The classical definition of hormones is "It chemical produced by endocrine gland and released into the blood and transported to target organ."
- Current scientific definition "Hormones are non-nutrient chemicals which act as intercellular messengers and are produced in small amount."
- Discovery – The first hormones was discovered by W.M. Bayliss and Ernest H. starling in 1903. It was secretin of GI tract The term hormones was coined by starling in 1905.
- Chemical Nature of Hormones – On the basis of chemical Nature hormones can be divided into following group.

  1. **Amino-acid derivatives –** Epinephrine and nor epinephrine.
  2. **Iodothyronines –** Thyrpxine (derived from tyrosine)
  3. **Steroid –** Hormones of adrenal cortex, testes, ovaries and Placenta.
  4. **Peptides –** Oxytocin, vasopressin, MSH, Insulin, glucagon, ACTH, calcitonin & Prathormones.
  5. **Proteins –** Gonadotrophic, somatotrophic & thyrotrophic (Polypeptide).

**Human Endocrine System**

| **Endocrine gland** | **Hetrocrine gland** |
|---|---|
| *(i)* Hypothalamus | *(i)* Gonads – 1. Testes 2. Ovary |
| *(ii)* Pituitary gland | *(ii)* Pancreas |
| *(iii)* Pineal gland | *(iii)* Kidney |
| *(iv)* Thyroid gland | *(iv)* G.I. Tract |
| *(v)* Parathyroid gland | *(v)* Liver |
| *(vi)* Thymus gland | *(vi)* Heart |
| *(vii)* Adrenal gland | *(vii)* Placenta |

- **Endocrine Glands –**

**(I) Hypothalamus –** Location – In Forebrain
Origin – Ectodermal

Their Hormones regulated the secretion of Pituitary gland.

**Hypothalamus**

| Releasing Hormones | Inhibitory hormones |
|---|---|
| Ex – GnRH | Ex- Somatostatin |
| ↓ | ↓ |
| Increase secretion Of Gonadotrophins | Decrease secretion of Growth hormones |

**(II) Pituitary gland –** Location – Sella tursica of cranium.
Origin – Ectodermal.

**(a) Anterior lobe –**

- Growth hormones – stimulate body growth.
- **Hyperseoretion** – → Gigantism – child
- → Acromegaly – Adult

  **Hyposecretion** – Dwarfism in child.
- Prolactin – Promotes lactation.
- Thyroid stimulating Hormones (TSH)
- Adrenocorticotropic Hormones (ACTH)
- Fillicle – stimulating hormones (FSH) → In male control spermats; → In female follicular development.
- . . . . . → Male - Secretion of androgen; → Female - ovulation.

**(b) Middle lobe –** Melanocyte stimulating hormones (MSH) – Acts on melanocyte and regulate pigmentation of skin.

**(c) Posterior lobe: –**

- ✓ Oxytocin – Initiates labour and milk ejection.
- ✓ Vasopressin or ADH – Stimulate water reabdorption form DCT.

**(III) Thyroid gland** – Endodermal origin. Largest Endocrine gland.

**Thyroxine (T3 or T4) –** Increase metabolism, bold pressure and tetradothronine regulate tissue growth.

Hyposecretion causes → cretinism – chid
→ Myxoedema – Adult

Hypersecretion cause - Exophdhalmic goiter (Grave's disease)

→ Calcitonim – regulate blood calcium level through up take thyro by bone.

**(IV) Parathyroid gland –** Endodermal.

Parathormones or – Increase blood calcium level by parathyroid hormones (PTH) absorption.

**(V) Pineal gland –** Ectodermal.

→ Melatonin – regulate rhythms of sleep-wake cycle.

**(VI) Thymus gland -** Endodermal

→ Thymosin – involve development of T-lymphocyte.

**(VII) Pancrease –** Endodermal.

**1-** Cells Insulin • Regulation of glucose level in blood.
• Hypo secretion cause Diabetes mellitus

**2-**~ Cells Glucagon - regulate glucose level in blood by glucogenolysis.

**(VIII) Adrenal gland –** (Meso & Endo)

**(a) Adrenal contex –**

- ✓ Glucocorticoid (cartisol) – regulate glucose of blood.
- ✓ Mineralocorticoid (adosteron) – $Na^+$ reabsorption – DCT
- ✓ Sexocerticoids (androgen) – Induces sex hormones

**(a) Adrenal Medulla –**

- ✓ Adrenaline (Emergency H.) – Increases alertness, pupilary dilation,
- ✓ Not adrenaline (Emergency H.) - sweating etc also increases the heart beat, respiration, glucose level etc.

**(IX) Gonads –** (1) Testes – Testosteron – Reproductive maturation and sperm production.

**(i)Ovary** – → Oestrogen – Regulation of Menstrual cycle, mammary gland growth.
→ Progestron – Maintain pregnancy

**(X) Heart:-** ANF (Arial, Natriuretic Factor) – reduce blood pressure by dilation of blood vessels.

**(XI) Kidney:-** Erythropoietin – Stimulates formation of RBCs.

**(XII) Gastroitestinal tract :-**

- ✓ Gastrin – It act on gastric gland & stimulatessecretion of HCL & pepsinogen.
- ✓ Secret in – It act on exocrine pancrease and stimulate secretion of water & bicarbonate.
- ✓ Cholecystokinin – Stimulate secretion of pancreatic emyme [CCK] and bile juice (gall bladder).
- ✓ Gastric Inhibitor Peptide (GIP) – Inhibits the secretion of gastric juice.

## EXERCISE

**1.** Name the part of brain, which fluid present in the cavity of brain.

**2.** Mention the function of following :

(i) Cerebrum (ii) Cerebellum (iii) Medulla oblongata

**3.** What are the two subdivision of the automatic nervous system.

**4.** Explain reflex action with examples.

**5.** Mention the function of following :

(i) Iris (ii) Pupil (iii) Retina

**6.** Name the condition caused due to oversecretion of thyroxin.

**7.** Name the source gland of ADH and write their function.

**8.** Draw a labelled diagram of cross section of spinal cord and the nervous pathway of a simple reflex concerned with it.

**9.** Explain the following term :

(i) Synapse (ii) Impulse

**10.** Are the endocrine gland and the ductless gland one and the same thing? Give on examples.

CHAPTER
13

# REPRODUCTION IN PLANT

In plant reproduction take place by following way- (a) Vegetative (b) Asexual (c) Sexual

**(a) Vegetative Reproduction :-** In this type of reproduction vegetative part of plat such as bud, stem, leaf, root etc. are involve in formation of new plant.

**e.**g.- Fragmentation in spirogyra, budding in yeast

**(b) Asexual Reproduction –** It is kind of reproduction take place through spores.

e.g. – Zoospore formation in ochlamydomonas

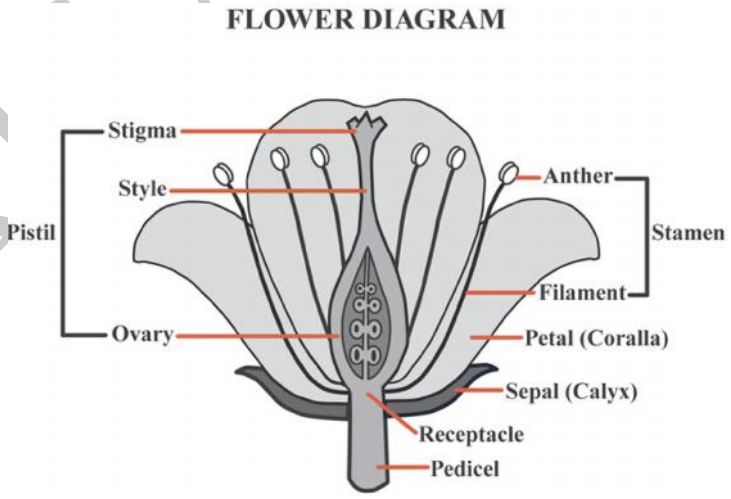
**(c) Sexual Reproduction –** It follow different events of sexual reproduction which occurs in flower.

**Flower :**

- ⇨ The sexual reproductive part of angiosperms is called flower. It develops after the completion of vegetative phase.
- ⇨ The branch of ornamental horticulture concerned with growing and marking of ornamental flowers is called floriculture.

**Part of flower :**

- ⇨ In a flower, four different sets of whorls or floral members are attached to a central axis called thalamus.
- ⇨ The outermost and the first accessory whorl is of sepals and is called calyx.
- ⇨ The second accessory whorl is of petals and is called corolla.
- ⇨ Next to the corolla, is the male reproductive whorl of stamens called and roecium.
- ⇨ The female reproductive whorl is of carpel's and is called gynoecium or pistil.



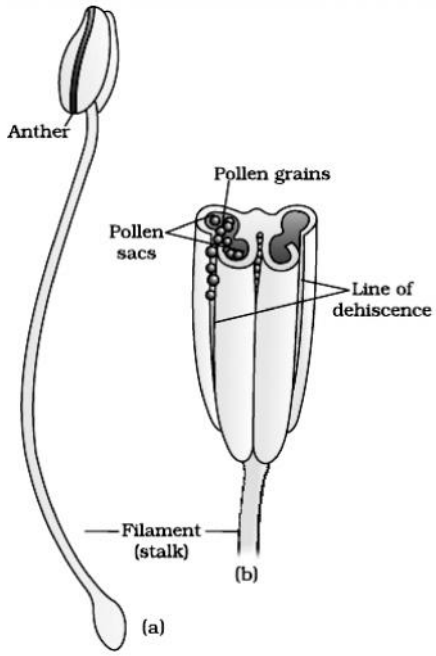

**A diagrammatic representation of L.S. of a flower**

**Male reproductive Unit :**

- ⇨ **Stamen** is the male reproductive unit and consists of the following two parts:
- ⇨ A long and slender stalk called **filament** which may be joined or free.
- ⇨ A bilobed terminal structure called anther.

**Structure A Anther**

- ⇨ It is composed of two anther sacs or lobes separated by a tissue called connective tissue.
- ⇨ The anther is bilobed and each lobe or sac consists of two theca separated by a septum.
- ⇨ The anther is a tetragonal (four-sided) structure, consisting of four micro sporangia, two in each of the lobes.
- ⇨ Micro sporangia develop further and get transformed into pollen sacs.




**Structure of Microsporangium :**

⇨ A typical microsporangium appears circular and is surrounded by four walls:

**(i) Epidermis:-** It is the outermost single layer of cell which is protective in nature.

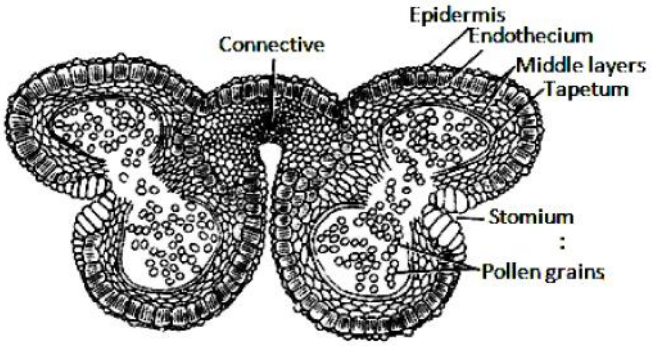
**(ii) Endothecium:-** It is the second layer with thick cells, help in dehiscence and is protective in

**(iii) Middle layer:**- It is the third layer composed of 1-3 layers of cells, help in dehiscence and is protective in nature.

**(iv) Tapetum:**- It is fourth and innermost layer of cell with dense cytoplasm and many nuclei. It provides nourishment to the developing pollen grains.

**Microsporogenesis:-**

⇨ The process of formation of microspore from a pollen mother cell by meiosis is called microsporogenesis



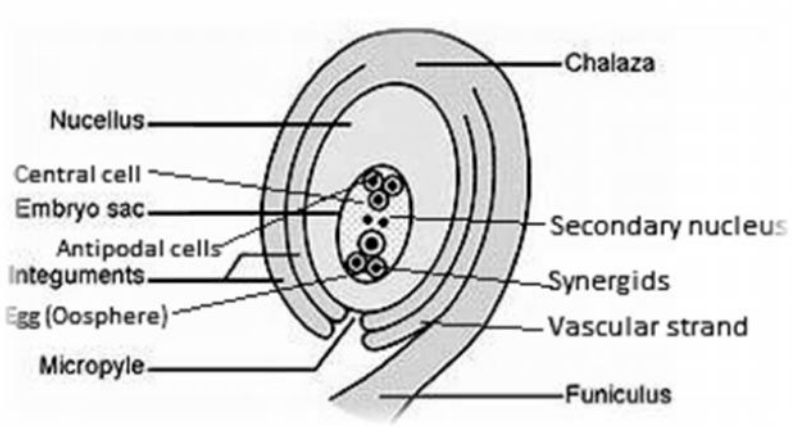

**T.S. mature dehisced anther with pollen grains**

- ⇨ Each cell of the sporogenous tissue in a microsporangium acts as a potential pollen mother cell **(PMC)** or **microspore mother cell.**
- ⇨ **PMC** undergoes meiotic divisions to form cluster of four cells called microspore mother cell.

**Female Reproductive Unit**

**Structure of Megasporangium (Ovule) Female Organ**

- ⇨ The ovule is stalked and is attached to the placenta by means of a stalk called **funicle**.




**A diagrammatic view of a typical anatropous ovule**

**Megagametogenesis**

- ⇨ The formation of female gametophyte (embryo sac) is called megagametogenesis.

*(i)* Megaspore is the first cell of the female gametophyte

*(ii)* The megaspore increases in size and its nucleus divides mitotic-ally into two nuclei which move apart to opposite poles. Thus, a 2-nucleate embryo sac is formed.

*(iii)* The two daughter nuclei undergo another mitotic division giving rise to the 4-nucleate stage.

*(iv)* The third mitotic division gives rise to 8-nucleate 7 called embryo sac.

*(v)* The central cell contains 2 nuclei known as polar nuclei.

*(vi)* The three nuclei at the micropylar region from the egg apparatus.

*(vii)* In the egg apparatus, the middle cell is the largest and is called **oosphere/egg/ovum**, while other two naked cell adjoining the egg cell are called **synergids**.

*(viii)* The three nuclei at the chalazal end are surrounded by cytoplasm and cellular wall. These are called antipodal cells.

*(ix)* The above mentioned method of female gametophyte formation is known as normal 8-nucleate type, because 8 nuclei contribute in the formation of gametophyte. It is very common among angiosperms.

**4. Pollination :**

⇨ The transfer of pollen grain from anther and their deposition over stigma of the pistil is termed as **pollination**. Depending upon sources of pollen grains, pollination is of three types.

**Pollination**

| **Autogamy** | **Geitonogamy** | **Xenogamy/Allogamy** |
|---|---|---|
| The transfer of pollen grains is from anther to stigma of the same flower, e.g., pea, rice, wheat, etc. It is self-pollination. | The transfer of pollen grains is from anther of one flower to the stigma of another flower of same plant, e.g., *Cucurbita*. | The transfer of pollen grains is from anther of one flower to stigma of another flower of different plant, e.g., papaya, maize. |

**Contrivances of Devices for Self-pollination (Autogamy)**

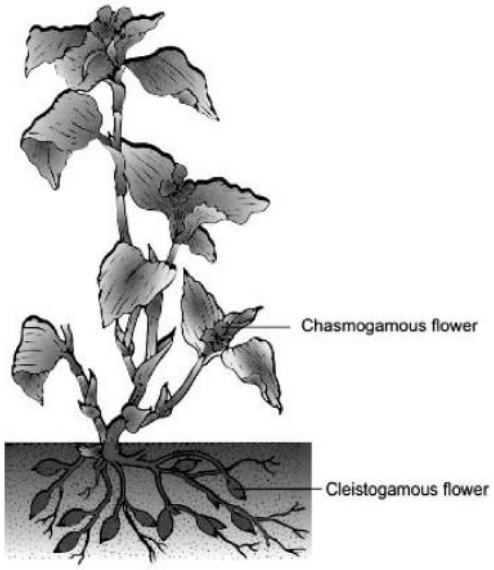
*(i)* Cross-pollination can be prevented by exhibiting which never open at all and the anthers dehisce in side these closed flowers, *e.g., Commelina.*

*(ii)* Homogamy: It is the condition of the maturity of anther and stigma at the same time, *e.g., Catharanthus (Vinca).*

**Adaptation for Wind Pollination/Anemophily**

(i) The form of pollination in which wind distributes the pollens is called anemophily.

(ii) Pollen grains are light in weight, non-sticky dry and winged.



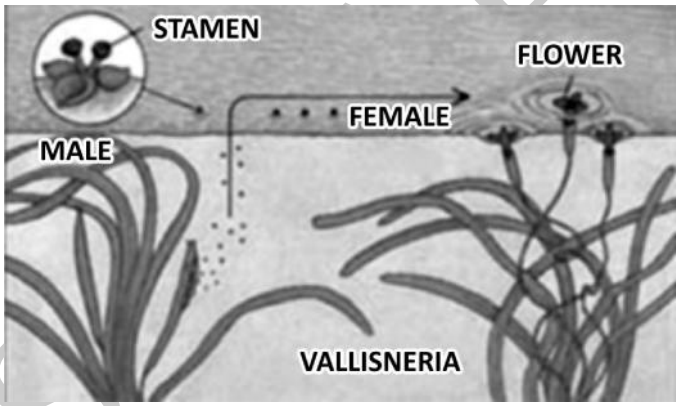
(iii) Stamens are well-exposed for easy dispersal of pollen grain in the wind.
(iv) The stigma is sticky, large and feathery to trap pollen grains floating in the air.
(v) Numerous flowers are packed together to form inflorescence.

**Adaptation for Insect Pollination/Entomophily**

(i) The form of pollination in which Insects distribute pollens is called entomophily.
(ii) Flowers are large, sticky and brightly coloured.
(iii) They have honey and nectar glands, which are highly fragrant to attract insects.
(iv) The pollen grain surface is sticky due to exine layer and stigma is sticky due to mucilaginous secretion.
(v) The flowers offer floral rewards like nectar and pollen grains for pollination to insects.
(vi) In some species, floral rewards provide safe place to lay eggs, e.g., *Amorphophallus*.
(vii) The flower sometimes secrete foul odour to attract insects like flies and beetles.

**Adaptation for Water Pollination/Hydrophily**

(i) The form of pollination in which pollens are distributed by water is called **hydrophily**.
(ii) It is very common in algae, bryophytes, pteridophytes and some angiosperms.
*(iii)* *Vallisneria* and *Hydrilla* are submerge d freshwater hydrophytes in which hydrophily is observed.
(iv) In sea-grasses, female flowers are submerged in water to receive pollen grains for pollination inside water. Pollen are long, needle-like and are carried passively by water.




**5. Double Fertilisation/Triple Fusion :**

(i) On reaching synergid, pollen tube releases the two male gametes into cytoplasm of synergid.
(ii) One of the male gamete fuses with egg nucleus to form a diploid cell called zygote. This event is called syngamy.
(iii) Other male gamete fuses with polar nuclei at the centre to produce a triploid **primary endosperm nucleus (PEN).** This is termed as **triple fusion.**
(iv) As syngamy and triple fusion take place simultaneously in the embryo sac, it is termed as double fertilization.
(v) The central cell after triple fusion forms primary endosperm cell (PEC) which later develops into endosperm.
(vi) The zygote later develops into an embryo.

**6. Post-fertilization Events :**

The following event after double fertilization are collectively called post-fertilization event:

(i) Development of endosperm from primary endosperm nucleus (PEN).

(ii) Development of embryo from zygote.

(iii) Development of seeds from ovule.

(iv) Development of fruit from ovary.

**Endosperm**

**Functions**

(i) The cells of endosperm tissue are triploid and filled with reserved food material to nourish the developing embryo.

(ii) The water of tender coconut in the centre is free-nuclear endosperm and white kernel in the outer part is the multicellular endosperm.

(iii) The endosperm may be completely consumed by the developing embryo, e.g., pea, beans, or it may persist in mature seed, e.g., coconut.

**Embryo Development**

(i) Embryo develops from zygote at the micropylar end of embryo sac.

(ii) The nutrition for development is provided by endosperm.

(iii) The zygote divides to form proembryo.

(iv) The different stages f the developing proembryo are globular and heart-shaped embryo, which finally forms mature embryo.

**Embryo in Dicots**

(i) The zygote undergoes transverse division forming a large basal cell and a small apical or terminal cell.

(ii) The large basal cell enlarges and undergoes transverse division to from a group of 6-10 cells called **suspensor**.

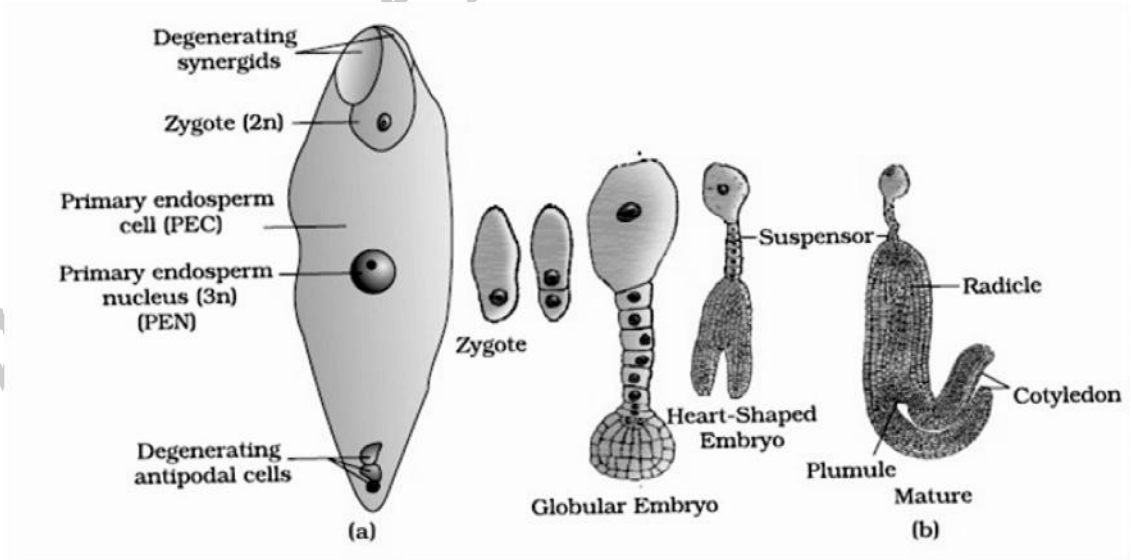



**Figure 2.13** (a) Fertilised embryo sac showing zygote and Primary Endosperm Nucleus (PEN); (b) Stages in embryo development in a dicot [shown in reduced size as compared to (a)]

**Seed**

(i) Seed is a fertilized ovule which is the final product of sexual reproduction.

(ii) It consists of the following:

**1) Seed coat(s):-** 1-2 in number having an opening called micropyle. Outer integument forms outer seed coat (testa) and inner integument forms inner seed coat (tegmen).

**2) Cotyledons:-** 1-2 in number and rich in reserve food material.

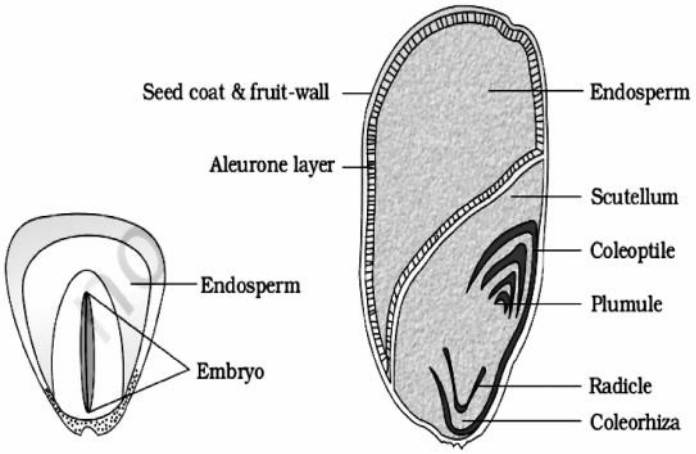
**3) Embryonal axis**

**Types of Seed**

| **Albuminous** | **Non-albuminous** |
|---|---|
| The seed with residual endosperm, e.g., wheat, maize. | The seed with no residual endosperm, e.g., pea, groundnut. |

⇨ Sometimes in the seed, nucellus may persist. This is called perisperm, e.g., in black pepper.

⇨ With maturity, the water content of seed decreases and finally enters a state of inactivity called **dormancy**.




**Advantaged of seeds**

(i) Seeds posses better adaptive strategies for dispersal to from a new colony.

(ii) The reserve food of seed support the growth of seedling till they become nutritionally independent.

(iii) The hard seed coats (testa + tegmen) provide protection against injury.

(iv) They provide genetic recombination and variation as they are the product of sexual reproduction.

(v) Seed are stored to be consumed throughout the year, to overcome drought and natural calamities.

(vi) Depending upon the mobility of seeds, they are used to raise cop in favourable season.

**7. Fruit :**

(i) The ovary matures to form **fruit** and the ovarian wall develops into the wall of fruit called **pericarp**.

(ii) Fruits can be

**(1) Fleshy *e.g.,*** orange, mango, etc. **(2) Dry, *e.g.,*** mustard, groundnut, etc.

**Types of Fruit**

| True Fruit | False fruits |
|---|---|
| Fruit that develops only from ovary e.g., pea, wheat, maize. | Fruit that develops from ovary and the thalamus or other part of flower, e.g., apple, strawberry. |

**Parthenocarpic Fruit**

Fruits that are formed without fertilization are called parthenocarpic fruits. These do not have seed, e.g., banana. Parthenocarpy can also be induced artificially by growth hormones.

**Vegetative Propagation :** It is two type : (i) Natural V.P., (ii) Artficial V.P.

**(i) Natural V.P. :**

**(a) By Roof :** Dalbergia sissoo, sweet potato, yam - root tuber.

**(b) By Leaf :**

| | | |
|---|---|---|
| Bryophyllum | - | Normal Leaf |
| Begonia | - | injured leaf |
| Kalanchoe | - | Normal leaf |
| Adiantum | - | walking fern |

**(c) By Stem :**

**Stem**

| Underground stem | Sub-aerial stem | Aerial stem |
|---|---|---|
| (i) **Tuber :** Potato Artichoke | (i) Runner : | • Phylooclade |
| (ii) **Rhizome :** Ginger, Turmeric, Banana | • Doob grass (cynodon) | eg. - Opuntia |
| | • Oxalis (wood sorrel) | |
| (iii) **Bulb :** Onion, Tulip, Lily | (ii) Stolon : Vallisneria | |
| (iv) **Corm :** Calocasia, Amorphophallus (zamikand) | • Strawberry | |
| | (iii) Offset : | |
| (v) **Sucker :** Mint, Chrysanthemum. | • Eichhornia (water hyacinth) "terror of Bengal" | |
| | •Pistia (water Lettuce) | |

- **Bubils :** These are multicellular fleshy bud or modified floral bud, Agave, oxalis, pineapple etc.
- **Artificial Vegetative Propagation :** Horticultural

**(1) Cutting :** Most common method. In this method a portion of leaf, stem or root, cut and rooted in soil, which develops into new plants.

(a) Leaf cutting : Snake plant, saintpaulia.

(b) Root cutting : Lemon, orange, blackberry etc.

(c) Stem cutting : (20-30 cm), 1 year old stem. eg. Rose, Sugarcane, citrus, grape, etc.

**(2) Layering :** It is process of rooting and cutting, in which adventitious root are induced to develop n a soft stem while it is still attached to plant.

**Mound layering :** Increase rooting by :

| | | |
|---|---|---|
| tongueing | - | oblique upward cut |
| ringing | - | bark ring cut |
| notehing | - | V - shape cut |

**Eg.** Jasmine, Strawberry, apple, pear

- Air - Layering (Gootee) : Eg. Pomegranate, orange, guava, lemon, china rose etc.

**(3) Grafting :** It is technique of connecting two part of plant, usually a root system, and a shoot system, and a shoot system of two different plant. In such a way that they unite and form single plant.

- Scion qualitative and stok with resistance power.

**eg.** - Mango, Citrus, Apple, Guava etc.

**Type of grafting :**

**(a) Scion grafting :** (i) Whip or tongue grafting
(ii) Wedge grafting
(iii) Crown grafting

**(b) Bud-grafting -** T-shap incision.

e.g. - Rose, Peach

**The Micropropagation (Tissue Culture) :** It is technique of plant tissue culture is utelised for propagation of plant. In this method a small piece of meristem transfered into nutrient medium. Tissue grow very fast and form undifferentiated mass of cell called callus. It transfered into specialised medium with hormones, it induces differentiation and plantlets are formed.

## EXERCISE

**1.** Explain the term isogamy taking chlamydononas as an example.
**2.** What is pollination? Explain self-pollination and cross pollination.
**3.** Draw a labelled diagram of a mature ovule.
**4.** Give the significance of fertilization.
**5.** Define the following term :
(a) Scion (b) Callus (c) Micropopagation
**6.** Write the example of :
(i) Rhizome (ii) Layering (iii) Grafting (iv) Stolon
**7.** In brief describe the various steps of micropropagation.
**8.** Draw a labelled diagram of a mature pollen grain.
**9.** Define the following term :
(i) Fruit (ii) Seed
**10.** Draw a labelled diagram of seed.

CHAPTER 14

# GROWTH AND DEVELOPMENT IN PLANTS

Growth can be defined as irreversible permanent increase in size of an organ or its parts or even of an individual cell.

**PHASES OF PLANT GROWTH**

If the logarithm of the size of a plant is plotted as a function of time in days after germination, a S-shaped curve is obtained, which is called sigmoid curve. The **sigmoid curve** is typical of all growth processes.

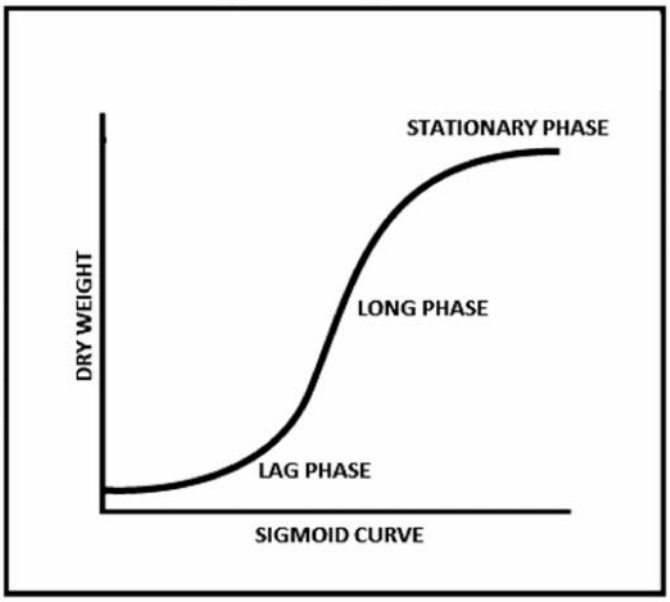
**A sigmoid curve can be divided into four parts:**

(i) The initial phase is called lag phase. During this phase. Little growth occurs.

(ii) In second phase, the log phase, which is a short phase, there is rapid growth. Therefore, this phase is also called exponential phase. It involves enlargement of cell and constant increase in growth rate.

(iii) In all cases of growth, the exponential increase declines and the rate of growth begins to decrease. The point at which this occurs is known as the inflexion point. This phase is called the deceleration phase.

(iv) The last phase is called the stationary phase. This phase marks the period when growth ceases.




- **Measurement of growth :-** It can be measured in term of :-
- ⇨ Increase in length (It is measure by auxanometer).
- ⇨ Increase in are or volume.
- ⇨ Increase in the number of cells.

**GROWTH (HORMONES)**

In all plants, minute quantities of certain substances are found **(plant growth regulators or phytohormones**), which regulate growth and differentiation.

**Five major types of growth substances are recognized : auxins, gibberellins, cytokinins, abscisic acid and ethylene.**

**1. Auxins :** The auxins are weak organic acids

*(i)* **Charles Darwin** conducted his experiments concerning growth on **Canary Grass** (Phalaris canariensis).

*(ii)* Went is credited with the discovery of **auxin** from coleoptiles of oat seeding.

*(iii)* Auxins are synthesized mainly in apices and exhibit **polar transport** through parenchyma.

**Functions of auxins:**

*(i)* Promote cell elongation by loosening of cell wall microfibrils

*(ii)* Responsible for Phototropism

*(iii)* Responsible for Geotropism

*(iv)* Promote apical dominance (in presence of apical bud, growth of lateral buds are inhibited)

*(v)* Promote root initiation in cuttings

*(vi)* Delay of abscission of leaves

**(2) Gibberellins :** Gibberellins are synthesized in the apices of young leaves, embryo, buds and roots and are transported through xylem.

Japanese former noticed 'bakanae' or **'foolish seeding disease'** of rice. As a result of the disease, certain rice seedlings grew excessively tall. Disease was caused by a fungus Gibberella fujikuroi (perfect stage of Fusarium moniliforme).

**Yabuta** and **Hayashi** (1930) isolated the growth inducing principle and called it **gibberellins**.

Chemically, all gibberellins are terpenes, a complex group of plant chemicals related to lipids. All are weak acids. Precursor is **Acetyl CoA.**

**Applications of gibberellins :**

***(i)* Internodal elongation :** Like auxins, the main effect of gibberellins is on stem elongation, mainly by effecting cell elongation. Gibberllins stimulate stem elongation and leaf expansion, but do not affect roots. Thus, gibberellins restore normal size and growth in genetically dwarf varieties of pear and maize.

***(ii)* Bolting :** In many plants, leaf development is profuse, while internode growth is retarded. This form of growth is called "**rosette**", e.g., cabbage. Just before the reproductive phase, the internodes elongate enormously, causing a marked increase in height. The stem sometimes elongates from 5-6 times the original height of the plant. This is called **bolting**. Bolting requires either long days or cold nights and gibberellins treatment.

***(iii)* Germination of seeds :** Especially in cereals.

***(iv)* Control of flowering :** Gibberellins promote flowering in long day plants and inhibit it in short day plants. These also control sex-expression in certain species. In general, the application of gibberellins promotes the production of **male flowers** in female plants of *Cannabis*.

***(v)*** **Control of fruit growth :** Along-with gibberellins, the auxins control fruit growth and development. Gibberellins cause **parthenocarpy** in **pome fruits** (apple, pear etc.)

**(3) Cytokinins :** Cytokinins are basic substances which act primarily on cell division and have little or no effect on extension growth.

**Applications of cytokinins :**

***(i)*** **Cell-division :** Cytokinins are quite abundant wherever rapid cell division occurs, especially in growth tissues.

***(ii)*** **Morphogenesis :** Cytokinins promote cell division. In the presence of auxins, cytokinins promote cell division even in non-meristematic tissues. In tissue cultures of parenchyma, mitotic divisions are accelerated when both auxin and cytokinin are present. **The ratio of cytokinins to auxins also controlscell differentiation.**

***(iii)*** **Apical dominance :** Cytokinins and auxins act antagonistically in the control of apical dominance.

***(iv)*** **Delay in senescence :** Cytokinins **delay the senescence** of plant organs by controlling protein synthesis and mobilization of resources. This is called **Richmond Lang effect**.

***(v)*** **Flowering :** Cytokinins also induce flowering in certain species of plants and are also responsible for breaking the dormancy of seeds in some plants.

**(4) ABA - Applications of ABA :**

*(i)* **Stoppage of cambial activity –** It inhibits mitosis in vascular cambium.

*(ii)* **Bud dormancy -** It induces axillary buds to become dormant as the winter approaches.

*(iii)* **Seed dormancy –** It induces dormancy in seeds.

*(iv)* **Transpiration –** It is a 'stress hormone' and helps the plant to cope with adverse environmental conditions by closing stomata (Antitranspirant).

*(v)* It may be sprayed on tree crops to regulate fruit drop at the end of the season.

**(5) Ethylene :** Ethylene is the **only gaseous** natural plant growth regulator. It could fit in both categories of promoters and inhibitors, but it is largely an inhibitors of growth activities.

Ethylene is produced by most or all plant organs. High concentrations of auxin induce the formation of ethylene. Through it is a gas, it does not generally move through the air spaces in the plants. Rather, it escapes from the plants surface. Precursor is **methionine**.

**Applications of ethylene :**

***(i)*** **Growth –** It inhibits stem elongation and stimulates its transverse expansion. As a result, the stem looks swollen.

***(ii)*** **Abscission –** It accelerates abscission of leaves, flowers and fruits.

***(iii)*** **Fruit ripening –** Its chief effects are on the ripening of fruits accompanied by a rise in the rate of respiration (**climacteric**).

***(iv)*** **Flowering –** Application of ethylene induces flowering in pineapple.

**DIFERENTIATION, DEDIFFERENTATION AND REDIFFERENTIATION**

***(i)*** **Differentiation :** Growth is invariably associated with differentiation. Differentiation is a permanent localized qualitative change in size, biochemistry, structure and function of cell, tissues or organs, e.g., fibre, vessel, tracheid, sieve tube, mesophyll, leaf, etc.

**Some examples:**

**(a)** Enlargement, lignocellulosic wall thickening

**(b)** Loss of end wall in case of vessel elements

**(c)** Deposition of suberin and tannins inc ells

**(d)** Secretion of mucilage in root cap

**(e)** Loss of nucleus in sieve tubes

***(ii)*** **Dedifferentiation :** It is the process of de-specialization of differentiated living cells so that they regain the capacity to divide and form new cells.

***(iii)*** **Re-differentiation :** Structural, chemical and physiological specialization of cells derived from dedifferentiated meristematic cells is called re-differentiation.

**DORMANCY**

In favourable conditions if viable seed fails to germinate, condition is called "dormancy". And if viable seed fails to germinate due to unfavourable conditions, it is called "quiescence".

Dormancy may be:

**Due to seed coat :**

• Seed coat impermeable for gases, *e.g., Xanthium*.

**SEED GERMINATION**

The first step is the process of plant growth is seed germination. The seeds germinate under favourable conditions of the environment. Some seeds undergo a period of dormancy and can germinate only after dormancy period gets over.

Seed germination to form seeding which grows into a plant. After the dormancy of the seed is over or is broke and the necessary conditions for germination are available the dormant embryo becomes metabolically action and starts growing. This process is known as seed germination. The conditions necessary for seed germination are availability of water and oxygen. The imbibitions or the uptake of water is the first step towards the germination of seed. It causes swelling of seed that ruptures the seed coat to enable the radical to emmer from one end of embryonic axis. The metabolic activities require oxygen for breaking down the food reserved. The mobilization of feed reserves involves the hydrolysis of stored polysaccharides, proteins, and lipids with the help of enzymes. It is of two types.

***(i)*** **Epigeal –** Hypocotyl grows first, cotyledons come out of soil as in cucurbits, mustard, castor, onion, tamarind etc.

***(ii)*** **Hypogeal –** Epicotyl grows first, cotyledons remain underground as in rice, maize, mango, Fabaceaese. Whenever seed germinates inside fruit, it is **vivipary** as in *Rhizophora*, *Sonneratia*, *Heritiera* etc.

**PHOTOPERIODISM (TERM BY GARNER & ALLARD)**

The response of plants to changes in the relative lengths of day and night is called **photoperiodism**. The plants exhibiting the response are called photoperiodic.

**Photoperiod :** The relative lengths of dark and light periods in day vary from place to place and from season to season. The length of light period is called **photoperiod**. At equators, day length is of 12 hour duration throughout the year.

**VERNALISATION**

The term **vernalisation** was coined by the Russian agronomist **Lysenko** to refer to the method of accelerating the flowering ability to biennials or winter annuals, by exposing their soaked seeds to low temperatures for a few weeks. However, presently the term is used in a wider sense to include the promotion of flowering in plants by exposing them to low temperatures at any stage in their life cycle It has been found that some plants especially biennials and perennials, are stimulated to flower by exposure to low temperatures. This promotive effect of temperature on flowering is called **vernalisation**. The vernalisation was first studied in Europe on the winter varieties of vereals such as wheat, barely, oats and rye.

**Site of vernalisation –** Shoot tip, embryo tip, root apex, developing leaves.

As a result of vernalisation a hypothetical hormone called Vernalin (by Melcher) is synthesized

**Requirements of vernalisation**

**(1) Low temperature –** $0^0 – 5^0C$

**(2) Period of low temperature –** Few hours – few days

## EXERCISE

**1.** What is differentiation?

**2.** Mention two function of Auxin.

**3.** Name the plant harmones concerened with :

(a) Shedding of leaves

(b) Breaking seed dormancy

**4.** Which two hormones are essential for vacular tissue differentiation.

**5.** Explain following term :

(i) Phototropsim (ii) Vernalisation

**6.** What is a signoid growth curve?

**7.** Distinguish between epigeal germination and hypogeal germination.

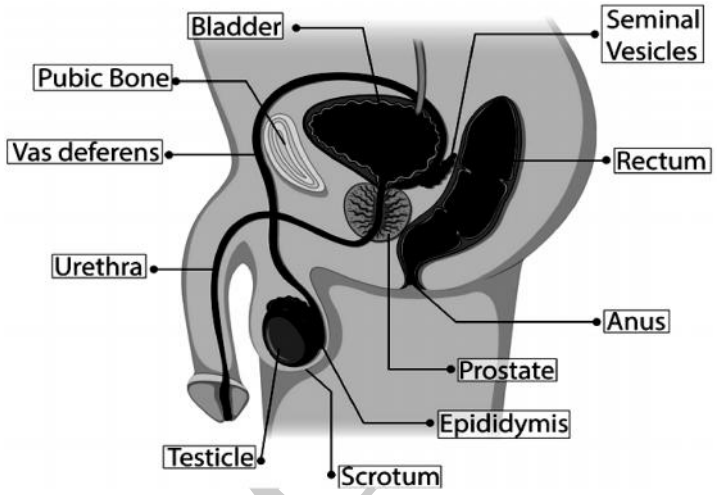
**8.** Explain the role of cytokinins and Ethylene in growth and development of plant.

CHAPTER 15

# REPRODUCTION AND POPULATION CONTROL

**Male Reproductive System :** It consist following structure :-

***(i)*** **Testes :-** Human male have a pair testes in extra-abdominal pouch called scrotum. It help to maintain the temperature of testes at about 2-3$^0$C. It is suitable for sperm formation. Testes form spermatozoa and male sex hormones testosterone.




***(ii)*** **Epididymis:–** Coiled tubules involve in sperm storage.

***(iii)*** **Vas-deferens:–** It enter the abdominal cavity and joins the duct of seminal vesicle to form the ejaculatory duct.

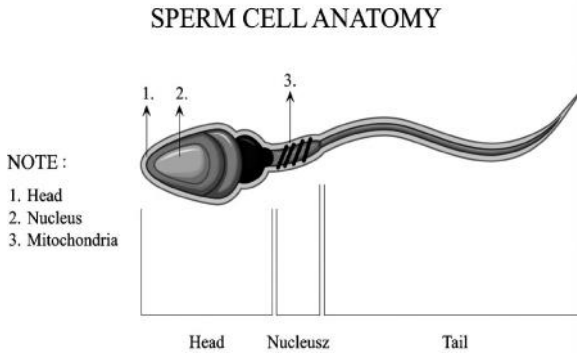
***(iv)*** **Urethra:–** It function as a passage for both semen and urine.

***(v)*** **Penis** - Copulatory organ in male.

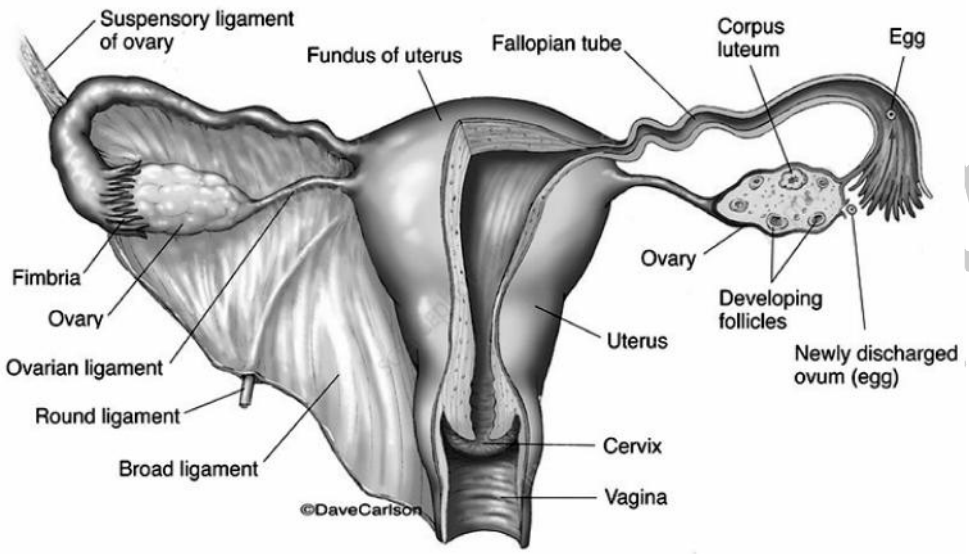
**Spermatozoa and Semen**

The process of formation of sperm is termed spermatogenesis. The secretion of various accessory gland along with sperm is called semen. Sperm rout –

Seminidymis tubules of testes ☞ Vasa efferentia ☞ Epididymis ☞ Vas-deferens ☞ Urethra in penis.



**Female Reproductive System –**




***(i)*** **Ovaries:-** There is a pair of ovaries, which lie in the lower part of the abdominal cavity, one on each side of the body. Ovaries produce ova and also secrete female sex hormones, oestrogen and progesterone. The process of formation of egg in the ovary is known as oogenesis.

***(ii)*** **Fallopian tube –** It is also called oviduct. It is site of fertilization, transfer fertilized egg to the uterus.

***(iii)*** **Uterus** – It is pear shaped, muscular, hick-walled organ the wall of uterus contain three coat, endometrium, myonetrix and Perimetrium. It provide site for implantation of embryo.

***(iv)*** **Vagina** – It is organ which take semen during coitus. It is muscular tube about 7 – 10 cm in length. The opening of vagina perforated by membrane is called hymen.

**Menstrual cycle in Human female –**

In female after sexual maturity a cyclic change occurs in endometrium of Uterus is called menstrual cycle. It complete in three step –

**(1)** Menstruation – 3.5 days

**(2)** Follicular phase – 12 days

**(3)** Luteal phase – 11 - 13 days.

*(v)* Initiation of menstrual cycle is called menarch. It comes in age of 11 – 13 years.

*(vi)* The permanent stoppage of menstruation in female is called menopause. It occurs at age 45 – 50 years.

**Fertilization and implantation:-** After ovulation ovum reach in fallopian tube and one sperm fuse with the ovum and form zygote, this process is called fertilization.

Zygote undergoes division and form multi cellular embryo. The embryo fix with wall of uterus is called implantation.

**Placenta :** The developing embryo is attached to the uterus by a tissue called placenta. Placenta serve as a tissue through which oxygen and food are supplied from the maternal blood to the factus. It also transport $CO_2$ and excretory waste from the factal blood to maternal blood.

**Process of childbirth:–**

**(1)** Uterus undergoes contraction (labour)

**(2)** Amnion bursts and amniotic fluid is discharged.

**(3)** Uterus contract vigorously, expelling the baby.

**(4)** The baby's lungs start functioning and the baby takes its first breathe.

**Lactation:–** The Secretion of milk from the mammary gland is called and the period during which milk secreted is called lactation period.

First secretion of mammary gland is called colostrums. It is rich in nutrient, fat and protein. It also contain antibody IgA which provide immunity to infant.

**Population – Problems and Controls**

**Demography:–** The scientific and statical study of human population.

**Birth Rate (Natality):–** The number of individuals add per 1000 person per year.

**Death rate (Mortality):–** The number of death per 1000 individual per year.

**Factor responsible for population explosion in India** -

**(1)** Advancement in medicine

**(2)** Religious and social customs.

**(3)** Illiteracy

**(4)** Economic reasons

**(5)** Desire of male child

**Problems Posed by increasing population** –

**(1)** Poor health of the mother

**(2)** Poor housing

**(3)** Economic pressure

**(4)** Improper education

**(5)** Food requirement.

**Population control and family planning** -

- ⇨ The government has taken many measures for providing family planning guidance and support, and family welfare measures.
- ⇨ Education help to make people aware of the advantages of a small family and the disadvantages of large family.

**Preventive methods for population control and family planning :**

- ⇨ Use of condoms in male and diaphragms in female.
- ⇨ Intrauterine device Cu-T are inserted in female body so that implantation is not possible.
- ⇨ Oral contraceptive polls prevent ovulation.
- ⇨ Vasectomy – Sterilization of male, in this method vas-deferens cut and bind.
- ⇨ Tubectomy – Sterilization of the woman by cutting fallopian tube and binding.
- ⇨ Abortion or Medical Termination of Pregnancy (MTP) – It is removal of unwanted factus from mother body.

## EXERCISE

**1.** Name three type of accessory gland found in the human male reproductive system.

**2.** State the function of following :
(i) Seminal Vesices (ii) Uterus

**3.** Define the following term :
(i) Implantation (ii) Placenta (iii) Morula

**4.** Explain the role of following :
(i) Prolactin (ii) Oxytocin

**5.** List any four reasons for population explosion in India.

**6.** What is reproduction? List organ of the human male reproductive system.

**7.** How does increasing population control in India?

**8.** Choose the odd one in each of following :
(i) Ovary, Fallopan tube, ureter, uterus
(ii) Epididymis, urethra, vas deferens, uterus
(iii) Grafian follicle, corpus litrum, leydig cell

**9.** Differential the Identical twins and fraternal twins.

**10.** Name the surgical method of contraception in human female.

CHAPTER
16

# PRINCIPLES OF GENETICS

- The process by which characters are transferred from one generation to the next generation is called **inheritance/heredity.**
- The differences in traits of individuals of a progeny from each other and from their parents are called **variations**.
- The branch of science which deals with inheritance and variation is called **genetics**.

**1. Mendel's Experiment :**

- Gregar Johann Mendel (1822 – 1884) is known as **'Father of Genetics'.**
- Mendel performed his experiments with garden pea plant (*Pisum sativum*).
- He Conducted artificial pollination/cross-pollination experiments using several true-breeding varieties having contrasting traits as shown in fig.
- He observed one trait at a time.
- He hybridized plants with alternate forms of a single trait (**Monohybrid cross**). The seeds thus produced were grown to develop into plant s of **first filial generation ($F_1$)**.
- Mendel then self-pollinated the F1 plants to generate plants of **second filial generation ($F_2$).**

**2. Mendel's Experimental Plant :**

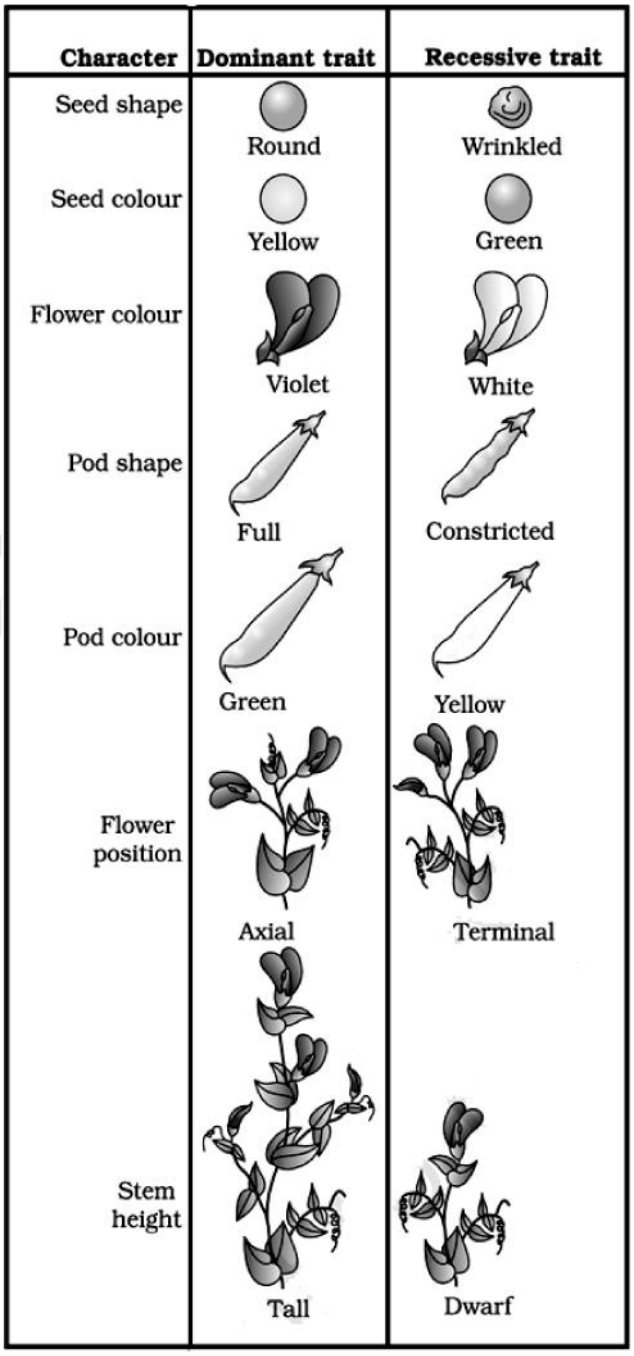
- Mendel selected garden pea as his experimental material because of the following reasons:

(i) It is an annual plant with a short life-cycle. So, several generations can be studied within a short period.

(ii) It has perfect bisexual flowers containing both male and female parts.

(iii) The flowers are predominantly self-pollinating. It is easy to get pure line for several generation.

(iv) It is easy to cross-pollinate them because pollens from one plant can be introduced to the stigma of another plant by removing the anthers.

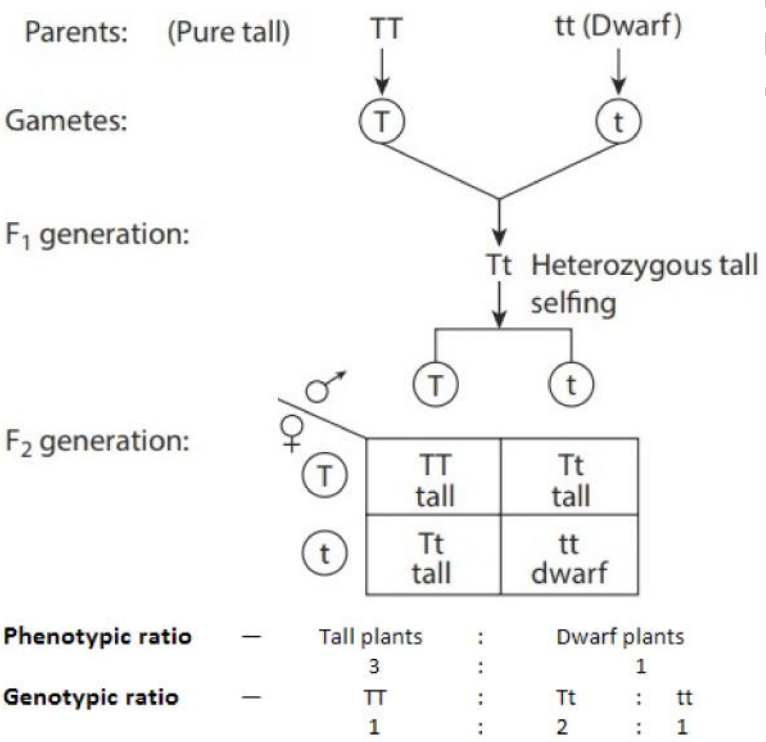



**Seven pairs of contrasting characters of pea plant selected by Mendel**

(v) Pea plant produces a large number of seeds in one generation.
(vi) Pea plants could easily be raised, maintained and handled.
(vii) A number of easily detectable contrasting characters/traits were available.

**3. Mendel's Observations**

- $F_1$ progenies always resembled one of the parents and trait of other parent was not seen.
- $F_2$ stage expressed both the parental traits in the proportion 3 : 1.
- The contrasting traits did not show any blending at either $F_1$ or $F_2$ stage.
- In dihybrid cross, he got identical results as in monohybrid cross.
- He found that the phenotypes in $F_2$ generation appeared in the ratio 9 : 3 : 3 : 1.




**Monohybrid cross of true-breeding pea plant**

**4. Mendel's Laws of Inheritance :**

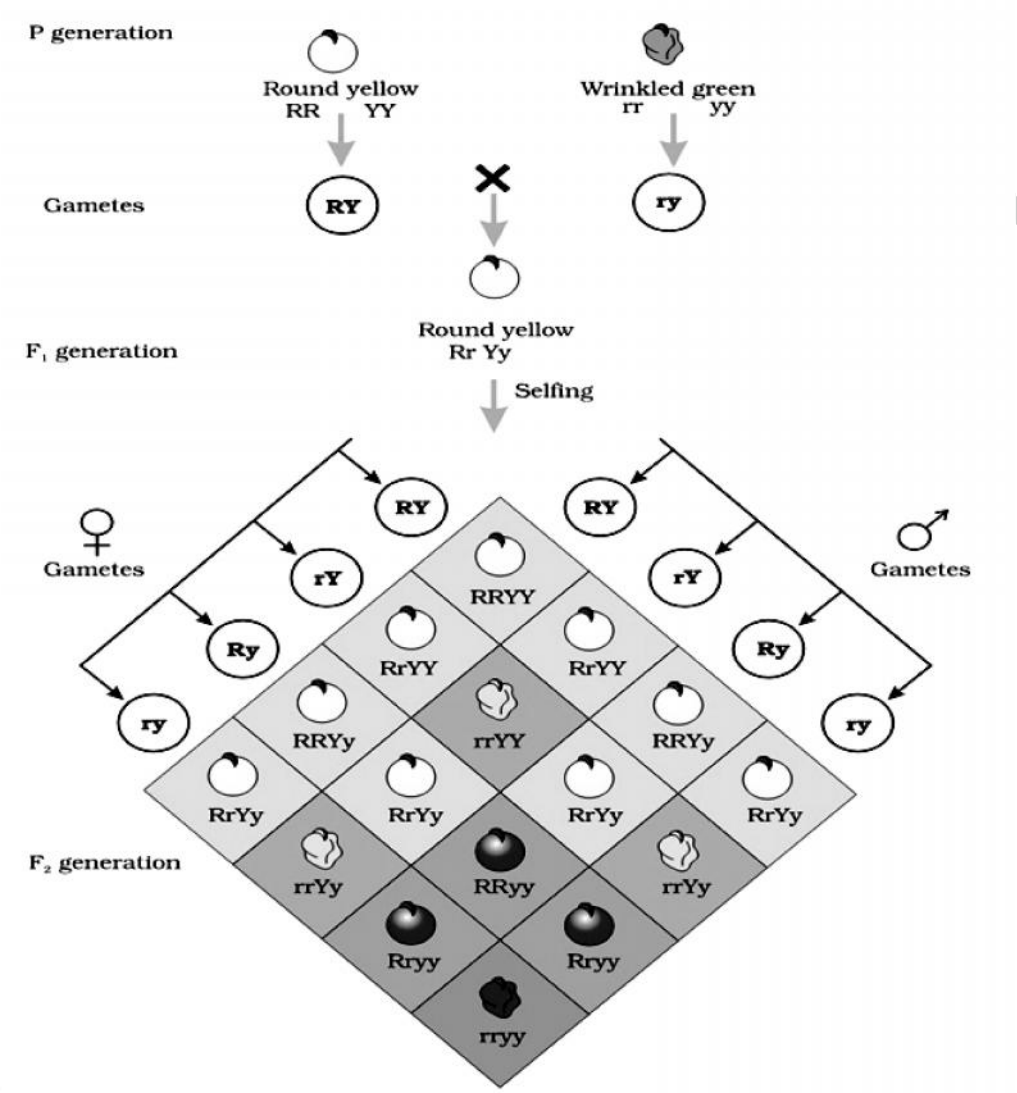
- Based on his hybridization experiments, Mendel proposed the laws of inheritance.
- His theory was rediscovered by Hugo de Vries of Holland, Carl Correns of Germany and Eric von Tschermak of Austria in 1901.

**(i) Law of dominance (First law)**

- This law states that when two alternative forms of a trait or character (genes or alleles) are present in an organism, only one factor expresses itself in $F_1$ progeny and is called dominant while the other that remains masked is called recessive.

**(ii) Law of segregation (Second law)**

- This law states that the factors or alleles of a pair segregate from each other during gamete formation, such that a gamete receives only one of the two factors. They do not show any blending.




**Phenotypic ratio :** round yellow : round green : wrinkled yellow : wrinkled green

9 : 3 : 3 : 1

Genotypic ratio — 1 : 2 : 2 : 4 : 1 : 2 : 1 : 2 : 1

**Figure** Results of a dihybrid cross where the two parents differed in two pairs of contrasting traits: seed colour and seed shape

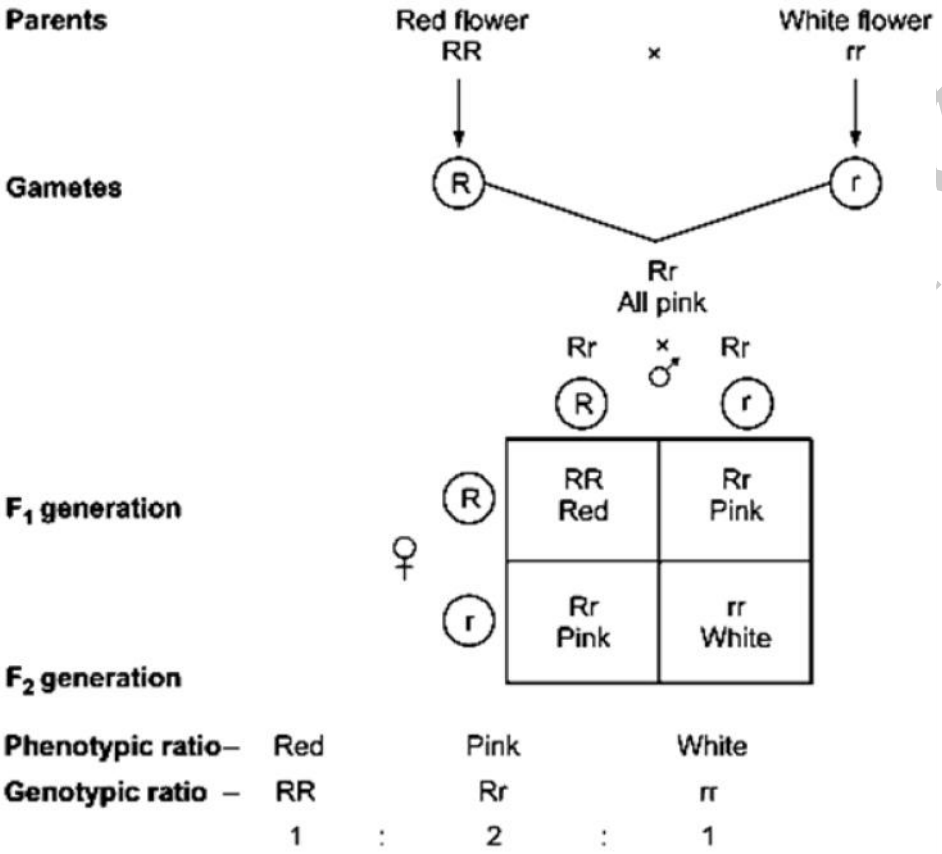
**(iii) Law of independent assortment**

- According to this law the two factors of each character assort or separate out independent of the factors of other characters at the time of gamete formation and get randomly rearranged in the offspring's producing both parental and new combinations of characters.

**5. Incomplete Dominance :**

- It is a phenomenon in which the F1 hybrid exhibits characters intermediate of the parental genes.

- Here, the phenotypic ratio deviates from the Mendel's monohybrid ratio.
- It is seen in flower colours of *Mirabilis jalapa* (4 o' clock plant) and *Antirrhinum majus* (snapdragon), where red colour is due to gene RR, white colour is due to gene *rr* and pink colour is due t gene *Rr*.




Monohybrid cross in Snapdragon, where one allele is incompletely dominant over the other allele

**6. Co-dominance :**

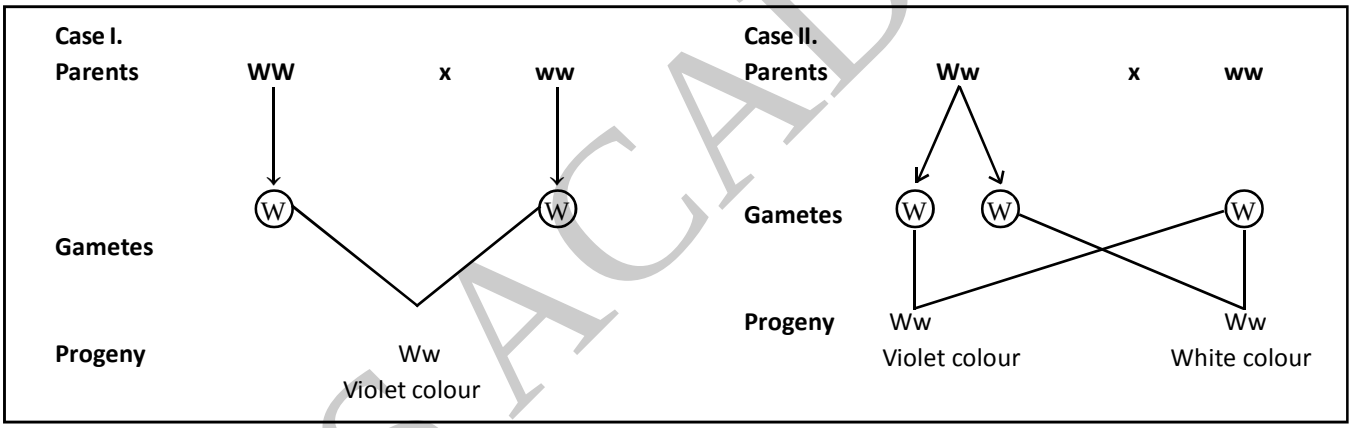
- The alleles which are able to express themselves independently, even when present together are called co-dominant alleles and this biological phenomenon is called co-dominance.
  For example, ABO blood grouping in humans.
- ABO blood groups are controlled by gene *I*. Gene *I* has three alleles $I^A$, $I^B$ and $I^O$/*i*.
- $I^A$ and $I^B$ produce RBC surface antigens sugar polymer A and B, respectively, whereas *i* does not produce any antigen.
- $I^A$ and $I^B$ are dominant over *I* hence $I^A$ and $I^B$ are dominant alleles and *i* is recessive allele as in $I^Ai$ and $I^Bi$.
- When $I^A$ and $I^B$ are present together both express equally and produce the surface antigens A and B, hence show co-dominance.

- Since humans are diploid, each person possesses any two of the three 'I' gene alleles, resulting into six different genotypic combinations and four phenotypic expressions.

| Allele from Parent I | Allele from Parent 2 | Genotype of offspring | Blood groups of offspring |
|---|---|---|---|
| $I^A$ | $I^A$ | $I^A I^A$ | A |
| $I^A$ | $I^B$ | $I^A I^B$ | AB |
| $I^A$ | $i$ | $I^A i$ | A |
| $I^B$ | $I^B$ | $I^A I^B$ | B |
| $I^B$ | $i$ | $I^B i$ | B |
| $i$ | $i$ | $i\ i$ | O |

**7. Test Cross :**

- It is a method devised by Mendel to determine the genotype of an organism.
- In this cross, the organism with unknown dominant genotype is crossed with the recessive parent.
- In a monohybrid cross between violet colour flower (W) and white colour flower (w), the $F_1$ hybrid was violet colour flower. The test crosses are:




- If all the F1 progeny are violet colour, then the dominant flower is homozygous and if the progenies are in 1 : 1 ratio, then the dominant flower is heterozygous.

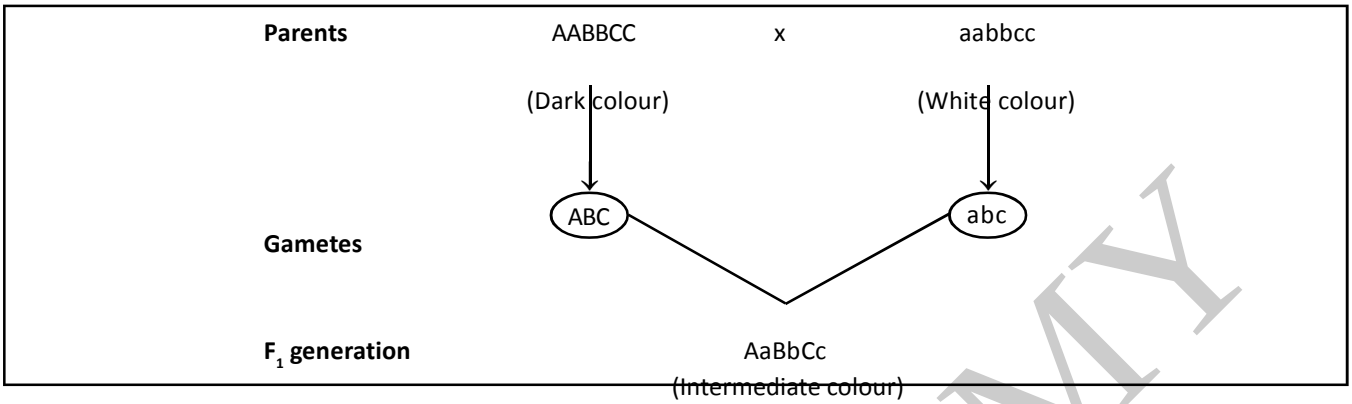
**8. Pleiotropy :**

- It is the phenomenon in which a single gene exhibits multiple phenotypic expression.
- The pleiotropic gene affects the metabolic pathways, resulting in different phenotypes.
- For example, phenylketonuria is caused by mutation in the gene coding for the enzyme phenylalanine hydroxylase. The affected individuals show mental retardation as well as hair and skin pigmentation.

**9. Polygenic Inheritance :**

- It is a type of inheritance, in which traits are controlled by three or more genes. Such traits are called **polygenic traits**.
- The phenotype reflects contribution of each allele and is also influenced by the environment.
- For example, human skin colour. Suppose 3 genes A, B and C control skin colour with A, B, C being the dominant alleles and a, b, c being the recessive alleles. Then,

- The F2 generation will have varied skin tones, with each type of allele in the genotype determining the darkness or lightness of the skin.




**10. Chromosomal Theory of Inheritance :**

- The chromosomal theory of inheritance was proposed independently by Walter Sutton and **Theodore Boveri** in 1902. According to this theory.

*(i)* Since the sperm and egg cells provide the only bridge from one generation to the other, all hereditary characters must be carried in them.

*(ii)* The hereditary factors are carried in the nucleus.

*(iii)* Like the Mendelian alleles, chromosomes are also found in pairs.

*(iv)* The sperm and egg having haploid sets of chromosomes fuse to re-establish the diploid state.

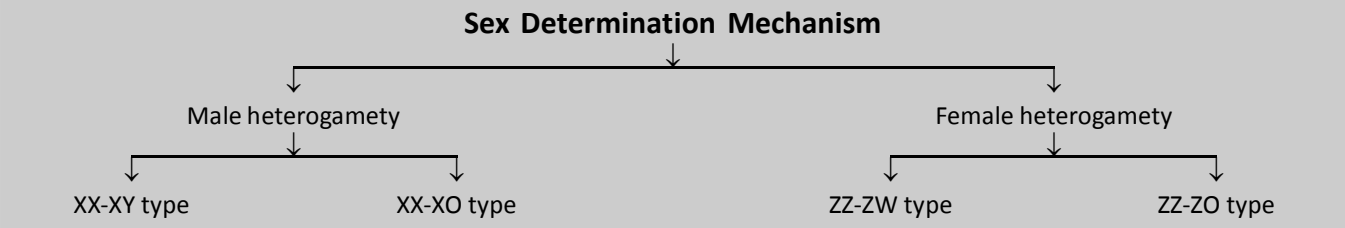
*(v)* The genes are located on the chromosomes in a linear order. As there are 2 chromosomes of each kind in somatic (diploid) cell there must be 2 genes of each kind, one in each of 2 homologous chromosomes.

*(vi)* Homologous chromosomes synapse during meiosis and get separated to pass into different cells. This forms the basis for segregation and independent assortment. A gamete receives only I chromosome of each type and this has only I gene for a trait. The Paired condition is restored by fusion of gametes.

**11. Linkage and Recombination :**

- T.H. Morgan carried out several dihybrid crosses in *Drosophila* to study the genes that are sex-linked. He observed that when the two genes in a dihybrid cross are located on the same chromosome, the proportion of parental gene combinations in the progeny was much higher than the non-parental or recombination of genes.
- Morgan and his group found that when genes are grouped on the same chromosome, some genes are tightly linked or associated and show little recombination.
- When the genes are loosely linked they show higher percentage of recombination.
- Morgan hybridized yellow bodied and white eyed females with brown bodied and red eyed males (wild type) (cross-A) and inter-crossed their $F_1$ progeny.

- Alfred Sturtevant determined that genes of *Drosophila* are arranged in a linear order. He measured the distance between genes and prepared **chromosome maps** with the position of genes on the chromosomes based on percentage of recombinants. These are also called **genetic maps.**

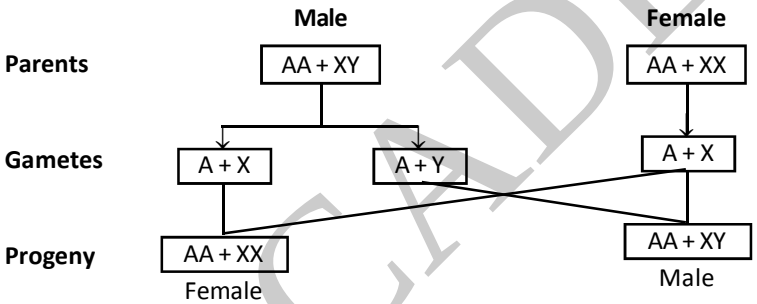



**12. Sex Determination Mechanism :**

Finalization of sex at the time of zygote formation is called **sex determination.**

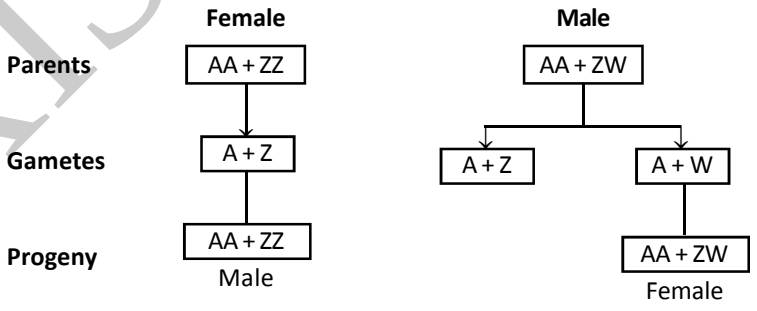
***(i)*** **XX-XY type**

- Seen in many insects and mammals including humans.
- Males have X and Y chromosomes along with autosomes and females have a pair of X chromosomes.




**(i) ZZ-ZW type**

- Seen in birds, fowl and fishes.
- Females have one Z and one W chromosome whereas males have a pair of Z chromosomes.




- **Cris – cross inheritance X-Linked inheritance -** The gene which are located on X-chromosome are called sex-linked gene. These gene show cris – cross inheritance. In this type of inheritance of recessive sex linked character from father to daughter and then the daughter to her son is known as cris – cross inheritance.

Eg. Colour blindness and Hemophilia.

⇨ Inheritance of mitochondrial DNA is called **maternal inheritance.**

➢ **Colour blindness**

*(i)* It is a sex – linked recessive disorder.

*(ii)* It results in defect in either red or/and green cone of eye, resulting in failure to discriminate between red and green colour.

*(iii)* The gene for colour blindness is present on X chromosome.

*(iv)* It is observed more in males ($X^0Y$) because of presence of only one X chromosome as compare to two chromosomes of females.

➢ **Chromosomal Disorders in Humans ⇨**

⇨ Chromosomal disorders are caused due to excess, absence or abnormal arrangement of one of more chromosomes.

⇨ Sometimes the chromatids fail to segregate during cell division, resulting in gain or loss of chromosome. This is called aneuploidy.

**(a) Down's syndrome**

**Cause:** Additional copy of chromosome number 21 or trisomy of chromosome 21.

**Symptoms:**

*(i)* Short statured with small round head.

*(ii)* Partially open mouth with protruding furrowed tongue.

*(iii)* Palm is broad with characteristic palm crease.

*(iv)* Slow mental development.

**(b) Klinefelter's syndrome**

**Cause:** Presence of an additional copy of X chromosome resulting in the karyotype 45+XXY.

**Symptoms:**

*(i)* Sex of the individual is masculine but possess feminine characters.

*(ii)* Gynaecomastia, i.e., development of breasts.

*(iii)* Poor bread growth and often sterile.

*(iv)* Feminine pitched voice.

**(c) Turner's syndrome**

**Cause:** Absence of one of the X chromosomes, resulting in the karyotype 45 + XO.

**Symptoms:**

*(i)* Sterile female with rudimentary ovaries.

*(ii)* Shield-shaped thorax.

*(iii)* Webbed neck.

*(iv)* Poor development of breasts.

*(v)* Short stature, small uterus, puffy fingers.

## EXERCISE

**1.** State one difference between :

(i) dominant and recessive traits

(ii) monohybrid and dihybrid cross

**2.** Define the term -

(i) Genetics (ii) Variation (iii) Allele (iv) Polygenes

**3.** Write the phenotypic and genotypic ratio in case of incomplete dominance.

**4.** Who proposed the chromosomal theory of inheritance?

**5.** A colour blind man married a normal woman whose father and mother both had normal colour vision : will any of their son be colour blind?

**6.** In honey bees "males have no father and cannot have son but have a grandfather". Justify the statement.

**7.** Explain cris-cross inheritance.

**8.** Explain dihybrid cross. Workout their inheritance.

**9.** Why is mitochondrial inheritance treated as a case of material inheritance?

**10.** State the chromosomal abnormality in Klinefelters. Turners shyndrome and in Mangolism.

CHAPTER 17

# MOLECULAR INHERITANCE AND GENE EXPRESSION

**Transforming Principle :**

- Frederick Griffith (1928) conducted experiments with *streptococcus pneumoniae* (bacterium causing pneumonia).
- He observed two strains of this bacterium—one forming smooth shiny colonies (S-type) with capsule, while other forming rough colonies (R-type without capsule.
- When live S-type cells were injected into mice, they died due to pneumonia.
- When live R-type cells were injected into mice, they survived.
- When heat-killed S-type cells were injected into mice, they survived and there were no symptoms of pneumonia.
- When heat-killed S-type cells were mixed with live R-type cells and injected into mice, they died due to unexpected symptoms of pneumonia and live S-type cells were obtained from mice.
- He concluded that heat-killed S-type bacteria caused a transformation of the R-type bacteria into S-type bacteria but he was not able to understand the cause of this bacterial transformation.

| | | | | | | |
|---|---|---|---|---|---|---|
| **Live Virulent S - cells** | **+** | **Live mice** | **–** | **Mice died** | **Ĝ** | **Virulent S-cells** |
| **Non-Virulent R-cells** | **+** | **Live mice** | **–** | **Mice lives** | **Ĝ** | **No Bacteria** |
| **Heat - Killed S-cells** | **+** | **Live mice** | **–** | **Mice lives** | **Ĝ** | **No Bacteria** |
| **Heat - killed S-cells + Live R- cells** | **+** | **Live mice** | **–** | **Mice died** | **Ĝ** | **Virulent S-cells** |

**Griffith's experiment on transformation**

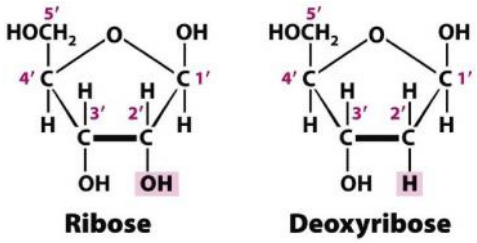
**The Structure of Polynucleotide Chain = DNA**

- A nucleotide is the basic unit of polynucleotide chain of DNA or RNA.
- Each nucleotide is composed of three components:

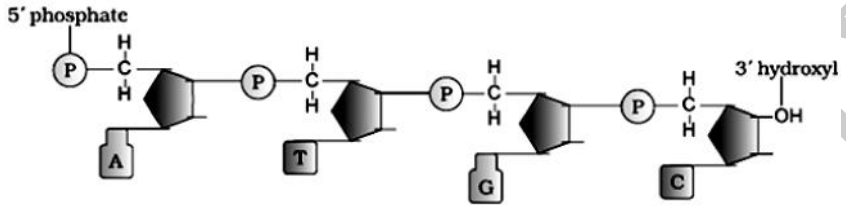
*(i)* A nitrogenous base,

*(ii)* **Types of sugar molecules**
Pentose sugar (ribose in case of RNA and deoxyribose for DNA), and

*(iii)* A phosphate group.



- **Nitrogenous base:** It is of two types, purine (adenine and guanine) and pyrimidine (cytosine and thymine). Uracil is only present in RNA instead of thymine.
- A nitrogenous base is attached to the pentose sugar by an N-glycosidic linkage to form a nucleoside.
- When a phosphate group is attached to 5'-OH of a nucleoside through phosphodiester linkage, a nucleotide is formed.
- Two nucleotides are joined through 3' – 5' phosphodiester linkage and a dinucleotide is formed. Thus, when numerous nucleotides are joined, a polynucleotide chain is formed.




**A polynucleotide chain**

- One end of polynucleotide chain contains pentose sugar with free OH at 5' end (it is called 5' – end) and the other end contains sugar with free OH at 3' end (it is called 3' – end).
- Sugar and phosphate constitute the backbone of polynucleotide chain and nitrogenous bases are linked to sugar moiety which projects from the backbone.

**Salient Features of Double Helical DNA**

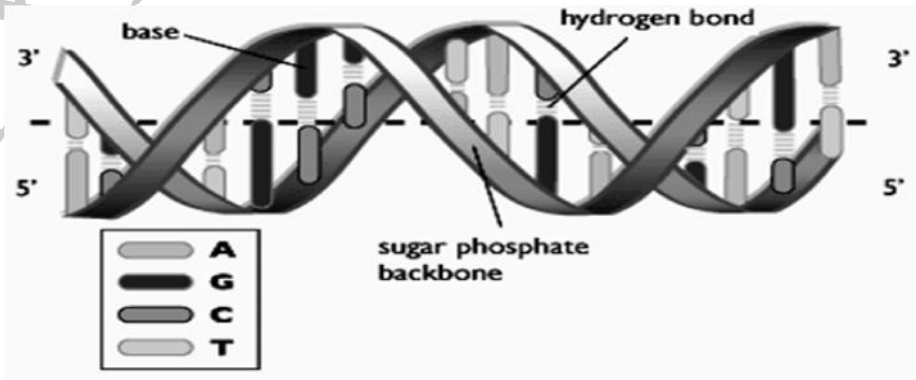
- James Watson and Francis Crick in 1953 proposed the double helix model of DNA based on the X-ray diffraction data produced by Maurice Wilkins and Rosalind Franklin and Erwin Chargaff's rules of base pairing.
- **Chargaff's rules:**

*(i)* The amount of adenine s always equal to the amount of thymine and the amount of guanine is always equal to the amount of cytosine, *i.e.,* [A] = [T], [G] = [C]

*(ii)* Adenine is joined to thymine with two hydrogen bonds and guanine is joined to cytosine by three hydrogen bonds.

*(iii)* The ratio of adenine and guanine to that of thymine and cytosine is always equal to one, *i.e.,*

$$\frac{[A+G]}{[T+C]}=1$$




**DNA double helix**

**Following are some features of DNA:**

*(i)* DNA is made up of two polynucleotide chains, where the backbone is made up of sugar and phosphate groups and the nitrogenous bases project towards the centre.

*(ii)* There is complementary base pairing between the two stands of DNA.

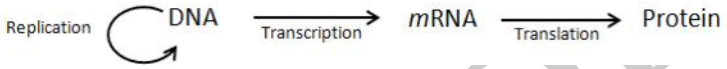
*(iii)* The two stands are coiled in right-handed fashion and are anti-parallel in orientation. One chain has a 5'→3' polarity while the other has 3'→5' polarity.

*(iv)* The diameter of the strand is always constant due to pairing of purine and pyrimidine, i.e., adenine is complementary to thymine while guanine is complementary to cytosine.

*(v)* The distance between two base pairs in a helix is 0.34 nm and a complete turn contains approximately ten base pairs. The pitch of the helix is 3.4 nm and the two strands are right handed coiled.

**Central dogma**

☞ **Francis Crick** proposed the central dogma of molecular biology which states that genetic information flows from DNA to *m*RNA (transcription) and then from *m*RNA to protein (translation) always unidirectionally (except bidirectionally in some viruses and the process is called reverse transcription).



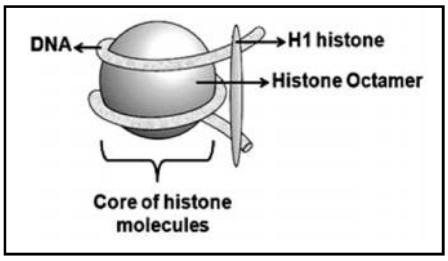

**Packaging of DNA**

***(i)* Packaging of DNA in prokaryotes**

- In prokaryotes, well-defined nucleus is absent so DNA is present in a region called nucleoid. The negatively charged DNA is coiled with some positively charged non-his tone basic proteins.
- DNA in nucleoid is organized in large loops held by proteins.

***(ii)* Packaging of DNA in eukaryotes**

- Roger Kornberg (1974) reported that chromosome is made up of DNA and protein.
- Later, Beadle and Tatum reported that chromatin fires look like beads on the string, where beads are repeated units of proteins.
- The proteins associated with DNA are of two types—basic proteins (histone and protamine) and acidic non-histone chromosomal (NHC) proteins.
- The negatively charged DNA molecule wraps around the positively charged histone proteins to form a structure called **nucleosome**.




- The nucleosome core is made up of four types of histone $_2$A, $H_2B$, $H_3$ and $H_4$— occurring in pairs.
- 200 bp of DNA helix wrap around the nucleosome by I ¾ turns, plugged $H_1$ histone protein.
- Repeating units of nucleosomes from the chromatin in nucleus, which is a thread-like structure.
- The chromatin is packed to form a solenoid structure of 30 nm diameter.
- Further super-coiling forms a looped structure called the chromatin fibre.
- These chromatin fibres further coil and condense at metaphase stage of cell division to form chromosomes.

**Ribonucleic Acid (RNA)**

- Ribonucleic acid (RNA) was the first genetic material.

- RNA behaved as a catalyst as well as genetic material.
- RNA can synthesise DNA (reverse transcription) and it is estimated that DNA has evolved from RNA with chemical modification.
- The backbone of RNA is made up of pentose ribose sugar and phosphate.
- The 2'-OH group of ribose makes RNA labile and easily degradable.
- RNA has two types of nitrogenous bases:

*(i)* Purines—Adenine and Guanine

*(ii)* Pyrimidines—Cytosine and Uracil

- Ribose sugar + Nitrogenous base ⟶ Ribonucleoside
- Ribonucleoside + Phosphate group ⟶ Ribonucleotide

**Differences between DNA and RNA**

| S.No. | DNA | RNA |
|---|---|---|
| *(i)* | The sugar present is deoxyribose. | The sugar present is ribose. |
| *(ii)* | Nitrogenous bases present are adenine, guanine, thymine and cytosine. | Nitrogenous bases present are adenine, guanine, cytosine and uracil. |
| *(iii)* | It is always double stranded. | It can be single stranded or double stranded. |
| *(iv)* | It is the genetic material of almost all living organisms. | It is the genetic material of only some viruses. |
| *(v)* | It is chemically less reactive and structurally more stable. | It is chemically more reactive and structurally less stable. |

**DNA Replication**

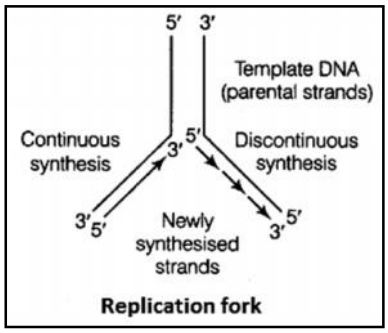
- ☞ Watson and Crick in 1953 proposed a scheme that DNA replication was semi-conservative.
- ☞ According to the scheme, the two parental strands separate and each strand acts as a template for synthesizing a complementary strand over it.
- ☞ After completion of replication, each DNA had one parental strand and one newly synthesized strand.

**Process of DNA Replication**

- ☞ DNA replication begins at a unique and fixed point called origin of replication or 'ori'.

**Initiation**

- ☞ The complementary strands of DNA double helix are separated by two enzymes, DNA gyrase and DNA helicase. This is called **unwinding** of double-stranded DNA.
- ☞ The separated strands tend to rewind, therefore these are stabilized by proteins called **single strand binding proteins (ssBPs),** which bind to the separated strands.
- ☞ Unwinding of double-stranded DNA forms a Y-shaped configuration in the DNA duplex, which is called **replication fork.**



Replication fork

**Elongation**

- ☞ An enzyme called **primase** initiates replication of the strand oriented in the 3' (towards origin)→5' (towards fork) direction. This generates 10-60 nucleotides long primer RNA (replicated in 5'→3' direction).
- ☞ The free 3'-OH of this RNA primer provides the initiation point for DNA polymerase for sequential addition of deoxyribonucleotides.

- ☞ DNA polymerase progressively adds deoxyribonucleotides to the free 3'-end of the growing polynucleotide chain so that replication of the 3'→5' strand of the DNA molecule is continuous (growth of the new strand in 5'→3' direction).
- ☞ The replication of 3→'5' strand us continuous and it is called **leading strand**, while the replication of second strand (5'→3' strand) of the DNA molecules id discontinuous and it is known as the lagging strand.
- ☞ The replication of lagging strand generates small polynucleotide fragments called **'Okazaki fragments'** (after R. Okazaki, who first identified them).
- ☞ These Okazaki fragments are then joined together by enzyme called DNA **ligase**.

**Genetic Code**

- ☞ The relationship between the sequence of nucleotides on *m*RNA and sequence of amino acids in the polypeptide is called **genetic code.**

**Salient features of genetic code**

*(i)* The codons are triplet. Out of 65 codons, 61 code for 20 amino acids and 3 codons (UAA, UGA, UAG) do not code for any amino acid hence, function as **stop** or **terminating codons**.

*(ii)* One codon codes for only one particular amino acid, hence the code is **unambiguous** and **specific**.

*(iii)* Some amino acids are coded by more than one codon, hence the code is **degenerate**.

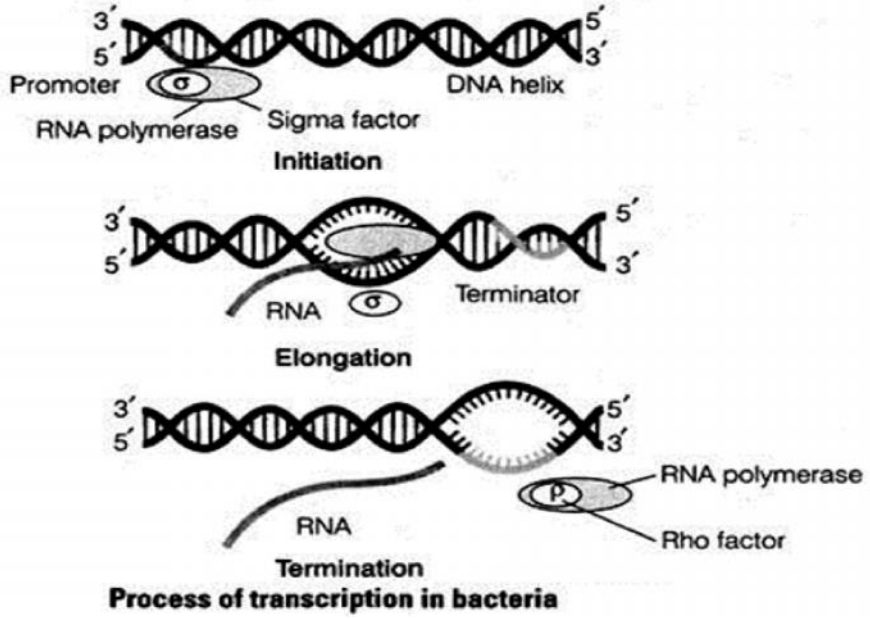
*(iv)* The codon is read on mRNA in a contiguous fashion, i.e., without punctuations and thus the code is **commaless**.

*(v)* The genetic code is nearly **universal**, *i.e.,* a particular codon codes for the same amino acid in all organisms except in mitochondria and few protozoa.

*(vi)* AUG is a dual function codon, it codes for methionine (met) and it also acts as initiator codon.

**Transcription in Prokaryotes (Bacteria)**

*Representation of initiation, elongation and termination are as given*




**Process of transcription in bacteria**

- In prokaryotes, the structural gene is polycistronic and continuous.
- In bacteria, the transcription of all the three types of RNA (*m*RNA, *t*RNA and *r*Rna) is catalysed by single DNA-dependent enzyme, called the **RNA polymerase**.
- In E. *coli* bacterium, the RNA polymerase has co-factors $\beta$, $\beta'$, $\alpha$, $\alpha'$ and $\omega$ along with $\sigma$ (sigma) factor, to catalyse the process.
- The transcription is completed in three steps: initiation, elongation and termination.
- **Initiation:** $\sigma$ (sigma) factor recognizes the start signal and promoter region on DNA which then along with RNA polymerase binds to the promoter to initiate transcription.

**Translation**

- Translation is the process of synthesis of protein from *m*RNA with the help of ribosome.
- A translational unit in mRNA from 5'3' comprises of a start codon, region coding for a polypeptide, a stop codon and untranslated regions (UTRs) at both 5'-end and 3'end for efficient process.
- There are three stages of protein synthesis:

***(i)*** **Initiation**

- Activation of amino acid: Amino acids become activated by binding with aminoacyl *t*RNA synthetase enzyme in the presence of ATP.

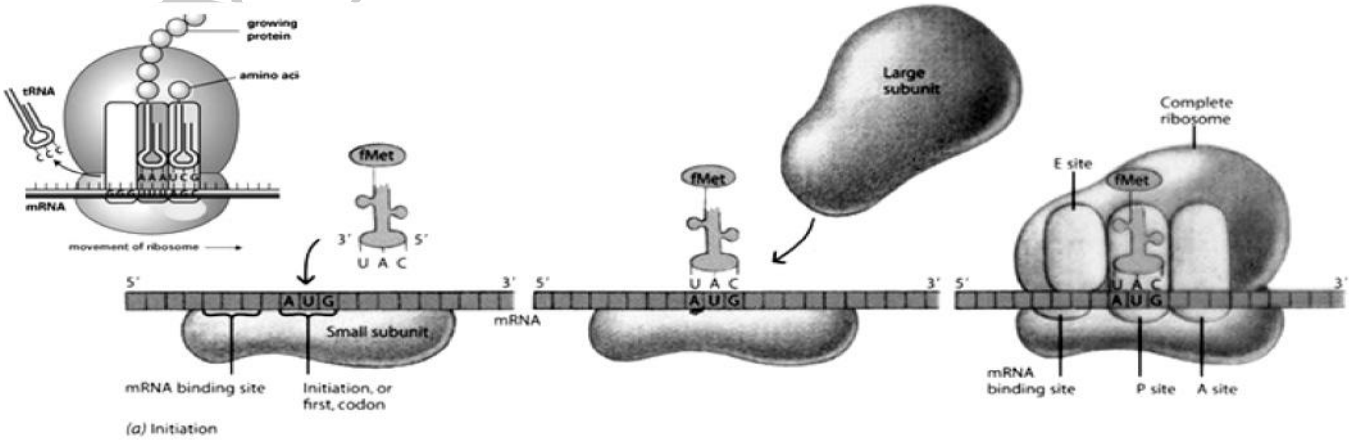
$$\text{Amino Acid (AA)} + \text{ATP} \xrightarrow[\text{synthetases}]{\text{Aminoacyl tRNA}} \text{AA-AMP-Enzyme complex} + P_i$$

- The cap region of mRNA binds to the smaller subunit of ribosome.
- The ribosome has two sites, A-site and P-site.
- The smaller subunit first binds to the initiator *m*RNA and then binds to the larger subunit so that initiation codon (AUG) lies on the P-site.
- The initiation *t*RNA, *i.e.,* methionyl *t*RNA then binds so the P-site.

***(ii)*** **Elongation of polypeptide chain**

- Another charged aminoacyl *t*RNA complex binds to the A-site of the ribosome at the second codon.
- A peptide bond is formed between carboxyl group (—COOH) of amino acid at P-site and amino group (—NH) of amino acid at A-site by the enzyme **peptidyl transferase**.
- The ribosome slides over *m*RNA from codon to codon in the 5'→3' direction.
- According to the sequence of codons, amino acids are attached to one another by peptide bond and a polypeptide chain is formed.

***(iii)*** **Termination of polypeptide**



(a) Initiation

- When the A-site of ribosome reaches a termination codon which does not code for any amino acid, no charged *t*RNA binds to the A-site.
- **Process of translation**

  Dissociation of polypeptide from ribosome takes place, which is catalyzed by a **'release factor'**.
- There are three termination codons namely UGA, UAG and UAA.

**Regulation of Gene Expression**

- Regulation of gene expression means controlling the amount and time of formation of gene products according to the requirements of the cell.
- In eukaryotes, gene regulation can take place at four levels:

*(i)* Transcription level (regulation of primary transcript formation),

*(ii)* Processing level (regulation of splicing),

*(iii)* Transport of *m*RNA from nucleus to the cytoplasm,

*(iv)* Translation level.

**The lac Operon**

- **Operon**: The concept of operon was first proposed in 1961, by Jacob and Monod. An operon is a unit of prokaryotic gene expression which includes coordinately regulated (structural) genes and control elements which are recognized by regulatory gene product.
- **Components of an operon**:

*(i)* **Structural gene:** The fragment of DNA which transcribe mRNA for polypeptide synthesis.

*(ii)* **Promoter:** The sequence of DNA where RNA polymerase binds and initiates transcription of structural genes is called promoter.

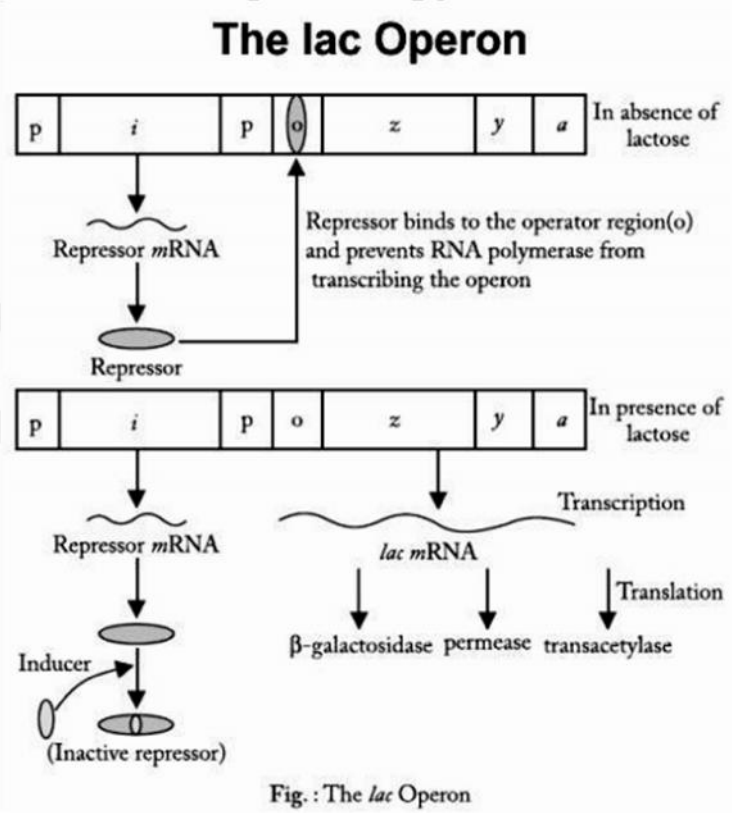



Fig. : The *lac* Operon

*(iii)* **Operator:** The sequence of DNA adjacent to promoter where specific repressor protein binds is called operator.

*(iv)* **Regulator gene:** The gene that codes for the repressor protein the binds to the operator and suppresses its activity as a result of which transcription will be switched off.

*(v)* **Inducer:** The substrate that prevents the repressor from binding to the operator, is called an inducer. As a result transcription is switched on. It is a chemical of diverse nature like metabolite, hormone substrate, etc.

☞ **The lactose operon:** The *lac z, lac y, lac a* genes are transcribed from a *lac* transcription unit under the control of a single promoter. They encode enzyme required for the use of lactose as a carbon source. The *lac* I gene product, the *lac* repressor, is expressed from a separate transcription unit upstream from the operator.

☞ *Lac* operon consists of three structural genes *(z, y, a),* operator *(0),* promoter *(p)* and a separate regulatory gene *(i).* Lactose is the unducer in *lac* operon.

☞ The three structural genes *(a, y, a)* transcribe a polycistronic *m*RNA.

☞ Gene z codes for β-galactosidase (β-gal) enzyme which breaks lactose into galactose and glucose.

☞ Gene y codes for permease, which increases the permeability of the cell to lactose.

☞ Gene a codes for enzyme transacetylase, which catalyses the transacetylation of lactose in its active form.

☞ **When Lactose is Absent**

*(i)* When lactose is absent, *i* gene regulates and produces repressor *m*RNA which translate repression.

*(ii)* The repressor protein binds to the operator region of the operon and as a result prevents RNA polymerase to bind to the operon.

*(iii)* The operon is switched off.

☞ **When Lactose is Present**

*(i)* Lactose acts as an inducer which binds to the repressor and forms an inactive repressor.

*(ii)* The repressor fails to bind to the operator region.

*(iii)* The RNA polymerase binds to the operator and transcribes *lac m*RNA

*(iv)* *Lac m*RNA is polycistronic, *i.e.,* produces all three enzymes, β-galactosidase, permease and transacetylase.

*(v)* The *lac* operon is switched on.

☞ **Mutations**

☞ Mutation is defined as the sudden inheritable change in the genetic material. It can be of the following two major types:

***(i)*** **Point mutation:** It is the mutation in the single base pair, which is replaced by another base pair. For example, in sickle-cell anaemia, point mutation in β-globin chain results in change of glutamate to valine.

***(ii)*** **Frameshift mutation:** It is the change in the reading frame because of insertion or deletion of base pairs.

**(a)** **Insertion:** It is the addition of one or more nucleotides in the DNA segment. Insertion of three or its multiple bases do not change the reading frame but add a new amino acid.

**(b)** **Deletion:** It is the removal of one or more nucleotides from the DNA segment. Deletion of three or its multiple bases do not change the reading frame but remove one or more amino acids.

**Normal DNA :** ATC GAT CGA

**Insertion :** ATC C**G** A TCG

**Deletion :** ATC ATC GA

## EXERCISE

**1.** Explain how replication take place?

**2.** Explain transcription in Eukaryotes and processing of hn RNA.

**3.** Explain how the lac operon gets switched on in the presence of lactose in E. coli.

**4.** Name three levels at which regulation of gene take place in a eukaryotic cell.

**5.** Define the following term :

(i) mutation

(ii) okazaki gragements

**6.** What are mutagens?

**7.** Where in the cell does translation accurs?

**8.** Name three type of RNA and explain their role during translation.

**9.** What is codon? Write three properties of codon?

**10.** Name the sugar and the nitrogeneous bases found in DNA.

CHAPTER
18

# PRINCIPLES OF ECOLOGY

Define the following term :

**(i) Environment :** It denotes all the physical and chemical and biotic condition surrounding and influencing a living organism. It have two main component - Abiotic (Non-living) and Biotic (living).

**(ii) Ecology :** It is study of the relationship and interaction b/w organism and their environment.

**(iii) Organisation of life :** Gene ⟶ Cell ⟶ Organ ⟶ Organism ⟶ Species population ⟶ community ⟶ Ecosystem ⟶ Biome ⟶ Biosphere.

**(iv) Habitat :** A population always lives a specific place known as its habitat. In common language it is 'addresses' of organism.

**(v) Niche :** The functional characteristic of a species in its habitat is referred to as 'niche'. While habitat of a species is like its 'address', niche can be thaught of as its 'profession'.

**(vi) Adaptation :** An adaptation is "the appearance or behaviour or structure or mode of life of an organism that allow its to survive in a particular environment."

**Population :** It is defined as a group of freely interbreeding individual of the same species present in a specific geographical area at a given time.

The characteristics of any population depends on the following factor - (i) density of the population (ii) natality (iii) mortality (death rate) (iv) dispersal (v) age distribution (vi) Growth form.

**(i) Density :** The number of individual per unit area at a given time.

**(ii) Natality (Birth rate) :** The rate of which new individual are born and added to a population under given condition.

**(iii) Mortality (Death rate) :** Loss of individual from a population due to death under given condition.

**(iv) Age distribution :** It refers to the proportion of individual of different age groups in a population.

**Biosphere :** A thin layer on and around the earth which sustain life is called biosphere. Life on earth is dependent on physical component of earth. The three physical component of earth are - atmosphere, lithosphere and hydrosphere.

**Ecosystem :** It is defined as a functionally independent unit where living organism intract among themselves as well as with their physical environment. It following type :

**(a) Terrestrial ecosystem :** Ex: Forest, desert and grassland.

**(b) Aquatic ecosystem :** Ex. Pond, lakes and wet land etc.

**Ecosystem - Structure and function :**

- **Stratification :** Vertical distribution of various species occupying different levels.

- **Food Chain :** Transfer of food from producer to consumer in a specific series in an ecosystem is called food chain.

**Ex.:** Grass ⟶ Grasshopper ⟶ Frog ⟶ Snake ⟶ Hawk

I II III IV V

Eac step of food chain is called food web.

- **Energy flow through an ecosystem :** In an ecosystm only 10% of the energy is transfered to next higher trophic level, this is knwon as 10% low.

Grass ⟶ Grasshopper ⟶ Frog ⟶ Snake ⟶ Hawk

10,000 kcal ⟶ 1000 kcal ⟶ 100 kcal ⟶ 10 kcal ⟶ 1 kcal

**Biotic Interaction in Ecosystem :**

| | **Type of Interaction** | | | **Effects of interaction of species A and B** |
|---|---|---|---|---|
| **(I)** | **Negative Inteaction :** | | | |
| | (a) Ammensalism | = | –/0 | - one is inhibited but other species is unaffected |
| | (b) Predation | = | +/– | - one benefits other harmed |
| | (c) Parasitism | = | +/– | - one benefits other harmed |
| | (d) Competition | = | –/– | - Both species are harmed |
| **(II)** | **Positive Interaction** | | | |
| | (a) Commensalism | = | +/0 | - one benefits other unaffected |
| | (b) Mutualism | = | +/+ | - Both species are benefited |

**Biome :** The plant growth is determined by physical, edaphic and geographical character of place. These are the natural broad biotic zone of the biosphere called Biome.

**(i) Terrestrial Biome :** Ex- Tundra, Forest, desert, etc.

**(ii) Aquatic Biome :** Ex.- Pond, Lake, river, oceans, etc.

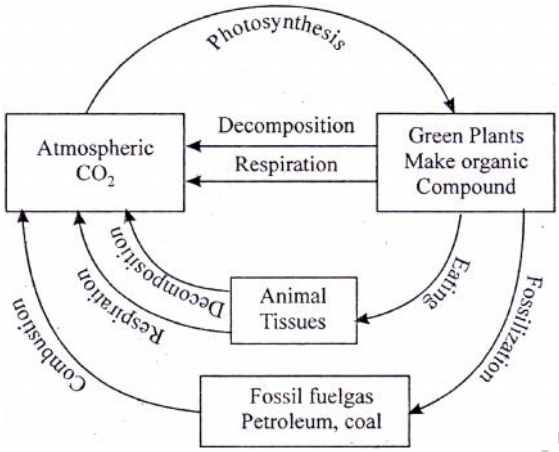
**Ecological Succession :** The Process by which communities of plant and animals species in an area are replaced by another over a period of time known as ecological succession. It is two type :

**(i) Primary Succession :** It take place over bare areas such as rock, newly form deltas where no communities has existed.

**(ii) Secondary Succession :** It is development of a community which from after the existing community is removed or destroyed by natural events.

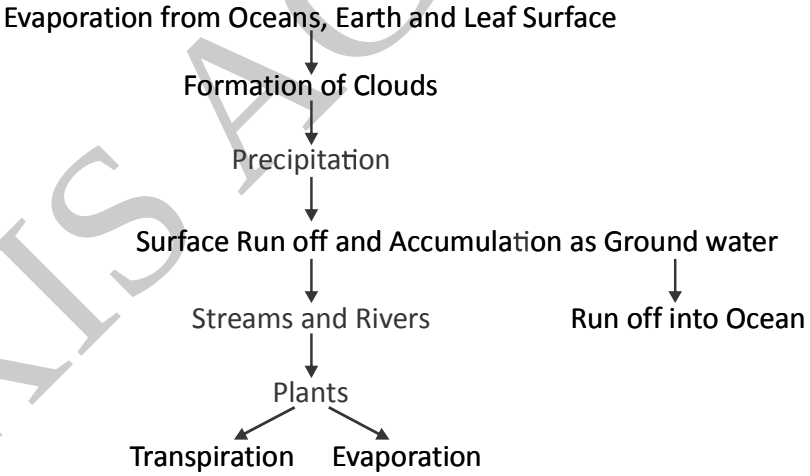
**Biogeochemical Cycles :** The cycling of the nutrients in biosphere is called biogeochemical or nutrient cycle some nutrient given below :

**(A) Carbon Cycle :** Carbon dioxide is continuously increasing in the atmosphere due to human activities such as industrialization, urbanization and increased use of automobiles. This increase in atmospheric $CO_2$ is bading to green house effect and global warming.



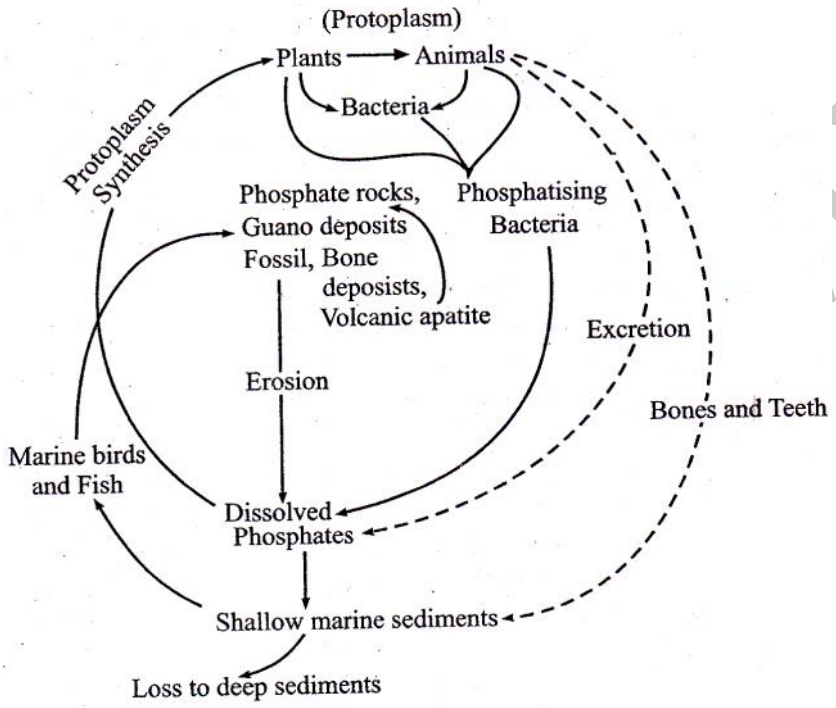

(Arrows indicate the processes of the carbon cycle and compartments are the sites of these processes or the store houses of carbon in the reservoir pool and ecosystem)

**(B) Water Cycle :** This is also known as hydrologic cycle. You have already studied that earth is a watery planet of the solar system but a very small fraction of this is available to animals and plants. Water is not evenly distributed throughout the surface of the earth. Major percentage of the total water on the earth is chemically bound to rocks and does not cycle. Out of the reamining, nearly 97.3% is in the oceans and 2.1% exists as polar ice caps. Thus only 0.6% is present as fresh water in, the form of atmospheric water vapors, ground and soil water. The ice caps and the water deep in the oceans form the reservoir.




**(C) Phosphorus Cycle :** We all know that phosphrous is a necessary and important constituent of the protoplasm in the living organisms. The reservoirs of phosphorus are the rocks or other deposits that have been formed in the past geological ages. The erosion of these deposits release phosphates in the ecosystem. However, much of it escapes into the sea where part of it is lost to the deep sediments and some of it deposited in the shallow marine sediments. Plants take up inorganic phosphate as orthophosphate ions. Animals (consumers) that feed on these plants in turn take up phosphate from

them. After the death of the plants and animals, the decomposers act on them and the phosphate is returned in the ecosystem in the dissolved form. The excreta of the animals also return some phosphorus to the cycle. Bones and teeth of animals are resistant to weathering and this accounts for some loss of phosphorus to the cycle. A study of phosphate cycle reveals that the return of phosphate to the cycle is inadequate to compensate the loss. It is human beings who have hastened the rate of loss of phosphorus.




**Phosphorus cycle**

## EXERCISE

**1.** Define the term ecoloyg - Nmae the major component of environment.
**2.** Give reason, why are decomposers necessry in a ecosytem.
**3.** Explain food chain with examples.
**4.** Define the term - (a) Ecosystem (b) Stratification
**5.** Define nutrient cycle. Name the nutrient cycle where atmosphere acts as the main reservoir.
**6.** Give differences between natural and human modified ecosystem.
**7.** Why is the number of trophic levels restricted to four or five in a food chain?
**8.** What are the benefit of natural ecosystem?
**9.** Represent the trophic level in following food chain -

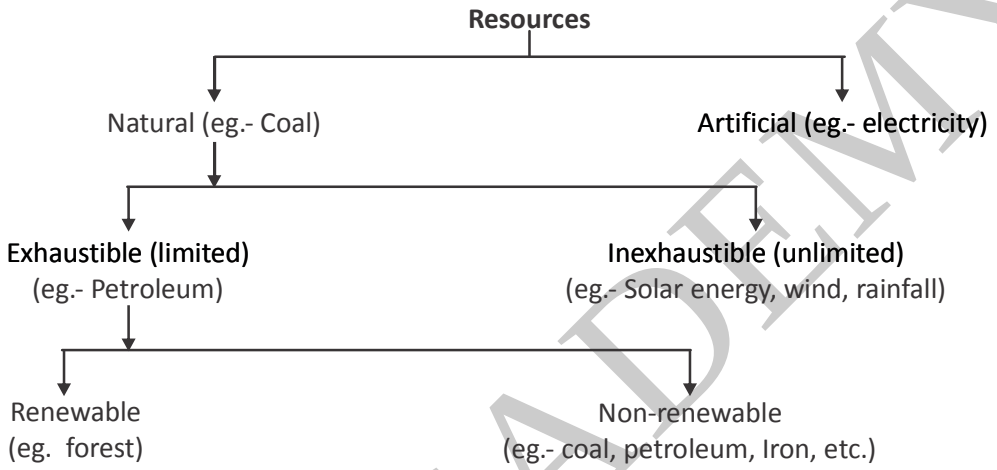
Grass ⟶ Grasshopper ⟶ Frog ⟶ Snake ⟶ Hawk

**10.** Why food web is more stable in comparison of food chain.

CHAPTER 19

# CONSERVATION AND USE OF NATURAL RESOURCE

**Natural Resource :** A resource can be defined as 'any natural or artificial susbtance, energy or organism, which is used bu human being for for its welfare.




**Conservation of Natural Resource :** It is proper management of a natural resource to prevent its exploitation, destruction or degradation.

**Need for conservation of Natural Resource :**

- to maintain ecological balance for supporting life.
- to preserve different kind of species.
- to maintain the resource available for present and future generation.
- to ensure survival of human race.

- Chipko movement in India is one best example of natural conservation.

**Soil Erosion :** Removal of top layers of soil by winds and water is called soil erosion.

**Conservation of Soil :**

(i) Maintanance of soil fertility.
(ii) Control on grazing.
(iii) Refrestration
(iv) Terracing
(v) Contaur ploughing

**Water Resource :** About 97% of water on earth is saline in natur, found in seas and oceans. The reamining 3% is fresh water, most of which is stored in ice caps and glaciers and just about 0.36% is distributed in lakes, rivers, ponds, etc. as fresh water.

**Conservation of Water :**

- Growing vegetation
- Constructing damps and reservoire
- Sewage treatment
- Rainwater harvesting

**Bio Diversity :** It can be defined as the flora and founa i.e. variety of all plants, animals and microbes of a region. Certain regions of the world are very rich in biodiversity. Such areas is called mega diversity or 'hot-spot'. Ex-western Ghats and the Eastern Himalays.

**Conservation of Bio-diversity :** There are two basic strategies for conservation :

(i) In-situ conservation

(ii) Ex-situ conservation

**(i) In-situ Conservation :** Conservation of plant and animals within their natural habitate or in protected area. eg.- National Park, Biosphere reserve and wildlife sancturies.

**(ii) Ex-Situ Conservation :** Conservation of plant and animals. eg. - Botanical garden, Zoo, Gene bank, Seed bank etc.

**Endangered Species :** Those species which are reduced in number to a critical level and facing a high risk of extinction in the near future. eg. Asiatic Lion, Tiger, Rhinoceros etc.

International union for the conservation of nature and Natural resource (IUCN) has enlisted endangered plant and animals in the Red Data Book.

**Wildlife :** The plants, animals and micro organism other than the cultivated plants and domesticated constitute wildlife.

**Need for Conservation of Wildlife**

Wildlife needs to be conserved for :

- maintaining ecological balance for supporting life.
- preserving different kinds of species (biodiversity).
- preserving economically important plants and animals.
- conserving the endangered species.

**Methods of Conservation of Wildlife**

After knowing the need for conservation of wildlife, let us discuss how to conserve it. We can protect it by adpoting various means, like :

- Establishing biosphere reserves, national parks and sanctuaries.
- Afforestation (Tree planting programme).
- Special schemes for preservation of threatened species.
- Improvement of natural habitats of wildlife.

**Wildlife Reserve in India :**

- Kaziranga Sanctuary (Assam) - one-horned rhinoceros.
- Gir forest (Gujarat) - Lion, Chital.
- Periyar S. (Kerala) - Elephant

• Kanha National Park ( M.P.) - Tiger, Leopard.

• Gorbett National Park (Uttaranchal) - Tiger, Barking deer.

**Agencies Dealing with conservation of Wildlife-**

• Indian Board for Wildlife - (IBWL)

• World Wildlife Fund for Nature (WWF)

• International Union for conservation of nature and Natural resource (IUCN), World Conservation Union (WCU).

• Convention of International Trade in Endangered species (CITES)

**Sustainable Development :** It is development that meets the needs of the present generation and conservation of resources for the future generation.

**Eg.:**

• recycling and reduce and reuse of waste materials.

• Planting more trees.

• Scientific managment of renewable resources.

**Energy Resource :** There are two main categories of energy source :

(i) Conventional source of Energy

(ii) Non-Conventional source of Energy

**(i) Conventional source of Energy :** Which are easily available and have been in usage for long time. Most important among them are the fossil fuels.

**Fossile Fuel :** Fossils fuel are the fossilised remains of plants and animals which overmilions of years have been transformed into coal, petroleum and natural gases.

• **Coal -** Use for cooking and industrial activities.

• **Petroleum -** Use as lubricant, solvent & fuel.

• **Natural gas** - The gas mainly contains methane. USA is the largest producer as well as consumer of natural gas. It use as :

PNG - Piped Natural Gas

CNG - Compressed Natural Gas

LPG - Liquified Petroleum Gas (propane + butane)

**(ii) Non-Conventional source of Energy :** They are other source of energy such as other than usual source. eg.- Solar energy, Hydro energy, Wind energy, Tidal energy, Nuclear energy, Geothermal energy, Biogas, Bio-fuel.

**Solar Energy :** It is the ultimate source of all energy on the earth. Various technologies n which solar energy can be utelised as follows - solar cookers, solar cookers, solar hot watr system, solar air heaters etc.

**Wind Energy :** Wind as an energy can be utelised in our daily life by converting its into mechanical energy. This mechanical energy is used to generate electricity, raise water froms wells, and rivers for irrigation and other purpose.

**Nuclear energy :** Radioactive element like uranium and thorium disintegrate spontaenously releasing large quantities of energy. This energy can be traped to produce electricity 25% of world's thorium reserve is found in India.

- 3% of India's electricity comes from nuclear power and about 25% is expected to come by 2050.

**Geothermal Energy :** This is the energy derived from the heat in the interior of earth. In volcanic regions, springs and fountains of hot water called 'geysers' are commonly formed. These eruption of hot steaming water can be used to turn turbine and produce electricity in geothermal power plants.

**Bio-fule :** Liquid hydrocarbon is bio-plant and the plant producing it are called petro-plant. e.g. Jatropha curcus. It produces bio-diesel.

**Advantages of Bio-diesel :**

- It is an agriculture based fuel.
- It can be made from both vegetable oil and animal fat.
- It can use without major modification.
- Handling bio-diesel is safer.
- Its combustion emits less co sulphate and particulate matter.

**Conservation of Energy Sources :**

(i) Minimise exploitation of non-renewable energy resource.

(ii) Emphasis on use of renewable source of energy.

(iii) Stop wastage of energy.

(iv) Make more use of bio-mass energy.

(v) Creating awarness among people regarding wise and judicous use of energy.

## EXERCISE

**1.** State any two reasons why shoule we conserve natural resources?

**2.** Define the term wildlife. What is Red Data Book?

**3.** Expand the following :

(i) WWF (ii) CITES (iii) IUCN

**4.** Write the full form of following with one use :

(i) CNG (ii) PNG (iii) LPG

**5.** Explain any five method of conservation of water.

**6.** Describe any three non-conventional source of energy.

**7.** Distinguish between in-situ and ex-situ conservation strategies.

**8.** Describe some method of conservation of soil.

CHAPTER
20

# NUTRITION AND HEALTH

**Food :** Food is any substance which perform the following function in the body :

(i) yields energy for life process.

(ii) build up new cells during growth.

(iii) repair damaged tissue.

**Biological Classification of Food :** Food can be classified into three categories based on their function:

**(i) Energy Providing food :** These are rich in carbohydrates and fats and provide energy on biological oxidation in the body. Ex- cereals, sugar, fat, oil, coconut and groundnuts.

**(ii) Body building food :** These are rich in minerals, vitamins, roughage, water. The help in regulation of internal metabolism in the body. Ex- vegetables, fruit, amla, citrus etc.

**(iii) Protective / regulatory food :** These are rich in protein and help in the formation of new tissue. Ex.- legumes, milk, egg, meat, fish, pulse, etc.

**Nutrition :** It is the sum of the processes by which an organism takes in, metabolises and utilise food substance for its various biochemical activities.

On the basis of requirement quantity, nutrient are two type -

**(a) Macronutrient :** It required in a large amount. eg.- vitamins and minerals.

**(b) Micronutrient :** It required in a small amount. eg.- vitamins and minerals.

**Vitamins :** They are organic compound do not yield energy but protect the body from various disease. Vitamins are grouped into two classes :

**Vitamins their deficiency disease and source**

| Vitamins | Deficiency disease | Source |
|---|---|---|
| Vitamin - B1 (Thiamine) | Beri-Beri | yeast, liver, meat, cheese |
| Vitamin - B12 (Riboflavin) | Pernicious anocmia | Liver, fish, Egg, milk |
| Vitamins - C (Ascorbic acid) | Seurvy | citrus fruit, tomato, chili |
| Vitamin - A (Retinol) | Night Blindness | milk, egg, carrot, papaya, spinach |
| Vitamin - D (Calciferol) | Rickets | sun light, milk, fish, egg yolk |
| Vitamin - E (Tocopherol) | Infertility | Grains, Vegetable oil, nuts, vegetable |
| Vitamin - K (phylloquione) | Haemorrhage | Green leaf, soyabean, tomato |

**(a) Water soluble vitamins :** Vitamins B and C.

**(b) Fat soluble vitamins :** Vitamins A, D, E and K.

**Roughage :** It is the fibre present in some food items like fruits and vegetable. It is not food but important for diet. It mainly contain cellulose.

**Function :**

- It help in bowel movement.
- It clean our digestive tract.
- It prevent constipation.

**Balance Diet :** It is one that contains all essentials nutrients in suitable proportion and amount to provide necessary energy and keep the body in a healthy state.

**Health :** It is state of complete physical, mental and social well being and not merely absence of disease.

**Deficienty disease :** The disease which occurs due to deficiency of one or more nutrient in out diet are called deficiency disease.

**Malnutrition :** The condition resulting from lack of nutrient in the diet is called malnutrition.

**Portion energy malnutrition (PEM) :** It result two disease- (i) marasmus (ii) Kwashiorkor

**(i) Marasmus :** It is caused due to thedeficiency of fat, carbohydrate and protein. It usually affect infact below the age of one year.

**Symtoms :** folded skin, thinning of limbs, ribs become prominent.

**(ii) Kwashiorkor :** This disease develops when mother stop feeding their babies with breast milk and low protein in diet.

**Symptom :** Under weight, has anaemia, stunted growth, loss of appetite.

**Deficiency of calcium :** It cause Rickets in chil,dren and osteomalacia in adult.

**Deficiency of Iron :** Anaemia

**Deficiency of Iodine :** Goitre

**Obesity and Excessive intake of food**

**Obesity :** The overweight and bulkiness of a person's body due to accumulation of carbohydrate and fat is called obesity.

**Cause :** overeating, insufficient exericse, hormonal imbalance or other metabolic disturbance.

**Harmful effect :** Hypertension, atherosclerosis, caronary attack.

**Methos of Prevent obesity :**

(i) avoid fried food.

(ii) not take cabohydrate rich food.

(iii) take regular exercise.

(iv) eat green leaf vegetable.

(v) not to take ghee, vegetable oil.

**Effect of excessive intake of Iron :**

(i) constipation and diarrhoea.

(ii) Nousea and vomitting

(iii) Heart hurn

**Effect of excessive intake of vitamins (Hyper vitamosis) :** The disease caused by presence of vimtamins in excessive quantities in the body is called hypervitaminosis.

**Hypervitaminosis A :**

(i) loss of hair

(ii) drowsiness

(iii) painful swelling of long bone

(iv) loss of apppetite

**Hypervitaminosis D :**

(i) High calcium absorption

(ii) deposition of Ca in soft tissue of body like kidney.

(iii) loss of weight.

## EXERCISE

**1.** Define roughage. Explain their role in nutrition.

**2.** Name the source of two water soluble vitamins.

**3.** What is PEM? Name two disease caused due to PEM.

**4.** Give two food items which an prevent vitamin a deficiency.

**5.** List any two cause of obesity and suggest two method to prevent obesity.

**6.** Define hypervitaminosis. Name two vitamin which when take regularly in diet cause hypervitaminosis?

**7.** Deifferentiate between Marasmus and Kwashiorkor.

**8.** What is deficiency disease? Name two disease caused by the deficiency of protein and vitamin A.

CHAPTER
21

# BIO-TECHNOLGOY

**Biotechnology**

↓

Biology ← → technological application

Biotechnology defined as the industrial application of living organism and thei biological process such as biochemistry, microbiology, and genetic engineering, in order to make best use of the micro-organism for the benefit of manking.

**Application of Biotechnology :**

**(i) Health and Medicine :** Fighting infectious disease such as SARS and influenza.

- Development of vacines and antibiotics.
- In forensic science - DNA fingerprinting.

**(ii) Environment :** Cleaning up and managing the environment.

**(iii) Agriculture :** Formation of pest and insect resistant plant.

**(iv) Industry :** Microbes use in formation of following procuts : (a) Alcohol, (b) yoghurt (c) protein (d) antibiotics (e) vitamins (f) Biogas

**(a) Alcohol :** It produces by process of fermentation by yeast Saccharomyces cerevisiae). eg. - Beer and buttermilk.

**(b) Yauhurt :** The milk becomes yoghurt or curd due to milk curding enzyme released by the increaing bacteria - lactobacillus. streptococcus use in formation of butter.

**(c) Antibiotics :**

| **Antibiotic** | **Source** |
|---|---|
| (i) Tetracyclin | Streptomyees sp. |
| (ii) Streptomycin | Streptomyces griseus |
| (iii) Penicillin | Penicillium chrysogenum |

**Vaccination :** It is discovered by Edward Jenner in 1790. Jenner proposed that if mild or attenuated (weakened) germ were introduced nto the body, they would not cause disease. He gave the term vaccine - vaccine is following kind -

**(i) First generation vaccine -** formed by attenuated (weak) pathogen. - eg. Polio vaccine.

**(ii) Second generation vaccine :** Produced by genetic engineering. eg. Hepatitis B, Herpes virus.

**(iii) Third generation vaccine :** formed by chemicals.

**Production of Vitamins :** Vitamins C was the first vitamin to be produced during a fermentation by Bacteria. Vitamin - $B_{12}$ and $B_2$ - obtained from liver extract.

**Production of Bio gas :** Bio gas is a new conventional source of fuel. A series of chemical reaction occurs in the presence of methanogenic bacteria leading to the production of $CH_4$ and $CO_2$.

**Advantages of Biogas :**

(i) It is a fule used to cook food, and light lamp.

(ii) Slurry left after biogas production forms a soil manure.

**Genetic Engineering or Recombinant DNA technolgoy :** The technique of genetic engineering is in the production of recombinant DNA. It involve cutting a piece of original DNA and inserting in its place a different segment of DNA having desred character.

The production of genetically identical individual or genetic material form a single cell is called cloning.

**Tools (Reqirement) of Recombinant DNA technology :** Following five requirement is necessary -

(i) Cell culture (ii) Restriction endonuclease (iii) Plasmid

(iv) Ligase (v) Host bacteria

**(i) Cell culture :** Cultured cell of an animals or plants carrying the requirement gene in its nucleus.

**(ii) The enzyme restriction endonuclease :** It involve in cutting of short specific DNA sequences. Each enzyme very specifically recognise a particular DNA sequence and cut it. The enzyme are also calls 'molecular scissors'.

**(iii) Plasmid :** It is extra chromosomal DNA molecule in a bacterial cell which able to ligate with other DNA. It involve in cloning.

**(iv) DNA ligase :** It is enzyme called 'joining enzyme'. It joins two fragement of DNA.

**(v) Host bacteria :** Host bacteria are the bacterium whose plasmid is used for carrying foreign DNA.

**Steps in recombinant DNA technology :**

(i) Specific restriction enzyme is selected.

(ii) Cell culture with required gene in the cell is obtained.

(iii) Restriction enzyme cut DNA at two ends.

(iv) Ligase joins the restriction fragment in the place vacated by the cut DNA segment of the plasmid (vector).

(v) The recombinant plasmid are then placed with comptent cell to enter the bacteria.

(vi) Bacteria divide reombinant plasmid replicate along with bacterial DNA and form many copies.

**Application of genetic engineering**

**(i) Protein manufacture :**

| | **Protein** | | **Use** |
|---|---|---|---|
| (i) | Insulin | - | Diabetes mellitus |
| (ii) | Erythropoietin | - | Anaemia |
| (iii) | Interferon | - | Viral infection |
| (iv) | Clotting factor viii | - | Hasmophilia A |
| (v) | Tissue plasminogen factor | - | Heart attack |

**(ii) Enzyme**

| | **Enzyme** | **-** | **Use** |
|---|---|---|---|
| (i) | Proteases | - | manufacture of detergent |
| (ii) | Amylase | - | manufacture of beer, bread & textiles. |

**(iii) Vaccine :** Bioengineered vaccine have been developed for rabies and hepatitis-B.

**Transgene and Transgenic :** Genetic Engineering has made possible production of organism of one species carrying gene of another species. The foreign gene is called a transgene.

Genetically engineered organism carrying foreign gene are termed transfenic animals or plants.

**Ex.** Transgenic animals - mice, goat, cattle, etc.

Transgenic plants - Bt-cotton, Bt-rice, etc.

**Bioremediation :** Genetically engineered bacteria can clean up pollutants from the environment. This is called Bioremediation.

**Gene Therapy :** Replacement and attraction of defective gene is called gene therapy. It is use in treatment of sickle cell anaemia, haemophilia, serve combined immuno deficiency (SCID) and colour blindness.

**Approach to human gene therapy :** There are two basic approaches to human gene therapy :

(i) Somatic gene therapy (ii) Germ-line gene therapy

**(i) Somatic gene therapy :** In this method body cells are targeted for genetic transformation. It is correction of a genetic defect confined to a specific organ or tissue.

**(ii) Germ line gene therapy :** In this method gamete or zygote are genetically modified to create and individual that will carry remedial gene in the following generation. Somatic gene therapy grouped into following categories : (a) Ex-vivo gene therapy, (b) In vivo gene therapy.

**(a) Ex-vivo (outside the body) gene therapy :** It involve following slepts -

(i) Isolating the cell with gene defect from a patient.

(ii) Growing the isolated cells in culture.

(iii) Altering the genome of the isolated cell with remedial gene.

(iv) Selecting, growing and testing the altered cells.

(v) Transplanting or transfusion use to treatment of SCID, sickle cell anaemia, thalassemia etc.

**(b) In-vivo (within the body) gene therapy :** In this type of gene therapy includes direct delivery of a remedial gene into the cells of a particular tissue of patient. It use to treatment of cancer, Alzheimer's disease and Parkinson's disease.

## EXERCISE

**1.** Name the bacterium responsible for curdling of milk.

**2.** What do you mean by second generation vaccines?

**3.** Which bateria cause the productionof bio gas?

**4.** Define the following term :

(i) Genetic engineering (ii) Clone

(iii) Plasmid (iv) Molecular scissors

**5.** Name any two protein or two enzyme obtained by recombinant DNA technology.

**6.** Define following :

(a) transgenic animals (b) bioremediation

**7.** What is gene therapy? Which kind of disease treated by this therapy?

**8.** Name any two genetic disease that can be treated by somatic gene theraphy.

**9.** What are antibiotics? Give some examples.

**10.** Enumerate in sequence the step of recombinant DNA technology.

**11.** How can a transgenic animals be obtained?

CHAPTER
22

# IMMUNOBIOLOGY

**Immunity:-** The overall ability of the host to fight the disease causing organism, provided by immune system is called immunity. The body is able to defend itself from most of these foreign agent.

Immunity is two type – (a) InnateImmunity (b) Acquired Immunity

**(a) Innate Immunity :-** It is non-specific type of defense, present from the time of birth. The entry of foreign agent is prevented by different type of barriers.

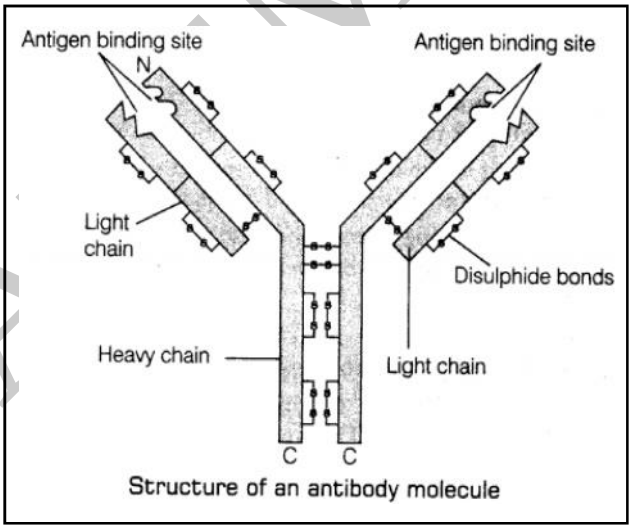
These are -

***(i)* Physical barriers:-** In human epithelial layer work as physical barriers. Eg. Skin prevent entry of microbes. Mucus coating of epithelium lining of respiratory, gastrointestinal and urinary tracts also help in trapping microbes entering our body.

***(ii)* Physiological barriers:-** Some chemical are secreted our body during some physiological function which prevent entry of pathogen in our body. Eg.

HCL in stomach, saliva (Lysozyme) in mouth, tears (Lysozyme) from eyes.

***(iii)* Cellular barriers:-** Certain type of leukocytes (WBCs) of our body like polymorpho–nuclear leukocytes (PMNL – Neutrophils) and monocyte in blood destroy the pathogen by phagocytosis.



Structure of an antibody molecule

***(iv)* Cytokine barriers:-** Virus infected cell secret protein called interferon's which protect non-infected cells from further viral infection.

**(b) Acquired Immunity:-** It is pathogen specific acquired after birth either by contracting the disease or by vaccination. Acquired immunity characterized by memory.

- ⇨ When the body encounters a pathogen for the first time, it produces an immune response called primary response, to eliminate the pathogens.
- ⇨ Subsequent encounter with the same pathogen elicits a highly intensified secondary or anamnestic response. This is described to the fact that our body appears to have memory of the first encounter.
- ⇨ The primary and secondary immune response are carried out with the help of two special type of lymphocytes present in our blood. B-Lymphocyte & T-lymphocyte. The B-lymphocyte produce an army of protein in response to pathogen into our blood to fight with them. These proteins are called antibodies. The T-Lymphocyte themselves do not secrete antibodies but help B cells produce them.
- ⇨ Each antibody consist of four polypeptide chain held together in the form of Y. Two polypeptide chain are small, called light chain and two longer called leavy chain. Hence, an antibody is represented as

$H_2L_2$. The tips of two upper arms has a antigen binding site. Antibody and antigen bind in a lock. Key manner to form antigen antibody complex. Different type of antibody produced in our body IgA, IgM, IgE, IgG, are some of them depending upon cell involved acquired immunity is two type:-

***(i)*** **Humoral Immune response:-** The antibody which are produced by Lymphocytes are present in blood and give response to antigens in blood. This also known as humoral immune response.

***(ii)*** **Cell-mediated Immunity (CMI):-** It is mediated by T-Lymphocytes. T-Lymphocyte are following type –

**(a) Killer T-Cells :–** These cells migrate to the site of infection at kills the specific target cell by a variety of mechanism.

**(b) Helper T-Cells :–** These cells stimulate the B-Cells to produces antibodies.

**(c) Suppressor T-cells :-** These cell inhibit the immune response of both T & B lymphocytes to foreign antigen when infection is controlled.

**(d) Memory T – Cell :-** These Cells keep ready to mount a rapid and vigraus attack as soon as the same pathogen infect the body again.

⇨ Tissue matching, blood group matching are essential before undertaking and graft/transplant and even this the patient has to take immune suppressants all his life. The body is able to differentiate 'self' and 'non-self' and the cell mediated immune response is responsible for the graft rejection.

⇨ Acquired immunity can be further classified into two type :-

(i) Active immunity (ii) Passive immunity

**(i) Active immunity :** Antibodies are developed by own cells in response to antigens and take long time to develop Immunity. Active immunity develops when a host is exposed to antigen. Which may be in the form of living or dead pathogen or other proteins or by vaccination.

**(ii) Passive Immunity:-** When ready made antibodies are directly given to protect the body against foreign agent, it is called passive immunity. It is used when the immune response has to be faster and immunity stays for short period.

***e.g.-*** immunity given by tetanus antitoxin immunity given to the infant by antibodies in colostrums.

Colostrums is the yellowish fluid secreted by mother during the initial days of location has abundant antibodies 'lgA' to protect the in feint.

**Vaccination and Immunization:-**

In 1796 vaccination was discovered by Edward Jenner's. He was discover a vaccine against small pox. Lauis Pasteur make vaccine for anthrax, & Rabies.

In vaccination a preparation of antigenic protein of pathogen or inactivated/weakened pathogen (vaccine) are introduced into the body. The antibody produced in the body against these antigens would neutralize the pathogenic agent during actual infection. The vaccine also generate memory B- and T-Cells that recognize the pathogen and give quickly response.

In a person is infected with some deadly microbes to which quick immune response is required as in tetanus, we need to directly infected the performed antibodies or antitoxin. Even in case of snake bite, the injection which is given to patient, contain performed antibodies against the snake venom. This type of immunization is called passive immunization.

**Human immune system :** It Consists of lymphoid organs tissues, cells and soluble molecules line antibodies.

Functions – Immune system:-

*(i)* Recognizes foreign antigens.

*(ii)* Responds to these antigens by producing antibodies.

*(iii)* Keeps memory of them by producing memory cells.

*(iv)* Plays and important role in allergic reactions, autoimmune disease and organ transplantation.

***(iv)* Lymphoid Organs:-** There are the organs where origin and/or maturation and proliferation of lymphocytes takes place, Lymphoid organs may be.

**(1) Primary Lymphoid Organs:-** Are bone marrow and thymus where immature lymphocytes differentiate into antigen sensitive specific lymphocytes.

**Bone Marrow:** It is the primary lymphoid organ where all blood cells including lymphocytes are produced. It helps in the development and maturation of B-lymphocytes.

**Thymus :** It is a lobed organ located near the heart beneath the breast bone. It is large at the time of birth and keeps reducing the size with age and by the time of puberty, it is reduce to very small size. It also provides micro environment for development and maturation of T-lymphocytes.

**(2) Secondary lymphoid Organs:-** After maturation the lymphocytes migrate to the secondary lymphoid organs like spleen, lymph nodes, tonsils, payer's patches of small intestine and appendix. They provide the sits for the interaction o lymphocytes with antigens and produce/proliferate to become effectors cells and memory cells.

**Spleen :** Is a large been-shaped secondary lymphoid organ. It mainly contains lymphocytes and phagocytes. It acts as a filter of the blood by trapping blood born microorganisms. It is also a large reservoir of erythrocytes.

**Lymph nodes :** They are small solid, structures located at different points along the lymphatic system. They serve to trap the micro organisms and other antigens that have entered into lymph and tissue fluid. Antigens trapped in lymph nodes, activate the lymphocytes present there and cause the immune response.

**Mucosal associated lymphoid tissue (MALT):-** It is located within the lining of major respiratory, digestive and congenital tracts. It constitutes 50% of the lymphoid tissue in human body.

**(2) Disorder of Immune system.**

**Energy :** Energy is the exaggerated response of the immune system to certain antigens present in the environment. The substances which evoke such an immune response are called allergens. The antibodies produced belong to IGE type. Common allergens are mites in dust, pollens, animal fur, etc. Sneezing, watery eyes, running nose and difficulty in breathing are the symptoms of allergic reaction. Symptoms are due to release of chemicals like histamine and serotonin from mast cells. The use of drugs like anti histamine, adrenalin and steroids quickly reduce the symptoms of allergy.

**Autoimmunity :** Memory based acquired immunity evolved in higher vertebrates based on the ability to differentiate foreign organism e.g. pathogens from self cells. The basis of this, can be understood from two facts of this ability.

***(i)*** Higher vertebrates can distinguish between foreign molecules and foreign organisms.

***(ii)*** Sometimes due to genetic and other unknown reasons, the boys immune system goes off the rack and starts attack on self cells and molecules and results in damage to the body, called autoimmune disease e.g. rheumatoid arthritis.

## EXERCISE

**1.** Write the name of Leucocyte which involve in production of antibody.

**2.** Write two main function of B-cells.

**3.** Name the organ where B-cells are formed?

**4.** Mention two physical barriersw of the body.

**5.** Define following term :

(i) immunity

(ii) antibody

**6.** Draw a schematic diagram of the structure of antibody.

**7.** Write the name of disease for which following vaccine are given :

(i) BCG

(ii) DPT

(iii) MMR