www.aisectuniversityjharkhand.ac.in | Follow us on:

AISECT UNIVERSITY™

JHARKHAND, HAZARIBAG AN AISECT GROUP UNIVERSITY

Recognized by : UGC

(Bio-diversity of Cryptogams)

(B.Sc.- Botany Sem. I)

Contact us:

8252299990

8404884433

AISECT University, Hazaribag

Matwari Chowk, in front of Gandhi Maidan, Hazaribag (JHARKHAND)-825301

www.aisectuniversityjharkhand.ac.in info@aisectuniversityjharkhand.ac.in

UNIT I

Viruses, Mycoplasma and Bacteria

Viruses:

Virus is a Latin word which means poison. Adolf Mayer described for the first time a disease of tobacco plant. Dimitri Ivanowski, a Russian botanist in 1892 demonstrated experimentally that sap of mosaic tobacco plant was capable of inducing the mosaic disease in healthy tobacco plants after it had been passed through bacteria proof filter.

This indicated that the infective agent was smaller than any known bacteria and so he was the first to give clear cut evidence of virus. Beizerinck, a Dutch microbiologist in the year 1898 confirmed the observation of Ivanowski and named the infectious fluid obtained from the diseased tobacco plant as 'contagium vivum fluidium' and referred it as virus.

Stanley (1935) isolated a crystalline protein from the diseased tobacco leaves. Bawden and Pirie (1937) established that viruses are nucleoproteins. Marcham (1949) isolated tobacco mosaic virus (TMV).

Viruses comprise a unique group of infectious agents which are characterised by their small size, simple composition and parasitic mode of life.

Mycoplasma:

Mycoplasmas are the "smallest, independently replicating prokaryotes"**.** These organisms were first discovered by Pasteur in eighteenth century when he studied the causative agent of the "Bovine pleuropneumonia" (A pulmonary disease of cattle which appeared in Germany and Switzerland in 1713. Due to its resemblance with pneumonia symptoms this disease is called as Bovine Pleuropneumonia).

Habit and Habitat of Mycoplasma:

Mycoplasmas are parasitic as well as saprophytic. More than 200 mycoplasma like bodies are found to be associated with sewage, plants, animals, insects, humus, hot water springs and other high temperature environment. They have been found in phloem tissues of diseased plants.

General Characters of Mycoplasma:

1. They are unicellular, smallest, non-motile and prokaryotic organisms forming fried egg shaped colonies.

2. They are pleomorphic i.e., able to change their shape depending upon culture media.

3. They may be rod like, ring like, globoid or filamentous. The filaments are of uniform diameter (100-300 nm) and vary in length from 3 nm to 150 nm.

4. Some mycoplasma predominantly assume spherical shape (300-800 nm in diameter).

5. They are ultra-filterable i.e., they can pass through bacteria-proof filters.

6. They do not possess rigid cell wall.

7. The cells are delimited by soft tripple layered lipo-proteinaceous membrane. It is unit membrane about 10 nm thick.

8. Within the cytoplasm ribosomes are found scattered in the peripheral zone. These are 14 nm in diameter and resemble with bacteria in sedimentation characteristic of both the nucleoprotein and nucleic acid.

9. The ribosomes are 72S type.

10. Within the cytoplasm fine fibrillar DNA is present. It is double stranded helix.

11. Mycoplasma generally grow more slowly than bacteria.

12. They require sterol for their nutrition.

13. They are usually resistant to antibiotics like penicillin, cephaloridine, vencomycin etc. which action cell wall.

14. They are sensitive to tetracycline.

15. They are also killed by temperature of 40-55°C in fifteen minutes.

16. They do not produce spores.

17. Like other prokaryotes, they usually divide by binary fission.

Characteristics of Viruses

Sizes and Shapes of Viruses:

Viruses are much smaller than bacteria and their size is variable. The larger viruses may be about 300 A in diameters, i.e., they may be as large as some of the small bacteria. The majority of the viruses are about 200 Å in diameters.

Viruses occur mainly in the following three shapes:

1. Spherical or Polyhedral, as for example. Polio virus, Adeno viruses and Herpes viruses (Fig. 1.5).

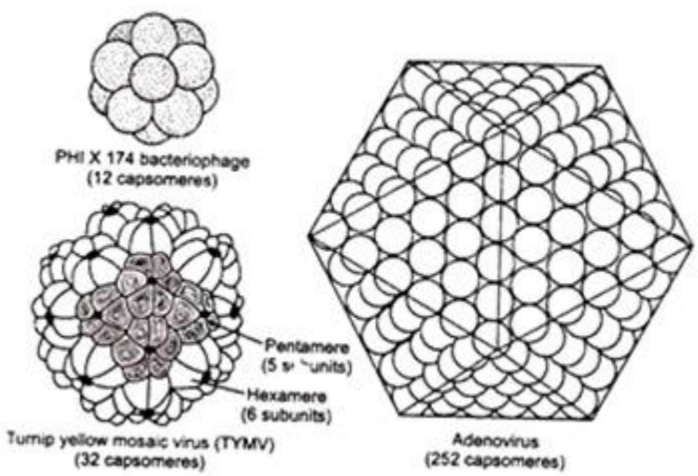


Fig. 1.5 Spherical or polyhedral viruses.

2. Helical or Cylindrical, as for example, Tobacco mosaic virus. Influenza virus, etc., (Fig. 1.6).

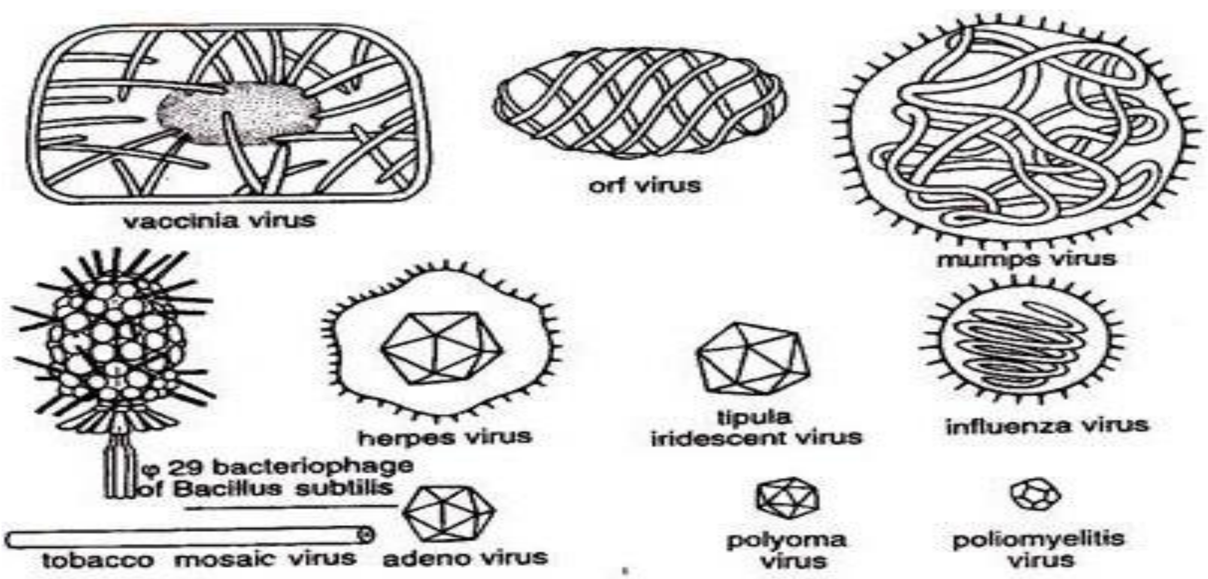


Fig. 1.6 **Viruses of different kinds.**

3. Complex symmetry, as for example. Vaccinia viruses and some bacteriophages.

Viruses cannot grow and multiply outside the living cell (total parasite). They do not have independent metabolic system of their own and are inactive when they are outside the host cell.

Structure of Viruses:

Viruses have simple morphology. They consist of two distinct parts: a core of nucleic acid and the protein coat. The protein coat is known as capsid. The protein coat or capsid is composed of several closely packed morphological unit called capsomeres (Fig. 1.7).

In this respect viruses differ from typical bacterial cells which are made up of proteins, carbohydrates, lipids, nucleic acids etc. Some viruses, e.g. Myxoviruses have additional membranous envelope containing proteins, lipids and carbohydrates outside the usual protein coat. They do not have plasma membrane.

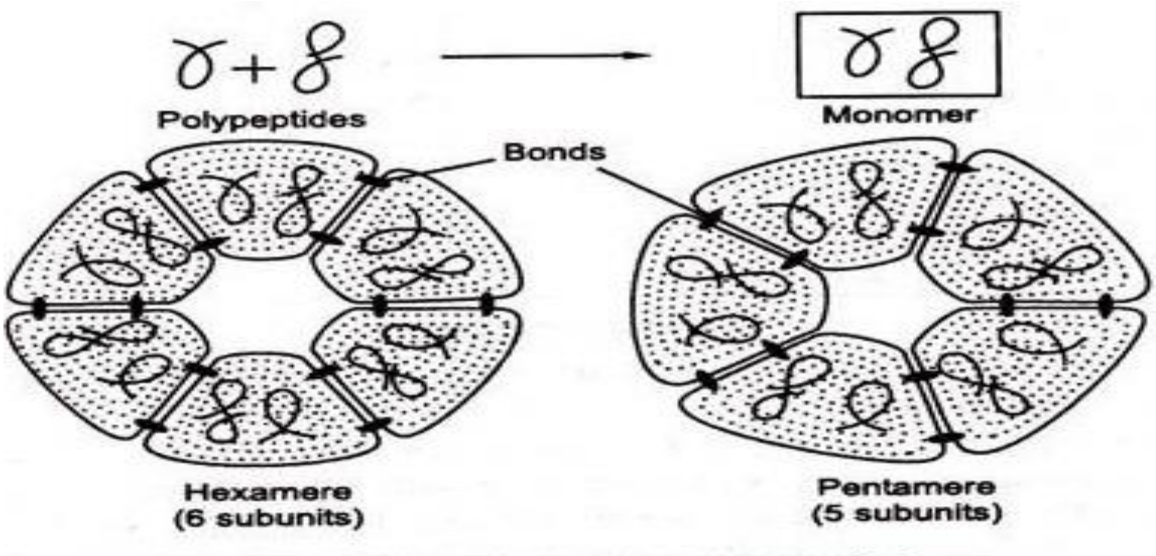


Fig. 1.7 Capsomeres in protein sheath of viruses.

Viruses lack cytoplasm and thus cell organelles such as mitochondria, golgibodies, ribosomes and lysosomes as well as enzyme systems are absent.

Viruses usually have either DNA or RNA whereas the typical cell contains both DNA and RNA. Certain animal viruses, e.g. Rous sarcoma virus (RSV) have both DNA and RNA.

Thus with respect to nucleic acid, the viruses are of three types:

1. RNA virus,

2. DNA virus, and

3. DNA-RNA virus.

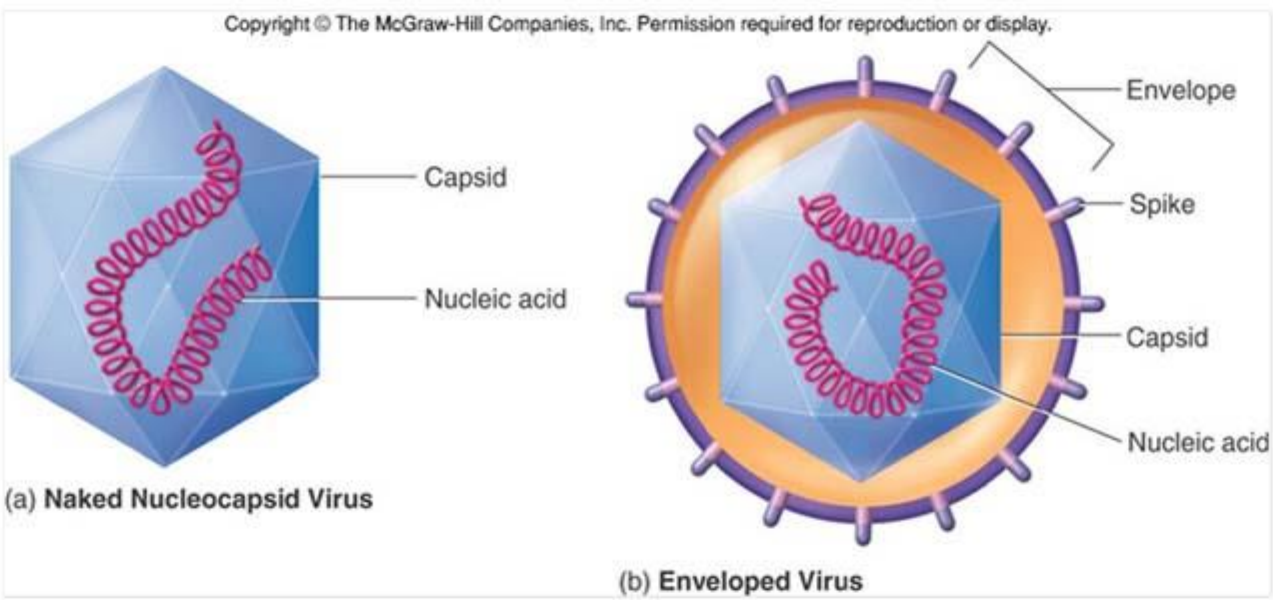
Structure of viruses

Lipid envelope

- Usually formed from a lipid bilayer taken from their host, into which the virus inserts its own glycoproteins (enveloped virus).
- Not all viruses have envelopes (naked virus).
- Viruses without envelopes are less prone to damage by external factors, such as pH, than those with envelopes.
- The lipid envelope also determines how viruses enter their host cells.

Glycoproteins

- Either function as transport channels or form viral antigens



Capsid

- Capsids are proteins that form a coat around the nucleic acid.

- The capsid and genetic information are grouped together and are collectively known as the nucleocapsid.
- Often the whole virus is actually just a nucleocapsid, without a membrane or envelope.

Genetic material

- The genetic material within viruses can be single- or double-stranded deoxyribonucleic acid (DNA) or ribonucleic acid (RNA).
- A protein coating often protects the genome from external factors.

Replication of viruses

Adsorption

- Glycoproteins in the viral lipid envelope or molecules on the nucleocapsid (naked viruses) attach to specific receptor molecules on the host cell.
- This viral-host receptor molecule relationship is often highly specific. Accordingly, many viruses can only infect a limited range of cells.
- For example, the human immunodeficiency virus (HIV) preferentially infects T-helper cells as they express CD4 and CXCR4 receptor molecules on their cell membrane. The glycoprotein 120 molecule found in the lipid envelope of the HIV is able to bind with these receptor molecules.

Entry

- The mechanism by which viruses gain entry to their host cells is dependent upon their structure; in particular, whether a lipid membrane is present.

a. Enveloped virus:

- Cytoplasmic membrane fusion: the virus fuses with the host cell cytoplasmic membrane and the viral contents are then released into the cytoplasm.
- Endocytosis: the virus is engulfed by the host cell cytoplasmic membrane.

b. Naked virus:

- Direct: the virus passes directly across the host cell cytoplasmic membrane.
- Endocytosis.

Un-coating

- Once inside the host cell, the viral lipid envelope or capsid is shed and the viral nucleic acids are released.
- At this stage, the virus ceases to be infective and will only regain infectivity after new virions have been formed (eclipse phase).

Tobacco Mosaic Virus (TMV):

TMV is a simple rod-shaped helical virus consisting of centrally located single-stranded RNA (5.6%) enveloped by a protein coat (94.4%). The rod is considered to be 3,000 Å in length and about 180 Å in diameter.

The protein coat is technically called 'capsid'. R. Franklin estimated 2,130 sub-units, namely, capsomeres in a complete helical rod and 49 capsomeres on every three turns of the helix; thus there would be about 130 turns per rod of TMV.

The diameter of RNA helix is about 80 Å and the RNA molecule lies about 50 Å inward from the outer-most surface of the rod. The central core of the rod is about 40 Å in diameter. Each capsomere is a grape like structure containing about 158 amino acids and having a molecular weight of 17,000 dalton as determined by Knight.

The ssRNA is little more in length (about 3300 Å) slightly protruding from one end of the rod. The RNA molecule consists of about 7300 nucleotides; the molecular weight of the RNA molecule being about 25,000 dalton.

Life-Cycle (Replication) of Tobacco Mosaic Virus (TMV):

Plant viruses like TMV penetrate and enter the host cells in toto and their replication completes within such infected host cells. Inside the host cell, the protein coat dissociates and viral nucleic acid becomes free in the cell cytoplasm.

Although the sites for different steps of the viral multiplication and formation of new viruses have not yet been determined with absolute certainty, the studies suggest ha alter becoming free in the cell cytoplasm the viral-RNA moves into the nucleus (possibly into the nucleolus).

The viral-RNA first induces the formation of specific enzymes called 'RNA polymerases' the single-stranded viral-RNA synthesizes an additional RNA strand called replicative RNA.

This RNA strand is complementary to the viral genome and serves as 'template' for producing new RNA single strands which is the copies of the parental viral-RNA. The new viral-RNAs are released from the nucleus into die cytoplasm and serve as messenger-RNAs (mRNAs). Each mRNA, in cooperation with ribosomes and t-RNA of the host cell directs the synthesis of protein subunits.

After the desired protein sub-units (capsomeres) have been produced, the new viral nucleic acid is considered to organize the protein subunit around it resulting in the formation of complete virus particle, the virion.

No 'lysis' of the host cell, as seen in case of virulent bacteriophages, takes place. The host ells remain alive and viruses move from one cell to the other causing systemic infection. When transmitted by some means the viruses infect other healthy plants.

UNIT II

Algae

Introduction

The term algae (Latin — seaweeds) was first introduced by Linnaeus in 1753, meaning the Hepaticeae. The algae comprise of a large heterogeneous assemblage of plants which are diverse in habitat, size, organisation, physiology, biochemistry, and reproduction.

It is an important group of Thallophyta (Gr. Thallos — a sprout; phyton — a plant), the primitive and simplest division of the plant kingdom. The orderly systematic study of algae is called Phycology (Gr.phycos — seaweeds; logos — study or discourse).

The algae are chlorophyll-containing primitive plants, both prokaryotic and eukaryotic, with wide range of thaifi starting from unicellular to multicellular organisations. Autophytic (which can manufacture their own food) and thalloid plant bodies are also found in Bryophytes.

However, the reproductive structures of some groups of algae (e.g., Chlorophyceae) are apparently multicellular and the sterile tissue is generally considered as vegetative. Bryophytes onwards in the scale of evolution have the uniform multicellular sex organs, the archegonia, which are not found in algae. For that reason briophytes are usually called archegoniate plants.

Characteristics of Algae:

1. Algae are chlorophyll-bearing autotrophic thalloid plant body.

2. Almost all the algae are aquatic.

3. The plant body may be unicellular to large robust multicellular structure.

4. The multicellular complex thalli lack vascular tissue and also show little differentiation of tissues.

5. The sex organs are generally unicellular but, when multicellular, all cells are fertile and in most cases the entire structure does not have any protection jacket.

6. The zygote undergoes further development either by mitosis or meiosis, but not through embryo formation.

7. Plants having distinct alternation of generations. Both gametophyte and sporophyte generations — when present in the life cycle are independent.

Occurrence of Algae:

The algae are ubiquitous (present everywhere) in distribution, i.e., they are found in fresh water as well as marine water, on soil, on rock, as epiphytes or parasites on plants and animals, in hot springs, in desert, on permanent snow-fields etc. But they mainly dwell in aquatic environments.

Based on habitat the algae may be categorized as:

1. Aquatic algae.

2. Terrestrial algae, and

3. Algae of remarkable habitats.

1. Aquatic Algae:

Aquatic algae may be fresh water (when salinity is as low-as 10 ppm) or marine (when salinity is 33-40%). Again, certain algae grow in brackish water which is unpalatable for drinking, but less salty than sea water. The fresh water algae usually grow in ponds, lakes, tanks, ditches etc.

The very common fresh water algae are Chlamydomonas, *Volvox*, Ulothrix, Chara, Oedogonium, Spirogyra, Nostoc, Oscillatoria etc. Some of the very common marine algae are Sargassum, Laminaria, Ectocarpus, Polysiphonia, Caulerpa, Bangia, Padina etc.

Fresh water algae may be termed as planktonic when they grow and remain suspended on the upper part of water (e.g., *Volvox*, diatom), while the benthic algae are bottom-dwellers. The algae that grow at air-water interface are called neustonic. The benthic algae may be epilithic, that grow on stones; epipelic attached to sand or mud; epiphytic — growing on plants; and epizoic — growing on animal body surface.

The marine algae may be supra-littoral or sub- aerial, as they grow above the water level and in the spray zone. The intertidal algae grow in such a depth so that they are exposed periodically due to tides. Other marine algae are sub-littoral, meaning hat they are constantly submerged at depths as great as 30-60 meters (100-200 ft).

2. Terrestrial Algae:

Some algae are found to grow in terrestrial habitats like soils,' rocks, logs etc. The algae that grow on the surface of the soil are known as saprophytes. Many blue-greens, on the other hand, grow under the surface of the soil, and are called cryptophytes.

The algae growing in the desert soil may be typified as endedaphic (living in soil), epidaphic (living on the soil surface), hypolithic (growing on the lower surface of the stones on soil), chasmolithic (living in rock fissures) and endolithic algae (which are rock penetrating).

The common terrestrial members are Oscillatoria sancta, Vaucheria geminata, Chlorella lichina, Euglena sp., Fritschiella sp. and Phormidium sp.

Habitats:

1. Halophytic Algae (or Eurhaline):

They grow in the highly concentrated salt lakes, and include Chlamydomonas ehrenbergli, Dunaliella and Stephanoptera sp.

2. Symbiotic Algae:

They grow in association with fungi, bryophytes, gymnosperms or angiosperms. The best examples of symbiotic algae found in association with fungi are Nostoc, Gloeocapsa, Rivularia; the members of Cyanophyceae and Chlorella, Cytococcus, Pleurococcus; the members of Chlorophyceae.

This symbiotic association consisting of algae and fungi is called lichen. Nostoc may also associate with Anthoceros and Anabaena associates with the roots of Cycas to form coralloid roots.

3. Cryophytic Algae:

This group of algae growing on ice or snow provides attractive colours to snow-covered mountains. The alpine and arctic mountains become red due to the growth of the Haemotococcous nivalis; green snow in Europe is due to the growth of Chlamydomonas yellowstonensis.

Scotiella nivalis and Raphidonema brevirostri cause black colouration of snow, whereas Ancyclonema nordenskioldii is responsible for brownish purple colouration.

4. Thermophytes or Thermal Algae:

This group of algae occurs in hot water springs (50- 70°C) where normal life is not possible. Many blue-greens (e.g., Oscillatoria brevis, Synechococcus elongates, Heterohormogonium sp.) are grown in such hot springs.

5. Lithophytes:

They grow on the moist surface of stones and rocks, e.g., Nostoc,. Gloeocapsa, Enteromofpha, Batrachospermum etc.

6. Epiphytic Algae:

They grow on other plants including other algal members.

These are:

a. Algae on Algae:

i. Ptilota plumosa and Rhodymenia pseudopalmatta on Laminaria hyperborean, ii. Diatoms on Oedogonium, Spirogyra etc.

b. Algae on Bryophytes:

Blue-green algae like Nostoc, Oscillatoria, diatoms like Achnanthes etc. grow on different bryophytes.

c. Algae on Angiosperms:

Algae like Cocconis, Achnanthes etc. grow epiphytically on Lemna, an aquatic angiosperm. Alga like Trentepohlia grows on the barks of different angiospermic plants, and is very common in Darjeeling (India).

7. Epizoic Algae:

The algae growing on animals like fish, snail etc. are called as epizoic, e.g., Stigeoclonium are found in the gills of fishes.

8. Endozoic Algae:

They grow in the tissues of animals, e.g., Zoochlorella sp. is found in Hydra viridis.

9. Parasitic Algae:

Some algae grow parasitically on different plants and animals.

These are:

a. Cephaleuros (Chlorophyceae) is parasitic and grows on the leaves of various angiosperms, such as tea (Camellia sinensis), coffee (Coffea arabica), Rhododendron, Magnolia and pepper (Piper nigrum). The most important one is Cephaleuros virescens, which causes Red rust of tea.

b. Rhodochytrium (Chlorophyceae) grows on ragweed (Ambrosia) leaves.

c. Phyllosiphon (Chlorophyceae) grows on the leaves of Arisarum vulgare.

d. Ceratocolax (Rhodophyceae) grows in Phyllophora thallus.

10. Psammon:

The algae which grow in sandy beaches are called psammon, e.g., Vaucheria, Phormidium etc.

Volvox

Systematic Position of *Volvox*:

Class	:	Chlorophyceae
Order	:	Volvocales
Sub-order	:	Chlamydomonadineae
Family	:	Volvocaceae
Genus	:	*Volvox*

Occurrence:

Volvox is free floating fresh water green algae. *Volvox* grows as planktons on surface of water bodies like temporary and permanent ponds, lakes and water tanks. During rainy season due to its fast growth the surface of water bodies become green. The *Volvox* colonies appear as green rolling balls on surface of water.

Volvox is represented by about 20 species:

Some common Indian species are—*Volvox globator, V aureus, V. prolificus, V. africanus* and *V. rousseletii.*

Structure of *Volvox*:

Volvox thallus is a motile colony with definite shape and number of cells. This habit of thallus is called coenobium.

The colony is hollow, spherical or oval in shape and the size of colony is about the size of a pin head. The number of cells in a colony is fixed. Depending upon the species of *Volvox* the cells can be 500-60,000. The central part of colony is mucilaginous and the cells are arranged in a single layer on periphery of the colony (Fig. 1A).

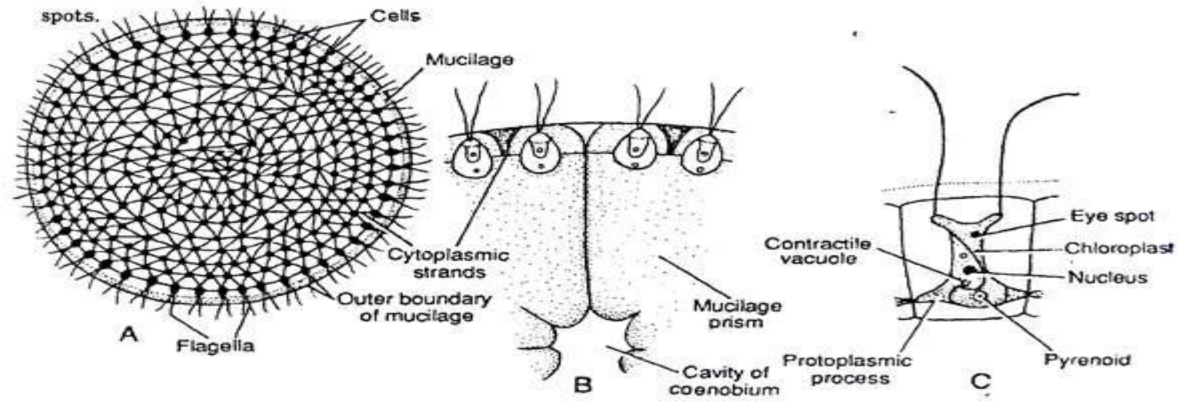


Fig. 1. (A-C) *Volvox*. A. A colony; B. A part of colony; C. Single cell.

The cells of anterior end possess bigger eye spots than those of posterior end cells. The cells of posterior side become reproductive on maturity. Thus, spherical or round colony of *Volvox* shows clear polarity. The cells of *Volvox* colony are *Chlamydomonas* type. Every cell has its own mucilage sheath.

The mucilage envelope of colony appears angular due to compression between cells. The cells are connected to each other through cytoplasmic strands. In some species of *Volvox* the cytoplasmic connections or strands are not present.

The cells of colony are usually pyriform with narrow anterior end and broad posterior end. The cells are biflagellate, the two flagella are equal, whiplash type and project outwards. The protoplasm of cell is enclosed within plasma membrane.

Each cell contains one nucleus, a cup shaped chloroplast with one or more *pyrenoids, an eye spot and 2-6 contractile vacuoles. In some species of Volvox e.g., in V. globator* and *V. rousseletii* the cells are of Sphaerella type.

The cells of colony are independent for functions like photosynthesis, respiration and excretion. The movement of colony takes place by coordinated flagellar movement. The reproduction is common to the coenobium.

Reproduction in *Volvox*:

Volvox reproduces both asexually and sexually. The asexual reproduction takes place under favourable conditions during spring and early summer. In *Volvox* mostly the cells of posterior part of colony take part in reproduction. These reproductive cells can be recognized by their larger size, prominent nuclei, dense granular cytoplasm, more pyrenoids and absence of flagella.

Asexual Reproduction:

During asexual reproduction some cells of the posterior part of colony become reproductive. These cells enlarge up to ten times, become rounded and lose flagella. These cells are called gonidia (Sing, gonidium). The gonidia lose eye spot. Pyrenoids increase in number.

The gonidia are pushed towards interior of the colony. The first division of gonidium is longitudinal to the plane of coenobium and this forms 2 cells.

The second division is also longitudinal and at right angle to the first, forming 4 cells (Fig. 2 B). By third longitudinal division all the four cells divide to make 8 cells of which 4 cells are central and 4 are peripheral. These 8 cells are arranged in curved plate-like structure and are called plakea stage (Fig. 2 C, D). Each of these 8 cells divides by longitudinal division forming 16 cells arranged in the form of a hollow-sphere.

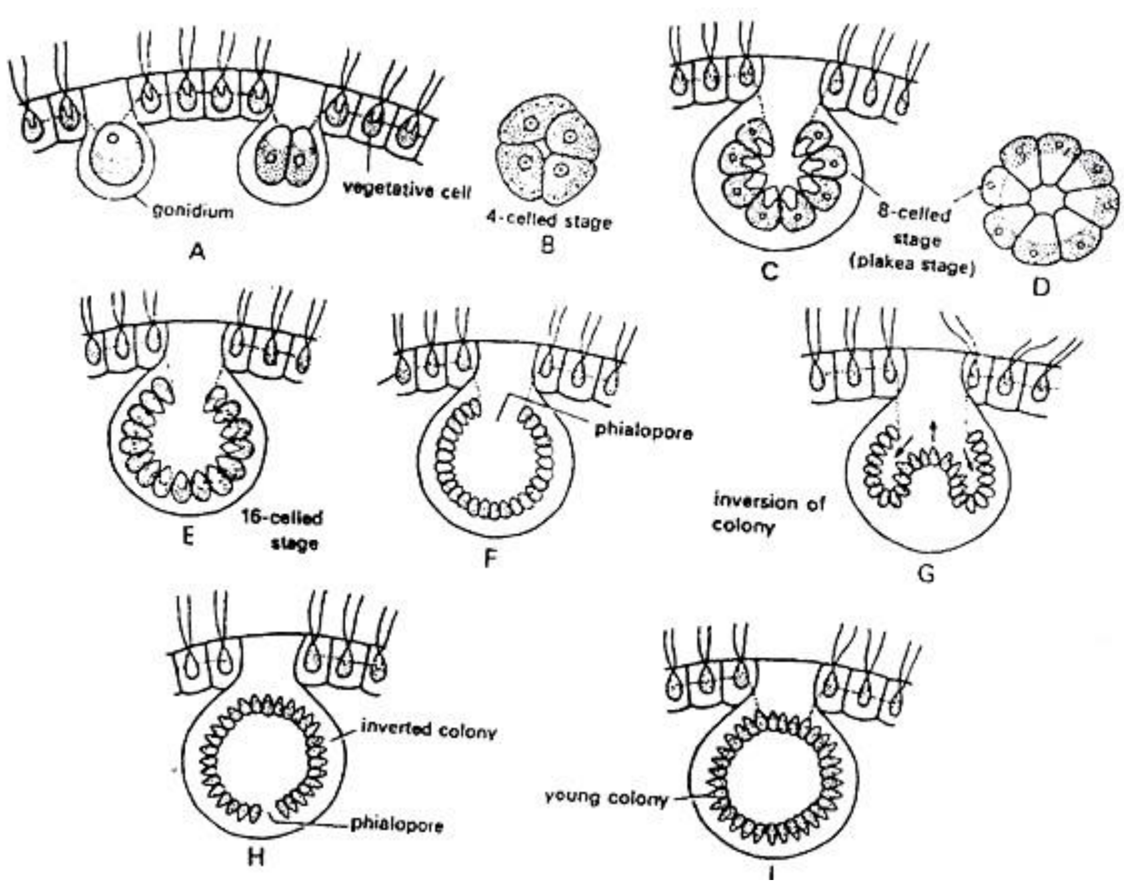
The sphere is open on exterior side as a small aperture called phialopore. The cells at this stage continue to divide till the number of cells reaches the characteristic of that species. The cells at this stage are naked and in close contact with each other. The pointed anterior end of cells is directed towards inside.

The next step is called inversion of colony. As cells become opposite in direction, their anterior pointed end has to face the periphery of colony.

The inversion of colony starts with formation of a constriction opposite to phialopore. The cells of posterior end along with constriction are pushed inside the sphere, till the whole structure comes out of the phialopore. After inversion, the anterior pointed end of the cell faces periphery.

The phialopore gets closed, and makes the anterior part of the colony. After inversion the cells develop cell wall, flagella and eye spot. The cells become separated due to development of gelatinous sheath around each cell. This newly developed colony is called daughter colony.

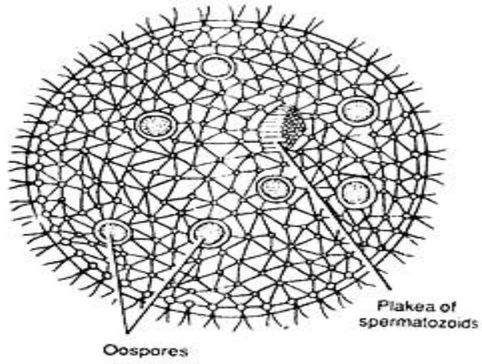
The daughter colonies initially remain attached to gelatinized wall of parent colony and later become free in gelatinous matrix of parent colony. The daughter colonies are released in water after the disintegration of parent colony or through the pores. Sometimes next generation of daughter colonies develop while the colonies are still attached to the earlier parent colony.



Sexual Reproduction:

The sexual reproduction in *Volvox* is oogamous type. Some species of *Volvox* e.g., V. globator are monoecious or homothallic i.e., the antheridia and oogonia develop on same colony. Other *Volvox* species e.g., V. rousseletii are dioecious or heterothallic i.e., antheridia and oogonia develop on different colonies.

Monoecious species are usually protandrous i.e., antheridia mature before oogonia but some species are protogynous i.e., oogonia develop before antheridia. V aureus is mostly dioecious but sometimes can be monoecious.

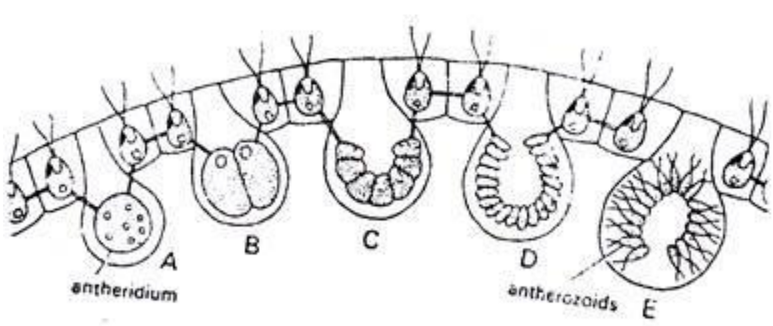


Reproductive cells mostly differentiate in the posterior part of colony. These cells enlarge, lose flagella and are called gametangia. The male reproductive cells are called antheridia or androgonidia and female reproductive cells are called oogonia or gynogonidia.

Development of Antheridium:

The development of antheridium starts with formation of antheridial initial or androgonidial cell mostly in posterior side of the colony. The initial cells enlarge, lose flagella, protoplasm becomes dense and nucleus becomes larger. The antheridial initial shifts inside towards cavity and remains connected to other vegetative cells through cytoplasmic strands.

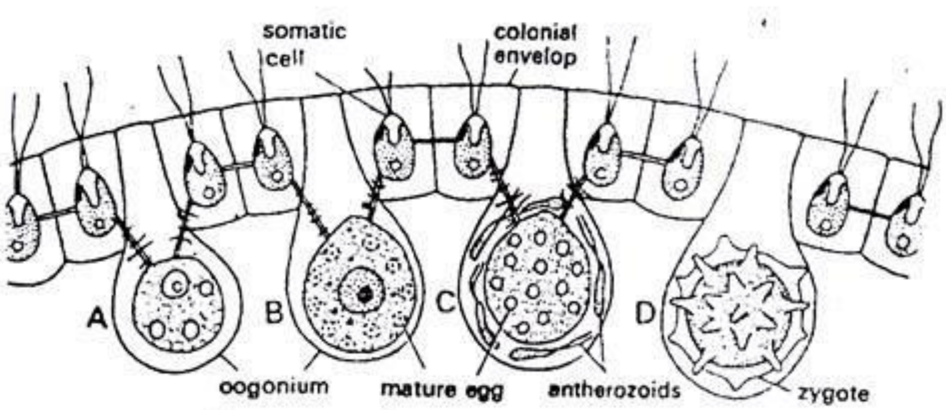
The protoplast of antheridial initial divides, longitudinally to form 16-512 elongated cells. The cells remain in plate-like structure or arrange in a hollow sphere. The inversion of cells also takes place as in asexual reproduction. Each cell differentiates in antherozoid or spermatozoid.



The antherozoid is spindle shaped, elongated, bi-flagellated structure containing two contractile vacuoles, nucleus, cup shape chloroplast, pyrenoid and eye spot. It is pale yellow or green in colour. The antherozoids are released individually or sometimes in groups.

Development of Oogonium:

The oogonia also differentiate mostly in posterior side of the colony. The oogonial initials enlarge, nucleus becomes larger, protoplast becomes dense, flagella are lost, eye spot disappears and many pyrenoids appear. The mature oosphere or ovum is round or flask shaped structure. The egg is uninucleate structure, the beak of flask shape oogonium functions as receptive spot.



Fertilization of *Volvox*:

After liberation from antheridium, the antherozoids swim freely on surface of water. Due to chemotactic response the antherozoids reach the oogonia.

Some antherozoids enter each oogonium. Only one antherozoid enters inside the oogonium through receptive spot. After this plasmogainy i.e., fusion of male and female cytoplasm and karyogamy i.e., fusion of male and female nuclei take place. This results in formation of diploid zygote.

The diploid zygote secretes a three layered thick wall. The layers of the wall are exospore, mesospore and endospore. The outer exospore is thick. It may be smooth e.g., *V. aureus* or spiny e.g., *V. globator*.

The mesospores and endospores are thin and smooth. The walls contain nucleus pigment haematochrome which imparts red colour to the zygote. The zygotes are released by the disintegration of parent colony. Then zygotes undergo a period of dormancy.

Germination of Zygote:

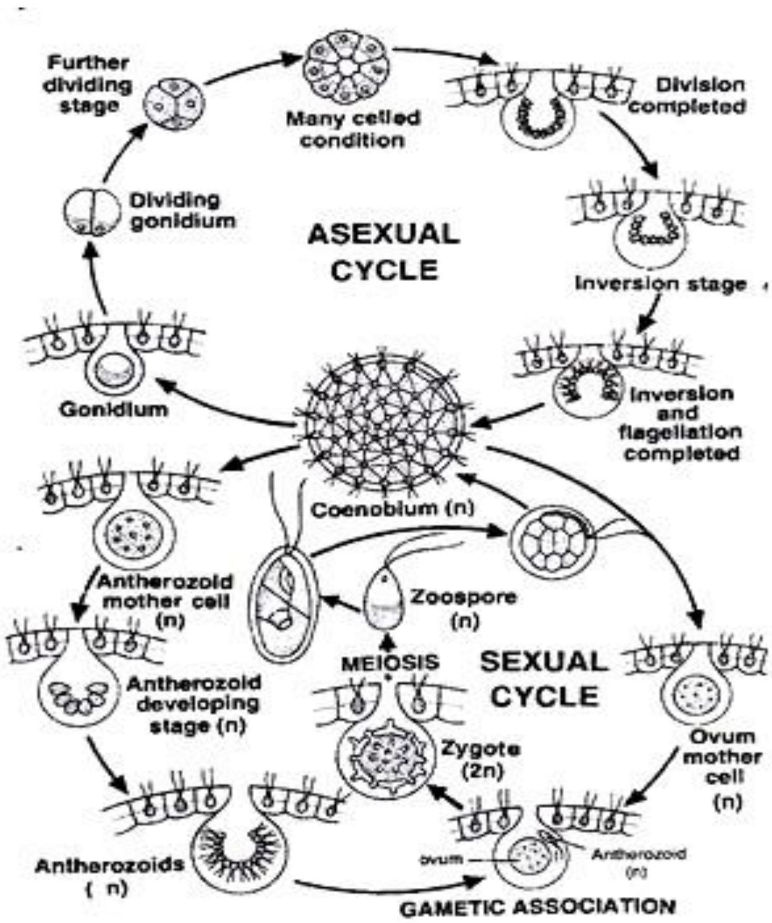
The dormant zygote germinates on approach of favourable climatic conditions. The diploid nucleus of zygote undergoes meiotic division forming four haploid cells. The outer two layers of zygote burst and the inner layer comes out as vesicle. The four haploid cells migrate with the vesicle. The development of new colony from zygote differs in different species of *Volvox*.

In V. aureus and V. minor the protoplasm of zygote divides repeatedly until the cell number of colony is reached and new colony is formed as in asexual reproduction process. In V. campensis the protoplast of zygote divides to make many biflagellate zoospores.

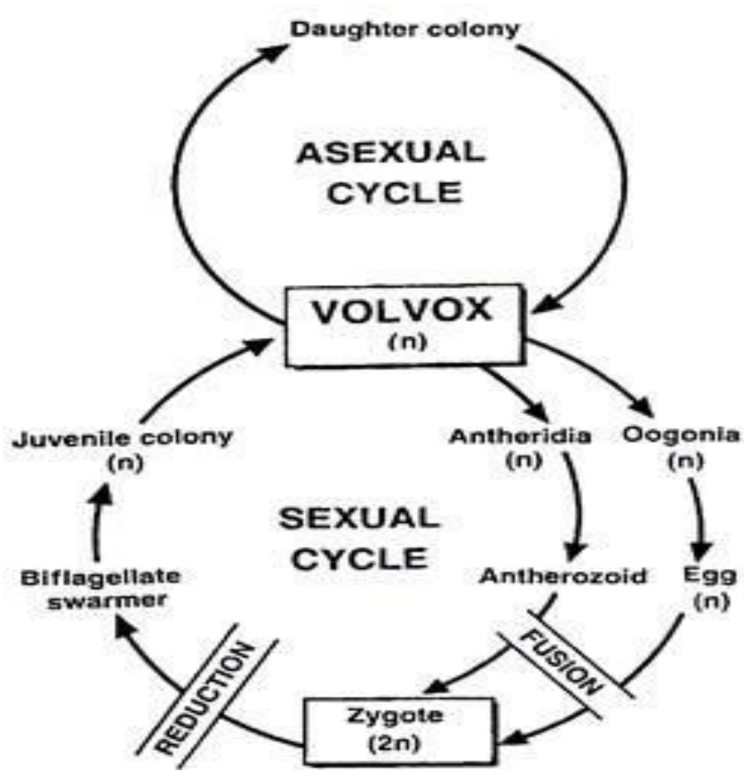
Only one zoospore survives and all other disintegrate. This zoospore comes out of the vesicle it divides to make many cells which arrange to form a colony. In V. rousseletii the zygote forms a single biflagellate zoospore, the protoplast of zoospore divides and forms a colony. In all the methods the cells divide and undergo inversion to make a mature colony.

Life Cycle of *Volvox*:

Volvox is haploid (n) algae, the haploid gametes fertilize to make diploid zygote (2n) which divides by meiosis to make haploid cells (n) which mature into haploid *Volvox* colony.



Life-cycle of *Volvox*



Economic importance of algae

Algae have diverse economic uses. They perform half of the total carbon dioxide-fixation on earth by photosynthesis, acting as the primary producers in aquatic habitats.

(a) Food source: Many species of marine algae such as Porphyra, Sargassum, and Laminaria are edible. Chlorella and Spirulinaare rich in proteins. Thus, they are used as food supplements.

(b) Commercial importance: Agar is used in the preparation of jellies and ice-cream. It is obtained from Gelidium andGracilaria. Carrageenin is used as an emulsifier in chocolates, paints, and toothpastes. It is obtained from the red algae.

(c) Medicines: Many red algae such as Corallina are used in treating worm infections.

UNIT III

Fungi:

Fungi (Lat. fungus—mushroom) are eukaryotes with a distinct nucleus and rigid chitinous cell wall and were formerly regarded as plants without chlorophyll and are now grouped with protozoa slime moulds and most algae as Higher Prostita. Mycoses are infections caused by true fungi.

Eumycetes contains more than 80,000 species and can be classified morphologically into:

(1) Phycomycetes:

They are fungi with a unicellular, non-septate mycelium (500 species). The spores (endospores) are enclosed in special sporangia. Reproduction is sexual and asexual. A typical representative of *Mucor* (bread mould) is *Mucor mucedo*. Pathogenic species of this *Mucor* (mould) may cause infection of lungs, middle ear and general severe infectious process in man.

The mould (filamentous) or mycelial fungi grow as long filaments (hyphae) and reproduce by formation of spores. The major part of the mycelium, the vegetative mycelium grows and penetrates into the substrate absorbing nutrients for growth; other hyphae form aerial mycelium and protrude from the vegetative mycelium into the air. They form various kinds of spores and disseminate them in the air.

(2) Ascomycetes:

Ascomycetes of sac fungi (35,000 species) have a multicellular mycelium. They reproduce sexually by means of ascospores (spores which develop in spherical spore cases), asci—ascus (Gr. askos—sac) and asexually by conidia (exospores which have the function of asexual reproduction in many fungi).

The genus *Aspergillus* belong to the class Ascomycetes. These fungi have divided separate mycelium and an unicellular conidiophore which terminates in a fan-like row of short sterigmata from which the spores are pinched off in chains-conidia (Gr. konia—dust).

The fruiting part of the *Aspergillus* resembles a jet of water from a watering can and hence the name "**Sprinkler**" mould. *Aspergillus niger* is a representative of Aspergilla and is widespread in nature, certain species may cause aspergillosis of the lungs, ear and eye of man and may infect the whole body.

The genus *Penicillium* belongs to the class Ascomycetes. The mycelium and conidiophore are multicellular. The fruiting body is in the shape of a brush. The conidiophore branches towards its upper part and terminates into sterigmata from which even-rowed chains of conidia are pinched off.

This genus of fungi is widespread in nature (fodder, milk products, moist objects, old leather, ink, jam). The type species is *Penicillium glaucum*. Certain species (*Penicillium notatum*, *Penicillium chrysogenum*) are used for the production of penicillin which is widely used in the treatment of many infectious diseases.

Some species of this genus of fungi are pathogenic and cause infection of the skin, nails, upper respiratory tract, lungs and other organs of man.

Yeasts belong to the class Ascomycetes. They are large, oval, round, rod shaped cells. They have a double cell wall and well defined nucleus. The cytoplasm is homogeneous—sometimes of a fine granular structure. It contains inclusions (glycogen, volutin, and lipid) and also filamentous bodies-chondriosomes which are responsible for synthetic process of the cell.

Yeasts multiply by budding, fission, sporulation and some of them reproduces asexually. Daughter cells produced by budding from the parent cell transform into independent individuals. The yeasts can also reproduce by sporulation. When there is lack of nutrition, 2, 4, 8 or 16 endospores are formed inside the cells of some species of yeast.

Yeast cell forming the ascospores is called the ascus (sac), while sporulating yeasts are known as Ascomycetes, since the yeasts ferment various carbohydrates, they are widely used in brewing beer, in wine making and in baking bread. Saccharomyces cerevisiae, S. elipsoides are typical representatives of the yeasts.

Among the asporogenic yeasts (family Saccharomycetaceae), there are species pathogenic to man; they are called as Candida which cause grave disease known as candidiasis. They occur as a result of the growth inhibition of the normal micro flora by antibiotics used for treating a number of infectious diseases and inflammatory processes.

(3) Basidiomycetes:

Fungi with a multicellular mycelium. These organisms predominantly reproduce asexually by basidiospores (basidia reproductive organs) in which a certain number of spores develop, usually 4. Certain species are free parasites. Two hundred species of mushrooms are used as food. Twenty-five species of mushrooms are poisonous.

Smut fungi invade grains crops causing disease known as smut. Rust fungi affect sunflowers and other plants producing orange coloured spots on infected plants. Imperfect fungi (Fungi imperfecti) are a rather large group of fungi consisting of a multicellular mycelium without either asco- or basidio sporangiophore, but only with conidia.

Reproduction is asexual; but the sexual reproduction is unknown. To this class belong the orders Hyphomycetes, Melanconiales and Sphaeropsidales.

Among the hyphomycetes, which may be of great interest to the physicians are:

Fusarium graminearum causing intoxication in human (drunken bread), and Fusarium sporotrichioides causing intoxication in man and domestic animals who had eaten the grain crops which had remained in the fields during the winter.

Pathogenic species of imperfect fungi are causative agents of dermatomycoses (superficial mycoses):

Favus *(Achorion schoenleini*); trichophytosis (*Trichophyton violaceum*), microsporosis (*Microsporum lanosum*), epidermophytosis (*Epidermophyton inguinale*).

Economic Importance of Fungi

(a) Role of fungi in Agriculture or crop production

1. **Decomposition and humus formation:** Fungi decompose the dead animals and plants. Fungi change them into humus. It plays an important role in germination of plant. It provides important nutrient to plants. Humus also holds the soil particles. Thus it reduces the chance of soil erosion and also increases the water holding capacity of soil.
2. **Biological succession:** Fungi are important part of lichens. Lichens play an important role in biological succession. They make barren land suitable for cultivation.
3. **Biological nitrogen fixation:** Lichens are also involved in biological nitrogen fixation. They fix the atmospheric nitrogen to form nitrates. These nitrates are absorbed by the plants. Some fungi are also involved in free biological nitrogen fixation.
4. **Role of mycorrhizae:** Mycorrhizae is an association between fungi and roots of higher plants. It has great survival value for plants. Fungi spread in large area around the plants. It absorbs water and minerals and transports them to plant. Thus, plants can survive in arid conditions.
5. **Commercial cultivation of fungi**: Some fungi are edible. They are commercially cultivated in many countries. Some fungi like morels and truffles

are very delicious. There is a great demand of these fungi in the market. Many countries are earning huge foreign exchange by exporting these fungi.

6. **Fungi as insecticides:** Some fungi attack insects. They kill the insects. For example, fungi are used to kill the wheat bulb flies in USA.
7. **Source of plant hormones:** Some fungi are source of plant hormones. Plant hormone gibberellins are obtained from *Gibberella.*

(b) Industrial application: Role of fungi in food and industry

1. **Edible fungi:** Certain fungi are edible. About 200 species of mus'irooms (Agaricus sp.) are used as food. For example: **Morels:** e.g. *Morchella esculenta*. **Truffles:** Underground fruiting bodies of some *Ascomycetes*, e.g. Tuber sp).
2. Used in **baking and brewing industries:** Yeasts can cause fermentation. So yeasts (*Saccharomyces cerevisiae*) are used in production of bread and liquor.
3. **Cheese preparation:** *Pencillium* species are used for giving flavour, aroma and characteristic colour to some cheese.
4. **Soya products:** Some species of Aspergillus are used for fermenting and producing soya sauce and soya paste from soya bears.
5. **Synthesis is of organic acids:** Citric acid is obtained from some *Asperigillus* species. Some fungi yield fumaric acid and lactic acids.
6. **Source of vitamins and enzymes:** *Saccharomyces cerevisiae* is a source of vitamin B. vitamin D and riboflavin. Some enzymes like diastase, pectinase also obtained from fungi.
7. **Antibiotics and other drugs:** Some fungi are source of antibiotics and other drugs.

(a) Penicillin was first antibiotic. It was discovered by **A. Fleming** in 1928. Penicillin is obtained from **Pencillium notatum.**

(b) Lovastatin is used for lowering the blood cholesterol.

(c)Cyclosporine is obtained from soil fungus. It is used in organ transplantation (like kidney). It prevents the transplant rejection.

(d) Ergotine is used to relieve headache by migraine.

(e) Griseofulvin is used to inhibit fungal growth.

8. **Natural dyes:** Some natural dyes are obtained from lichens. These are used in textile industry.

***Peziza* :**

Kingdom Fungi

Division Ascomycota

Family Pezizaceae

Order Pezizales
Genus *Peziza*

It is well developed, frequently perennial and consists of a dense network of hyphae. The hyphae are branched and septate. The cells are uni-nucleate.
The hyphae are hidden from view as they ramify within the substratum. They from a complex system which extracts nourishment from the substratum. The fruiting bodies are above ground.

Reproduction in *Peziza*:

1. Asexual Reproduction:

It takes place by the formation of conidia and chlamydospores. The conidia are exogenously formed spores. They are abstricted from the tips of conidiophores. Each conidium germinates to form a new mycelium.
The chlamydospores are thick-walled resting cells. They are intercalary in position. They may be formed singly or in series within the cells of the hyphae. Under suitable conditions each chlamy-dospore germinates and gives rise to a new mycelium.

2. Sexual Reproduction:

The sexual apparatus is wholly lacking in *Peziza vesiculosa*. This does not prevent the development of a fructification. The sexual process does take place. It is extremely simplified and consists in the association of two purely vegetative nuclei in a pair.

The adult mycelium consists of a tangled mass of hyphae. Certain vegetative cells in the centre of the tangled hyphal mass have been seen to possess nuclei which become associated in pairs.

These pairs of nuclei are called the dikaryons. The dikaryotic condition is brought about either by autogamous pairing or by somatogamous copulation between the vegetative cells of the adjacent hyphae of the tangled hyphal mass.

The cells with the dikaryons give rise to the ascogenous hyphae which become multicellular by cross walls. Their cells are binucleate. The terminal binucleate cell of each ascogenous-hypha functions as an ascus mother cell.

Formation of croziers in the development of asci has not been reported in P. vesiculosa. The ascogenous hyphae and dikaryotic cells from which they are developed together with the ascus mother cells represent the dikaryophase in the life cycle of *Peziza*.

The two nuclei of the ascus mother cell fuse to form the synkaryon. The young ascus with the synkayon represents the transitory diplophase. The synkaryon undergoes three successive divisions. Of these the first and the second constitute meiosis.

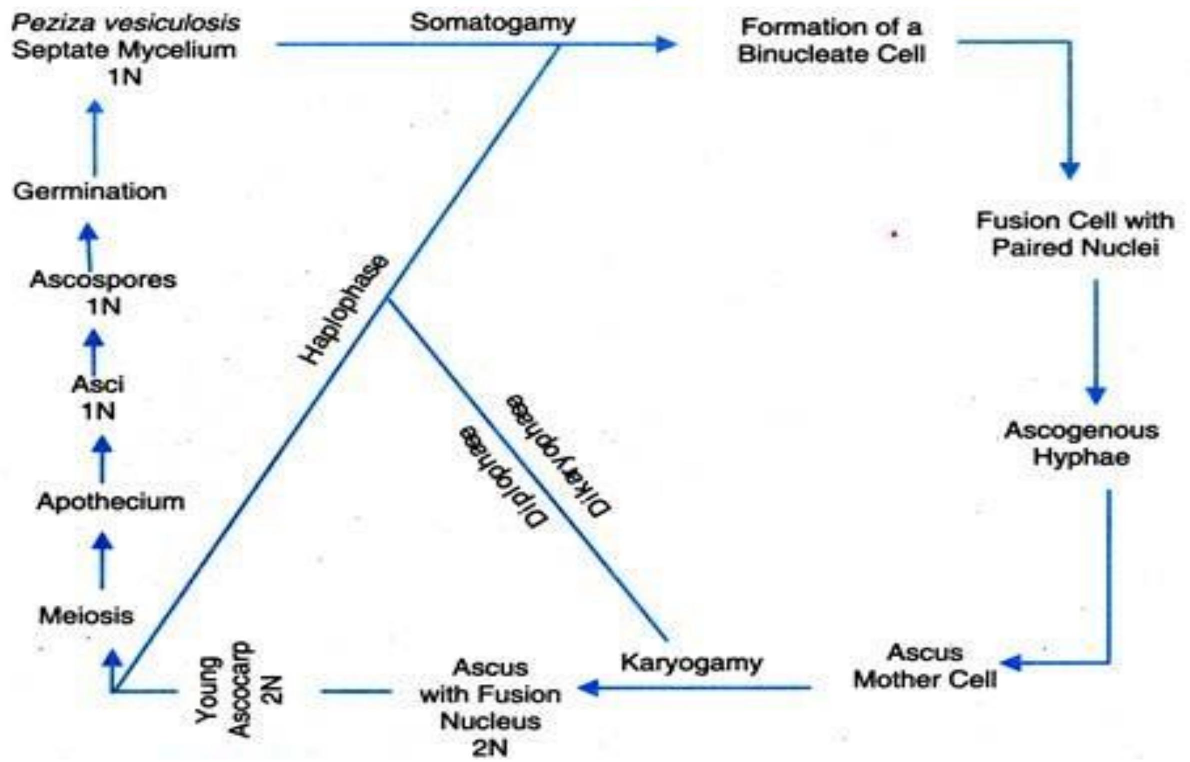
This results in the formation of eight haploid nuclei which become organised into ascospores. The mature ascus is an elongated, cylindrical cell.

The ascus wall is lined by a thin layer of cytoplasm (epiplasm) which encloses a central vacuole filled with sap. In the vacuole lie the oval ascospores.

The erect asci lie side by side lining the cavity of the cup-shaped apothecium. The asci near the margin of the cup bend towards the source of light being positively phototropic.

Interspersed between the asci are the sterile hyphae called paraphyses. The rest of the apothecium consists of densely interwoven, branched hyphae forming a pseudo-parenchymatous tissue which supports the hymenium.

The apothecia are sessile or shortly stalked cup-shaped structures regular in form and large in size varying from 2 cm. to several inches in diameter. In *P. vesiculosa* the apothecium is of pale fawn colour but *P. aurantia* has brilliant orange apothecium.



Unit IV

Bryophyta

The division Bryophyta (Gr. bryon=moss) includes over 25000 species of non-vascular embryophytes such as mosses, liverworts and hornworts.

Bryophytes are small plants (2cm to 60cm) that grow in moist shady places. They don't attain great heights because of absence of roots, vascular tissues, mechanical tissues and cuticle. They are terrestrial but require external water to complete their life cycle.

Hence, they are called "Amphibians of plant kingdom".

The fossil record indicates that bryophytes evolved on earth about 395 – 430 million years ago (i.e. during Silurian period of Paleozoic era). The study of bryophytes is called bryology. Hedwig is called 'Father of Bryology'. Shiv Ram Kashyap is the 'Father of Indian Bryology'.

Salient features of Bryophytes:

1. Bryophytes grow in damp and shady places.

2. They follow heterologous haplodiplobiontic type of life cycle.

3. The dominant plant body is gametophyte on which sporophyte is semi-parasitic for its nutrition.

4. The thalloid gametophyte differentiated in to rhizoids, axis (stem) and leaves.

5. Vascular tissues (xylem and phloem) absent.

6. The gametophyte bears multi-cellular and jacketed sex organs (antheridia and archegonia).

7. Sexual reproduction is oogamous type.

8. Multi-cellular embryo develops inside archegonium.

9. Sporophyte differentiated into foot, seta and capsule.

10. Capsule produces haploid meiospores of similar types (homosporous).

11. Spore germinates into juvenile gametophyte called protonema.

12. Progressive sterilization of sporogenous tissue noticed from lower to higher bryophytes.

13. Bryophytes are classified under three classes: Hepaticae (Liverworts), Anthocerotae (Hornworts) and Musci (Mosses).

Classification of Bryophytes:

According to the latest recommendations of ICBN (International Code of Botanical Nomenclature), bryophytes have been divided into three classes.

1. Hepaticae (Hepaticopsida = Liverworts)

2. Anthocerotae (Anthocertopsida= Hornworts)

3. Musci (Bryopsida= Mosses)

Class 1. Hepaticae or Hepaticopsida:

1. Gametophytic plant body is either thalloid or foliose. If foliose, the lateral appendages (leaves) are without mid-rib. Always dorsiventral.

2. Rhizoids without septa.

3. Each cell in the thallus contains many chloroplasts; the chloroplasts are without pyrenoi.

4. Sex organs are embedded in the dorsal surface.

5. Sporophyte may be simple (e.g., Riccia) having only a capsule, or differentiated into root, seta and capsule (e.g., Marchantia, Pallia and Porella etc.)

6. Capsule lacks columella.

7. It has 4 orders:

(i) Calobryales

(ii) Jungermanniales

(iii) Spherocarpales

(iv) Marchantiales.

Class 2. Anthocerotae or Anthocerotopsid:

1. Gametophytic plant body is simple, thalloid; thallus dorsiventra without air cambers, shows no internal differentiation of tissues.

2. Scales are absent in the thallus.

3. Each cell of the thallus possesses a single large chloroplast with a pyrenoid.

4. Sporophyte is cylindrical only partly dependent upon gametophyte for its nourishment. It is differentiated into bulbous foot and cylindrical capsule. Seta is meristematic.

5. Endothecium forms the sterile central column (i.e., columella) in the capsule (i.e. columella is present). 6. It has only one order-Anthocerotales.

Class 3. Musci or Bryopsida:

1. Gametophyte is differentiated into prostrate protonema and an erect gametophores

2. Gametophore is foliose, differentiated into an axis (=stem) and lateral appendages like leaves but without midrib.

3. Rhizoids multi-cellular with oblique septa.

4. Elaters are absent in the capsule of sporangium.

5. The sex organs are produced in separate branches immersed in a group of leaves.

6. It has only three orders:

(i) Bryales,

(ii) Andriales and

(iii) Sphagnales.

Economic importance of Bryophytes:

1. Protection from soil erosion:

Bryophytes, especially mosses, form dense mats over the soil and prevent soil erosion by running water.

2. Soil formation:

Mosses are an important link in plant succession on rocky areas. They take part in binding soil in rock crevices formed by lichens. Growth of Sphagnum ultimately fills ponds and lakes with soil.

3. Water retention:

Sphagnum can retain 18-26 times more water than its weight. Hence, used by gardeners to protect desiccation of the seedling during transportation and used as nursery beds.

4. Peat:

It is a dark spongy fossilized matter of Sphagnum. Peat is dried and cut as cakes for use as fuel. Peat used as good manure. It overcomes soil alkalinity and increases its water retention as well as aeration. On distillation and fermentation yield many chemicals.

5. As food:

Mosses are good source of animal food in rocky and snow-clad areas.

6. Medicinal uses:

Decoction of Polytrichum commune is used to remove kidney and gall bladder stones. Decoction prepared by boiling Sphagnum in water for treatment of eye diseases. Marchantia polymorpha has been used to cure pulmonary tuberculosis.

7. Other uses:

Bryophytes arc used as packing material for fragile goods, glass wares etc. Some bryophytes act as indicator plants. For example, Tortell tortusa grow well on soil rich in lime.

Unit V

Pteridophytes:

Pteridophyta (Gr, Pteron = feather, phyton = plant), the name was originally given to those groups of plants which have well developed pinnate or frond like leaves. Pteridophytes are cryptogams (Gr. kruptos = hidden, and Gamos = wedded) which have well developed vascular tissue.

Therefore, these plants are also known as vascular cryptogams or snakes of plant kingdom. They are represented by about 400 living and fossil genera and some 10,500 species. Palaeobotanical studies reveal that these plants were dominant on the earth during the Devonian period and they were originated about 400 million years ago in the Silurian period of the Palaeozoic era.

General Characters of Pteridophytes:

(i) Majority of the living Pteridophytes are terrestrial and prefer to grow in cool, moist and shady places e.g., ferns. Some members are aquatic (e.g., Marsileci, Azolla), xerophytic (e.g., Selaginella rupestris, Equisetum) or epiphytic (e.g., Lycopodium squarrosum).

(ii) Majority of the Pteridophytes are herbaceous but a few are perennial and tree like (e.g., Angiopteris). Smallest Pteridophyte is Azolla (an aquatic fern) and largest is Cyathea (tree fern).

(iii) Plant body is sporophytic and can be differentiated into root, stem and leaves.

(iv)Roots are adventitious in nature with monopodial or dichotomous branching. Internally usually they are diarch.

(v) Stem is usually branched. Branching is monopodial or dichotomous. Branches do not arise in the axil of the leaves. In many Pteridophytes stem is represented by rhizome.

(vi)Leaves may be small, thin, scaly (microphyllous e.g., Equisetum), simple and sessile (e.g., Selaginella) or large and pinnately compound (megaphyllous e.g., Dryopteris, Adiantum).

(vii) Vascular tissue is present in stem and root. It consists of xylem and phloem. Xylem consists of tracheids only and phloem has only sieve tubes.

(viii) The steel is protostele (e.g., Rhynia, Lycopodium), siphonostele (e.g., Equisetum), dictyostele Adiantum) or polycyclic (e.g., Angiopteris).

(ix) Cambium is absent; hence, they do not show secondary growth.

Reproduction in Pteridophytes:

(i) Reproduction takes place by means of spores which are produced inside sporangia.

(ii) The development of the sporangium may be leptosporangiate (sporangium originates from a single cell) or eusporangiate (sporangium develops from a group of cells).

(iii) Sporangia may be borne either on stem or leaves. On the stem they may be terminal (e.g., Rhynia) or lateral (e.g., Lycopodium). On the leaves (sporophylls) they may be ventral, marginal (Pteris, Adiantum) or dorsal (e.g., Polypodiceae). In Equisetum the sporangia are borne on special structures called sporangiophores which constitute a cone. In Marsilea, Azolla, Salvinia sporangia are produced in sporocarps.

(iv)Spores on germination give rise to multicellular gametophytic bodies called prothalli (sing. prothallus).

(v) In homosporous Pteridophytes prothalli are monoecious (antheridia and archegonia develop on the same prothallus). In heterosporous species prothalli are always dioecious. Microspores on germination give rise to male prothalli and megaspores to the female prothalli.

(vi) Antheridia and archegonia are developed on prothalli.

(vii) Antheridium is surrounded by a single layered sterile jacket.

(viii) Archegonium consists of four vertical rows of neck cells, 1-2 neck canal cells, ventral canal cell and egg.

(ix) Antherozoids are unicellular, biflagellate (e.g., Selaginella) or multiflagellate (e.g., Equisetum and ferns) and motile.

(x) Antherozoids are attracted towards the neck of the archegonium chemotactically by certain substances like malic acid) present in the mucilaginous substance formed by the degeneration of neck canal cells and venter canal cell.

(xi) Water is essential for fertilization (zooidogamous). Therefore, Pteridophytes are also known as amphibians of the plant kingdom.

(xii) Fertilization results in the formation of zygote or oospore, which ultimately develops into well-developed sporophyte.

(xiii) The fertilized egg divides transversely or vertically. Another cross wall forms a quadrant stage producing stem, leaf, foot and root.

(xiv) Plants show heteromorphic alternation of generation. The main plant body is sporophytic and forms a dominant phase in the life cycle.

Affinities of Pteridophytes:

Similarities with Gymnosperms:

(i) Plant body is sporophytic, dominant and can be differentiated into root, stem and leaves in both the groups.

(ii) Gametophytic phase is of short duration.

(iii) Young leaves show circinate vernation.

(iv) Vascular tissue is well developed. Xylem lacks vessels (except in order Gnetales of Gymnosperms) and companion cells are absent in phloem).

(v) Like Gymnosperms many Pteridophytes are heterosporous (e.g., Marsilea, Selaginella).

(vi) Like Pteridophytes many Gymnosperms show ciliate antherozoids (e.g., Cycas, Ginkgo).

(vii) Like Gymnosperms, in some Pteridophytes megaspore is retained within the megasporangium (e.g., Selaginella).

(viii) Regular alternation of sporophytic and gametophytic phase is present.

Differences Between Pteridophytes and Gymnosperms

S. No.	Character	Pteridophytes	Gymnosperms
(i)	**Habitat**	Hygrophytes (*i.e.*, grow in moist and shady places)	Xerophytes (grow where the water supply is scanty)
(ii)	**Root**	Adventitious roots	Tap root
(iii)	**Vascular cambium**	Absent	Present
(iv)	**Archegonium**	Neck canal cells, venter canal cell present	Absent
(v)	**Water**	Essential for fertilization	Not necessary.
(vi)	**Microspores and megaspores**	Develop independently after being shed from their sporangia	Microspores are shed for a short time from microsporangia and the megaspores are permanently retained within megasporangia.
(vii)	**Pollen tube**	Absent	Present
(viii)	**Ovule**	Absent	Present
(ix)	**Seed**	Absent	Present
(x)	**Gametophyte**	Independent of the sporophyte	Dependent on the sporophyte.

Development of Sporangia in Pteridophytes:

On the basis of development, the sporangia in Pteridophytes are divided into two types:

(i) Eusporangiate type

(ii) Leptosporangiate type

(i) Eusporangiate Type:

Sporangium develops from group of superficial cells. These cells divide periclinally into primary wall layers and inner primary sporogenous cells. The outer wall layers form the wall of the sporangium while inner sporogenous cells divide meiotically and form spores.

(ii) Leptosporangiate Type:

This type of sporangium arises from a single superficial cell. It divides transversely to form an outer and an inner cell. While the inner cell forms the stalk, the entire sporangium develops from the outer cell. The outer cell divides by three successive periclinal divisions and in this way a tetrahedral apical cell is formed.

It divides by periclinal division to form the outer jacket cell and inner primary sporogenous cell (Fig. 3D). Jacket cell forms the single layered sporangial wall while primary sporogenous cell divides into tapetal initial and sporogenous tissue. Sporogenous tissue divides meiotically to give rise to haploid spores while tapetal initial forms two layered tapetum.

Differences Between Eusporangiate and Leptosporangiate Type of Sporangium

S. No.	Eusporangiate Type	Leptosporangiate Type
1.	Sporangium is massive	Sporangium is small
2.	Sporangium is formed from many initials	Sporangium is formed from single initial
3.	Sporogenous tissue is derived from the inner daughter cell	Sporogenous tissue is derived from the outer daughter cell.
4.	Wall is several cells thick	Wall is only one cell thick.
5.	Examples : *Lycopodium, Selaginella, Equisetum*	Examples : *Pteris, Polypodium, Marsilea.*

Life Cycle Patterns in Pteridophytes:

Pteridophytes show heteromorphic alternation of generation. The main plant body is sporophytic and forms a dominant phase in the life cycle. Sporophytic plant body develops sporangia in which sporogenous tissue is formed. Sporogenous tissue divides meiotically to form haploid spores.

Majority of the Pteridophytes are homosporous e.g., Lycopodium, Pteris etc. Spores on germination produce monoecious gametophyte. Some Pteridophytes are heterosporous and produce two types of spores: microspores and megaspores.

Microspores on germination produce male gametophyte (prothallus) while megaspores on germination produce female gametophyte (prothallus). So, the prothalli are dioecious.

Antheridia and archegonia develop on the same prothallus (monoecious) or on different prothalli (dioecious). The male and female gametes fuse to form zygote which develops into sporophyte. Thus, the life cycle of a Pteridophyte consists of an alternate succession of sporophytic and gametophytic generations.

Apogamy, Apospory and Parthenogenesis:

Pteridophytes show heteromorphic alternation of generation. However, there are certain other modifications where the essential stages of life cycle are eliminated. These modifications are called apogamy, apospory and parthenogenesis.

Apogamy:

The formation of a sporophyte directly from the vegetative cells of the gametophyte without the act of syngamy or gametic union is called apogamy (Winkler, 1908). The term apogamy was first used by De Bary (1878). It was first reported in Pteris cretica by Farlow (1874).

Later, apogamy has been described in many Pteridophytes e.g., Selaginella (Hieronymus, 1911, 1913), Marsilea (strasburger, 1907) etc. The apogamous embryo may develop from one or more cells of the gametophyte. The sporophytes, produced as a result of apogamy, possess the same number of chromosomes as the gametophyte.

Apospory:

The formation of gametophyte from a sporophytic cell without meiosis is known as apospory. It was first discovered by Druery (1884) as a natural phenomenon in Athyrium filix-femina var. clarissima. Since then it has been reported in many Pteridophytes e.g., Tricohmanes (Bower, 1888), Pteris aquilina (Farlow, 889) Asplenium dimorphum (Goebel, 1905), Osmunda Javanica (Sarbadhikari, 1936), Tectaria trifoliata Steil. 1944) etc.

In apospory, a filamentous or heart shaped gametophyte may be formed from one or more cells of any vegetative portion of a young or mature sporophyte. Due to apospory polyploidy is common in ferns. It has been observed that there is no change in the chromosome number (from the parent plant) when the aposporous gametophytes originate.

Parthenogenesis:

Formation of sporophyte from egg without fertilization is called parthenogenesis. In homosporous leptosporangiate ferns, it was observed that apospory was followed by neither apogamy nor fertilization but by parthenogenesis (Farmer and Digby, 1907). Strasburger (1907) reported parthenogenesis in Marsilea drummondii.

In many species of Selaginella (e.g., S. spinulosa, S. rubricaulis etc.), archegonia failed to open and the egg developed into sporophyte parthenogenetically. Parthenogenesis in S. intermedia and S. langere was first reported by Hieronymus in 1911.

Economic Importance of Pteridophytes:

The Pteridophytes are of little economic value.

Some of the major uses of Pteridophytes are:

(i) As ornamentals:

Many species of Pteridophytes are grown as ornamental plants e.g., Selaginella, (species of Selaginella for e.g., S. willedenovii, S. caesia have metallic tints and therefore used as ornamentals, me other species of Selaginella e.g., S. lepidophylla and S. pilifera are sold as curiosities under the name of resurrection plants.

Plant is a ball like structure under dry conditions and on availability of water, it becomes green and flat on soil Lycopodium, Osmunda, Polypodium, Pteridium, Nephrolepis etc.

(ii) In Soil conservation:

Many species of Pteridophytes are used in soil conservation e.g., Lycopodium, Selaginella etc.

(iii) As medicines:

(a) Extracts of Lycopodium plants are used as kidney stimulant.

(b) Lycopodium clavatum is used in skin diseases.

(c) Equisetum arvense is used as diuretic (promoting urine discharge).

(d) Rhizome and frond bases of Dryopteris filix-mas are used as taenifuge.

(iv)Some other uses:

(a) Several species of Lycopodium e.g., L. obscurum are used in Christmas wreaths and other decorations. It is commonly called as ‘Christmas green’.

(b) Equisetum arvense is biological indicator (for the presence of gold in the soil).

(c) Equisetum deposit large amount of silica in their cell walls. So formerly, it was used in cleaning and polishing the metal pots. Therefore, the plant has been given the name 'scouring rushes'.

(d) Young shoots of Dryopteris filix-mas are used as vegetables.

(e) Starchy paste of sporocarps of Marsilea drummondii is used in making cakes and is called 'nardoo'

(f) Azolla is grown in the rice fields to maintain its fertility because it has the symbiotic association with the cyanobacteria (blue green algae) Nostoc.

****