লাল-সবুজে দাগানো

TEXT BOOK

Botany

UNMESH

Medical & Dental Admission Care

5 Chapter Five
Algae and Fungi

Algae and Fungi are often confused to be the same but they are both quite different from one another. Algae are the green slimy blankets that cover the rock surface or the top of the ponds or a poorly kept aquarium. Fungi on the other hand are a group of simple plants that have no chlorophyll and so are not even green. Lichen is a special creature that forms from the result of a partnership between fungi and algae. In this chapter a discussion has been made about the algae, fungi and lichen.

Key words: Algae, fungi, trichome, *Ulothrix, Agaricus,* fruitbody, parthenogenesis, mycelium, lichen, symbiosis, late blight disease, ringwarm.

Periods 10: After reading this chapter student should be able to (Learning output) -
☐ Describe the characteristics, structure, reproduction and importance of algae.
☐ Describe the habitat, structure and reproduction of *Ulothrix.*
☐ **Practical:** Identify and draw figure of *Ulothrix* after observing a permanent slide.
☐ Describe the characteristics, structure, reproduction and importance of fungi.
☐ Describe the structure with figure of *Aaricus.*
☐ **Practical:** Identify of fruit body of *Agaricus.*
☐ Describe the reasons, symptoms and remedy of fungal disease.
☐ Analyze the symbiotic relationship of algae and fungi.

5.1 Algae

The algae (singular- alga) belong to the subphylum Thalophyta of the kingdom Protista in modern classification of organisms. Latin *alga* means seaweed. These are eukaryotic organisms, autrophic in nature as have chlorophyll in their cells. There are about 30,000 species of algae have been identified. Most algae are aquatic but some grow in semi-aquatic and terrestrial environment. Many algae live as **endophytes** in plant or animal tissue and many grow on plant or animal as **epiphytes.** Aquatic floating small algae are called as **phytoplankton.** Algae grown on stone are called as **lithophytes.** Some of them make a symbiotic relationship with fungi and exist as **lichen.** Green algae, brown algae, red algae, golden-yellow algae are main types of algae. The oceans cover about 71% of the Earth's surface, yet algae produce more than 71% of the Earth's oxygen; in fact, some scientists believe that algae produce 87% of the world's oxygen. The study of algae is known as **Phycology** or **Algology.**

Characteristics of algae

1. Algae can be unicellular, colonial or large multicellular organisms.
2. The multicelluiar algae develop specialized tissues, but they lack the true stems, leaves, or roots of the more complex structure like higher plants.
3. Cells with photosynthetic chlorophyll and other pigments.

4. Algal cell wall composed of cellulose and pectin.

5. With few exceptions most algae are autotroph, they do not have vascular tissues.

6. Most algae store carbohydrate as reserve food, few member contains alcohol, fat or oil as reserve food.

7. They reproduce through vegetative, asexual and sexual methods. Asexual reproduction held by different spores. Sexual reproductions can be isogamous, anisogamous or oogamous type.

8. Gametangia (reproductive organ) always single celled, if multicelled, do not covered with sterile cell layer.

9. Zygote never form embryo when it is in gemetangium.

10. Meiosis cell division seen in different stages of life cycle.

11. Most algae are aquatic but some are semi-aquatic and terrestrial.

Algal diversity

Green algae: (Division-Chlorophyta)

- They are a diverse group of algae that can be found all over the world.
- There are about 7000 species of green algae, which can be found in both fresh or saltwater and also in damp places.
- Almost all of them contain chloroplast, within which the photosynthetic pigments ***chlorophyll 'a'*** and ***'b'*** can be found. These pigments are responsible for imparting a rich green color to these algae.
- Out of all green algae, the members of the order *Charales* are considered as the closest relatives of higher plants.
- Some of them form symbiotic relationships with fungi to form **lichens**.
- e.g., *Spirogyra, Zygnema, Oedogonium, Volvox, Chlamydomonas, Mougeotia* are some other common green algae that are often found on the surface of freshwater ponds and ditches.

Brown algae: (Division-Phaeophyta)

- Brown algae are a large group of algae with about 2000 species, mostly live in the ocean.
- The brown or yellowish-brown color is formed by the **fucoxanthin** pigment, an element only found in this type of algae.
- The giant kelp *Macrocystis* is a brown alga that forms underwater **kelp forests,** and it may grow to 60 meters.
- The **Sargasso Sea** gets its name from the *Sargassum* seaweed that floats on the surface. Many brown algae grow on rocks at the seashore.
- Brown algae have an antioxidants which can help with cancer and protects the body, can help inflammation and strengthen the immune system.
- Two of the most popular edible brown seaweeds are **Arame** and **Kombu** (used liberally in Japanese cuisine).

Red algae: (Division-Rhodophyta)

- This is a large assemblage of 7,000 marine species also called the **marine moss.**
- Red algae are red because of the presence of the pigment ***r-phycoerythrin*** in their cell.

- Red algae have contributed far more to reef structure than other organisms, even more than corals.
- The reef-building red algae are called **coralline algae**, which secrete calcium carbonate and play a major role in building coral reefs.
- Red marine algae have a wide range of medical applications. They are supposed to improve the body's immune system by increasing the count of white blood cells.
- Several species are important food crops, in particular members of the genus *Porphyra*, variously known as ***nori*** (Japan), ***gim*** (Korea), or **laver** (Britain). e.g., *Corallina, Bangia, Stylonema, Polysiphonia* etc.

Golden-yellow algae or Diatoms: (Division- Bacillariophyta)

- Diatoms are a major group of unicellular widespread algal group and can be found in the oceans, in fresh water, in soils, and on damp surfaces and are the most common types of **phytoplankton**.
- More than 200 genera of living diatoms are known, with an estimated 10,000 extant species.
- A unique feature of diatom cells is that they are enclosed within a cell wall made of silica called a **frustule.** Diatoms are **producers** within the food chain.
- Certain diatoms (called **Dinoflagellate**) produce light (phenomenon called **bioluminescence**) that is easily visible during the night.
- Diatoms are often referred as **"jewels of the sea"** or **"living opals"** thanks to their photonic crystal properties. e.g., *Fragilaria Tabellaria, Asterionella, Navicula* etc.

Structure of algae

Vegetative structure

There is a vast variation in the vegetative structures (thallus) of algae. They may be simple unicellular to complex multicellular. Their size ranges from small as less than 2 micrometer (e.g., *Micromonas*) to large as 30-60 meter long (e.g *Macocystis pyrifera*, a type of marine algae). The followings are the diverse vegetative structures of algae:

1. **Unicellular motile:** Body consists of single cell. In these algae movement takes place by flagella e.g., *Chlamydomonas.*
2. **Unicellular non-motile:** Body single celled round shape. They exist as solitary or in group within mucilage covering. e.g., *Chlorella, Gloeocapsa.*
3. **Motile colonial:** In this case, definite numbers of unicellular algae are found and these are motile. This type of colony is known as motile colony. e.g. *Volvox.*
4. **Non-motile colonial:** Number of unicellular algae in these colonies are indefinite and they are non motile e.g., *Scenedesmus, Hydrodictyon.*
5. **Palmelloid type:** Algal cells in this case are surrounded by a viscous mucilaginous substance e.g. *Tetraspora, Aphanothce.*
6. **Dendroid:** Cells of these forms produce mucilaginous substance and are folded in such a manner that they look like branches of a plant, e.g., *Prasino cladus.*
7. **Filamentous:** These are of (i) Simple unbranched filaments, e.g. *Ulothrix, Spirogyra* and (ii) Simple branched filaments, e.g., *Cladophora.*

8. Heterotrichous: Thallus consists of two parts, i.e. horizontally running main shoot or trichome and a vertical erect trichome or shoot e.g., *Coleochaete.*

9. Parenchymatous: In these algae, cell division takes place on different sides with the result that they become parenchymatous, e.g., *Ulva.*

10. Siphonous: These algae consist of multinucleate tube like cells having no septa, e.g., *Vaucheria, Polysiphonia.*

12. Nodous: Algae with nodal and internodal areas. e.g., *Chara.*

13. Complex: Algae as like as multicellular plants. Body divisible into holdfast, stipe and frod. e.g., *Sargassum, Laminaria.*

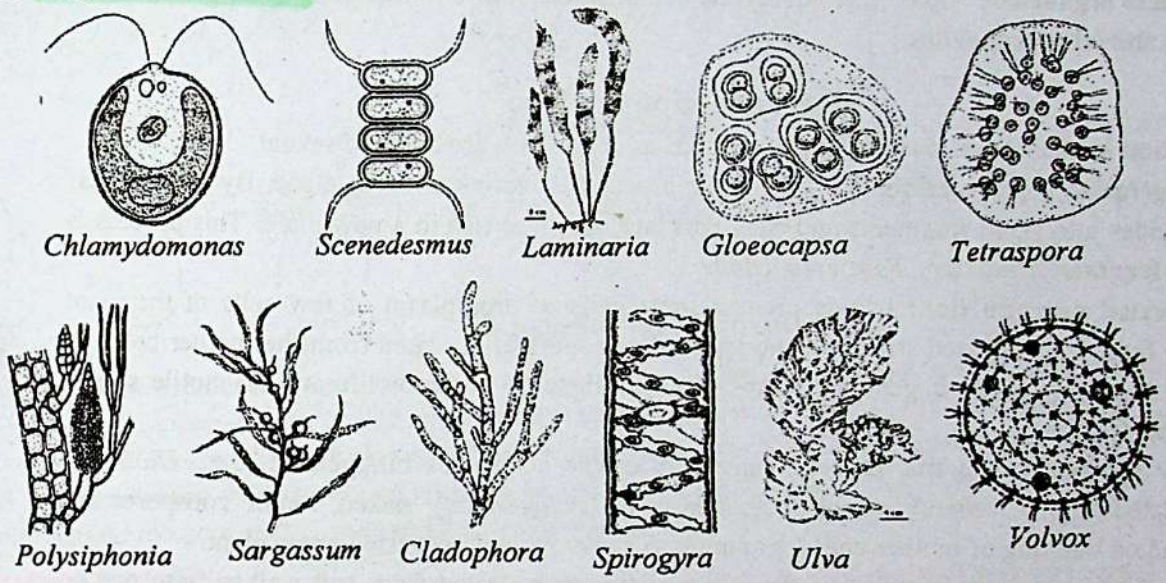

Fig 5.1 Different vegetative structure of algae

Cellular structure

1. Cell wall: Most of the algal cells have cell wall. Some flagellated algae lacking cell wall. Algal cell wall consists of two layers: inner microfilamentous strong layer and outer gelatinous irregular layer. Chemically cell wall composed of cellulose, pectin, mucilage like carbohydrate. In some case cell wall bear stored protein. Unicellular diatom algae have strong, rigid, siliceous ornamented two valved cell wall. **The siliceous ornamented cell wall of complete diatom is called frustule.**

2. Plasma membrane: It occurs below the cell wall. Structure of algal plasma membrane as like as of other eukaryotic cells. Some filamentous algae lacking of cell wall have stout and strong plasma membrane. This type of plasma membrane is known as **periplast.**

3. Nucleus: Most of algal cells are uninuleated but in some cases they are multinucleated.

4. Plastids: Algal cells have colourful plastids, the chloroplasts. Their number and shape varies in different species. In most cases chloroplasts have glycoprotein structure **pyrenoid.** Chloroplasts of all kinds of algae have photosynthetic chlorophyll pigments.

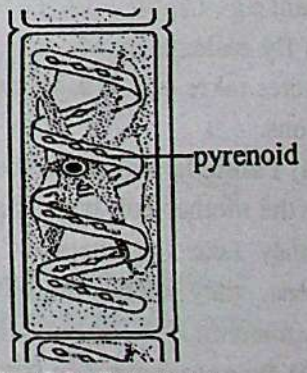

Fig 5.2: *Spirogyra*

Besides chlorophyll, they also show various carotenoid pigments which impart different colours to algae as blue **phycocyanin**, yellow-brown **fucoxanthin,** brown **phaeophycin,** red **phycoerythrin** etc.

5. Reserve food: The staple reserve food of algal cell is carbohydrate. Different algae have different types of reserve carbohydrates. Green algae (Chlorophyceae) have **starch,** brown algae (Phaeophyceae) have **laminarin** and **mannitol,** yellow-golden (Chrysophytes) algae have **volutin,** red algae (Rhodophyceae) have **floridian starch** as reserve food. Besides these algae have oil and fat, leucocin, paramylum as reserve food.

6. Others organelles: Like other eukaryotic cell algal cells have mitochondria, Golgi apparetus, ribosomes and other organelles.

Reproduction in algae

Reproduction in algae takes place by three methods as vegetative, asexual and sexual.

1. Vegetative reproduction: It is a simple process of reproduction in algae. By this process thallus divides into small fragments and each part later on gives rise to a new plant. This process is termed as **fragmentation**. e.g., *Spirogyra, Ulothrix.*

2. Asexual reproduction: In this process some cells or protoplasm of few cells of the plant divides to form a small sized structure, the **spore**. Each spore is liberated from the mother cell and gives rise to a new plant. It generally takes place in algae by some motile and no-motile spores described as follows:

(i) By zoospores: In this process, under favourable conditions biflagelated (e.g., *Ulothrix*), tetraflagelated (e.g., *Ulothrix*) or multiflagelated (e.g., *Oedogonium*) naked, motile zoospores are formed and on bursting of mother cells (sporangium) come out and give rise to new plant.

(ii) By aplanospores: In this case the protoplasm gets separated from cell wall to form one or more thin-walled, nonciliated aplanospores and each aplanospore gives rise to a new plant, e.g., *Chlorella.*

(iii) By hypnospores: In this process under unfavourable conditions the protoplasm of the cell separates from the cell wall and collects in the centre. These are non-motile and thick-walled. They give birth to new plant on the commencement of favourable conditions, e.g., *Vaucheria.*

(iv) By akinetes: In this process, entire cell becomes thick. Akinetes are formed under unfavourable conditions and on commencement of favourable conditions each akinete develop into a new plant e.g., *Cladophora, Gloeotrichia.*

(v) By endospores: In most of the members of Myxophyceae, development of large number of endospores takes place inside the mother cell. Endospores give rise to a new plant under favourable conditions.

(vi) Palmella stage: On the approach of dry conditions, zoospores or aplanospores do not come outside the mother cell but get surrounded by mucilaginous sheath. The division continues with the result they take the shape of a colony. This is known as **palmella stage**. Under favourable conditions, they come out. Each zoospore or aplanospore gives rise to a new plant, e.g., *Chlamydomonas.*

(vii) By autospores: In some algae, the resting spores develop into new plants inside the mother cell, e.g., *Chlorococcus.*

(viii) By cysts: In some algae under unfavourable conditions and abundant food supply, the thallus divides into multinucleate and thick walled smaller segments, which are termed as **cysts.** In favourable conditions cysts give rise to new plants, e.g., *Vaucheria*.

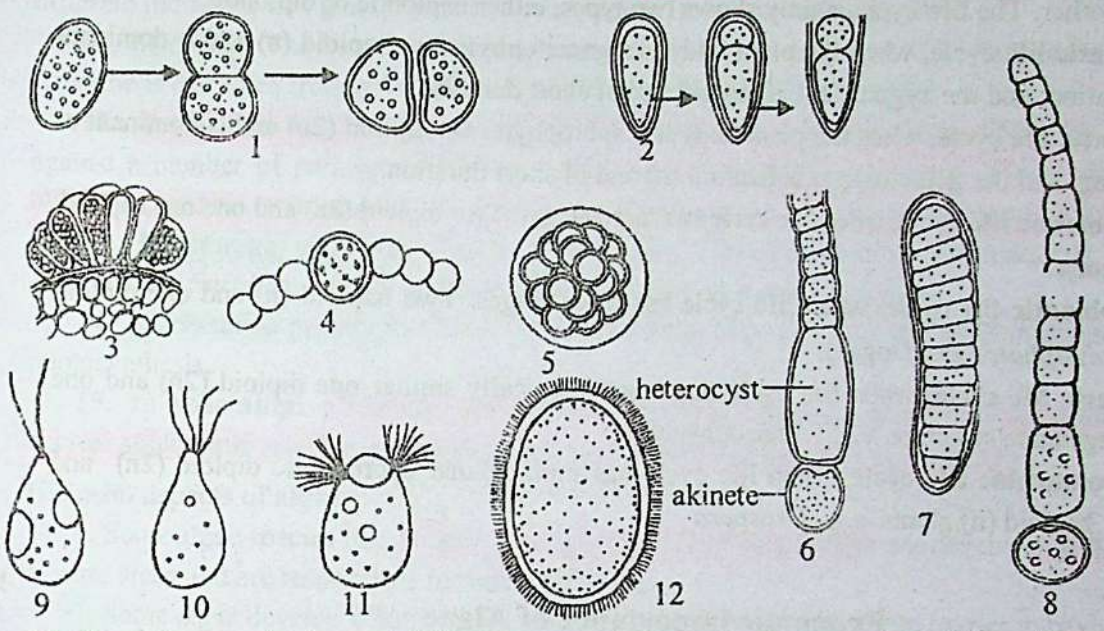

Fig 5.3 Vegetative reproduction and different spores of algae: 1. Fragmentation of *Synechococcus*, 2. Endospore of *Chaemaesiphon*; 3. Endospore of *Dermocarpa*; 4. Akinete of *Nostoc*; 5. Aplanospore of *Microspora*; 6. *Gloeotrichia* with akinete and heterocyst; 7. Hormospore of *Westiella*; 8. Fragmentation of *Cylindrospermum*; 9 Biflagelate zoospore of *Ulothrix*; 10. Tetraflagelate zoospore of *Ulothrix*; 11. Multiflagelate zoospore of *Oedogonium*; 12. Multiflagelate zoospore of *Vaucheria*.

3. Sexual reproduction: Sexual reproduction takes place by fusion of gametes. These gametes develop in gametangia. These are following types:

(i) Isogamous: In some algae the gametes are similar in their external morphology and size. In this case (+) and (-) strain gametes fuse together to form **zygospore.** Isogametes may be motile (zoogametes) e.g., *Chalmydomonas* and *Ulothrix* or nonmotile (aplanogametes) e.g., *Spirogyra*.

(ii) Anisogamous: In some algae the gametes are similar in their external morphology but they differ in behaviour and size. The larger gamete is passive and it is known as **macrogamete**. The smaller gamete is active and is known as **microgamete**. The fusion of these two gives zygote which later on undergoes reduction divisions to form new plants, e.g., *Chlamydomonas*.

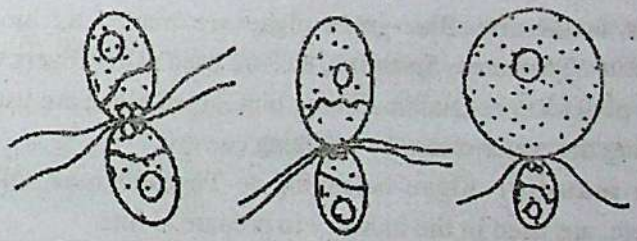

Fig 5.4 Different sexual reproduction of algae

(iii) Oogamous : In this type of sexual reproduction, fusion of small, biflagellate or multiflagellate and active male gamete with large non-flagellate and passive female gamete takes place and **oospore** is formed, e.g., *Oedogonium* and *Chlamydomonas*.

Life cycles of algae

Algae show both a gametophytic (haploid) stage and a sporophytic (diploid) stages, which alternate each other. The life-cycle mainly shows two types, either haplontic or diplontic.

(a) Haplontic life cycle, when the plant body is a gametophyte *i.e.*, haploid (n) and is dominant or of long duration, and the zygote (2n) is diploid and of short duration.

(b) Diplontic life cycle, when the plant body is a sporophyte, *i.e.* diploid (2n) and is dominant or of long duration, and the gametophyte is haploid (n) and of short duration.

(c) Haplobiontic life cycle, when life cycle has three stages. Two diploid (2n) and one one haploid. e.g., *Coleochaete*.

(d) Diplobiontic life cycle, when life cycle has three stages. Two haploid (n) and one diploid (2n). e.g., *Polysiphonia* (Red algae).

(e) Isomeric life cycle, when life cycle has morphologically similar one diploid (2n) and one haploid (n) vegetative structure. e.g., Phaeophyceae

(f) Heteromorphic life cycle, when life cycle has multicellular sporophytic diploid (2n) and gametophytic haploid (n) plants. e.g., *Urospora*

Economic importance of Algae

Since from olden day's algae species are intimately connected with human beings as a source of food, medicine and other uses. Algae are taking an active role in human beings.

Beneficiary aspects of algae

1. As producers: Algae are the main oxygen producers in aquatic areas. They are also useful in decreasing water pollution by realizing oxygen. Ten percent of photosynthesis is occurred by the algae in total photosynthesis quantity.

2. As food: *Laminaria* species is the important edible seaweed in Japan and the food item 'Kombu' is prepared from it. Several species of red algae are important food crops, in particular members of the genus *Porphyra*, variously known as ***nori*** (Japan), ***gim*** (Korea), or **laver** (Britain).

3. As fodder for cattle: *Laminaria saccharina, Pelvitia, Ascophyllum,* etc. species are used as food for cattle.

4. As fertilizers: Blue-green algae are treated as bio-fertilizers from olden days. *Nostoc, Oscillatoria, Scytonema, Spirulina,* etc. are used as fertilizers to rice fields.

5. In pisiculture: Diatoms, some blue-green algae are used as food material to fishes. These are also making the water clean, by realizing oxygen.

7. In industry: Algae belonging to Phaeophyceae, like *Laminaria, Phyllophora, Ecklonia, Eisenia,* etc. are used in the industry to prepare iodine.

8. Alginates: Alginates are used in the preparation of flame-proof fibrics, plastics, paints, gauze material in surgical dressing, soups, ice creams etc. Alginates are extracted from *Fucus, Laminaria, Macrocystis* and *Ecklonia.*

9. Agar-Agar: Agar-agar is used as a **culture medium** for growing callus in tissue culture and for bacteria and fungi in the labs. It is a gelatinous substance obtained from certain red algae like *Gelidium, Graciliaria,* and *Gigartina.*

10. Diatomite: Diatoms deposits at marine and fresh water areas. They are rich with silica. It is called as **diatomite**. It is used in the preparation of dynamite in olden days. But now it is used in different industries like glass, metal polishing, paints, tooth paste, soaps, etc.

11. Minerals: The brown sea weeds popularly called as kelps yield potash, soda, and iodine. Bromine is extracted from red algae such as *Polysiphonia* and *Rhodymenia.*

12. Antibiotics and medicines: Antibiotic **chlorellin,** obtained from *Chlorella* is effective against a number of pathogenic bacteria. Red algae are used in treatment of cold sores, urinary infections, asthma, stomach disorders and to boost immune system and lower blood cholesterol level.

13. In sewage disposal: Some species like *Chlamydomonas, Scenedesmus, Chlorella, Pondorhina, Euridina,* etc. are useful to clean the water by realizing oxygen.

14. As research material: *Chlorella, Scenedesmus* and *Anacystis* are used in investigations in photosynthesis.

15. In spaceship: *Chlorella* and *Synechococcus* are finding application in spaceships and nuclear submarines as oxygen regenerating and food and water recycling organisms.

Harmful aspects of algae

1. Some algae species like *Anabaena, Nostoc, Rivularia, Oscillatoria* are develop **water blooms** in aquatic areas and are responsible for water pollution.
2. Some algae develop colony on the wall of buildings and some create barrier to navigation.
3. Some algae secrete toxic materials into water. That they polluted the water.
4. The algae, *Cephaleuros virescence* causes for red rust tea in tea plant.
5. Some algae species are caused for some skin diseases.
6. Dianoflagellate is caused for the death of fishes in water.
7. Some algae such as *Anabaena, Gloeotrichia, Microcystis* caused for the death of cattle.
8. *Oedogonium* creates disease in the gills of fishes.

5.2 Genus- *Ulothrix*

Systematic Position

Kingdom	: Protoctista
Division	: Chlorophyta
Class	: Chlorophyceae
Order	: Ulotrichales
Family	: Ulotrichaceae
Genus	: *Ulothrix*

Habit and Habitat

Ulothrix is a genus of filamentous green algae, generally found attached to the substratum in cold, slow moving streams or in water which is constantly renewed. Occasionally it is also found floating on the surface of water as a pale-green mass. Its cells are normally as broad as they are long, and they thrive in the low temperatures of spring and winter.

Structure

Body of *Ulothrix* has unbranched filaments of indefinite length. It is divisible into apical and basal parts. Filaments contain short cylindrical cells joined end to end. The filament remains attached to substratum by modified elongated basal cell called **holdfast**. Cells are rectangular or somewhat square in shape. Upper cell or tip cell is sub spherical in outline. Each cell except holdfast cell has got an outer wall composed of cellulose plus pectic substances. The cytoplasm forms a parietal layer enclosing a large central vacuole. Each cell has a single nucleus and a single girdle-like chloroplast both lying in the parietal layer of the cytoplasm. Each chloroplast has two to many **pyrenoids**.

Holdfast possesses no chloroplast. According to species, the chloroplast extends the entire length of the cell or only part of the length. Filament is autotrophic in nutrition and grows in length.

Reproduction of *Ulothrix*

Reproduction of *Ulothrix* takes place by vegetative, asexual and sexual method.

1. Vegetative reproduction: It takes place by chance but not by regular method of multiplication. In this case the filament of *Ulothrix* breaks up into two or more parts and each part is capable of converting itself into a new filament.

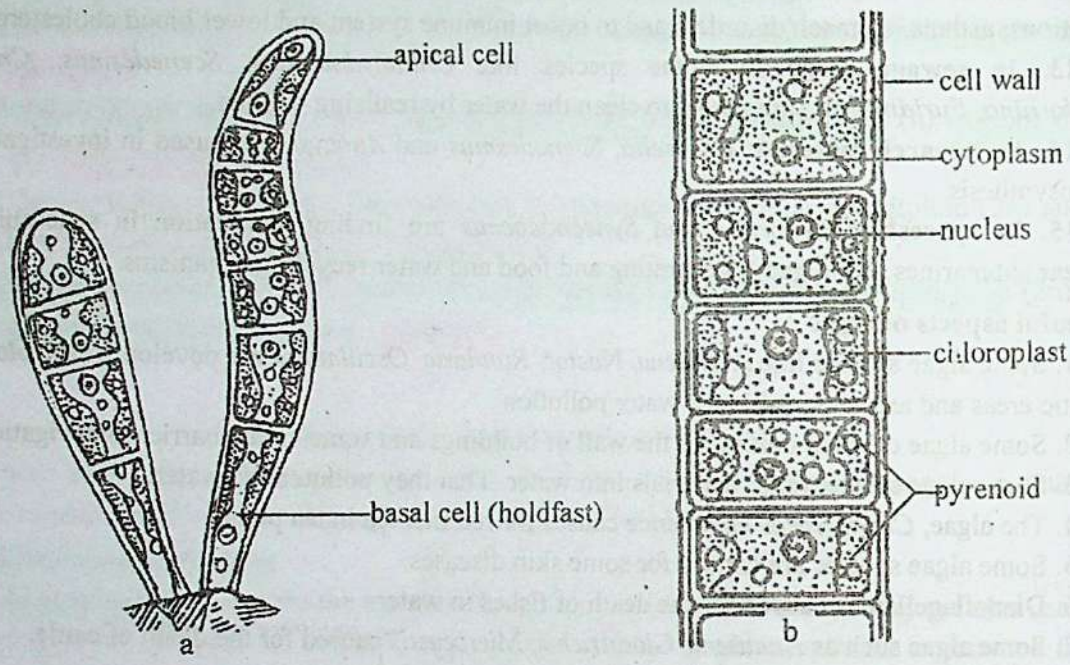

Fig 5.5 (a) Vegetative structure, (b) Cellular structure of *Ulothrix*

2. Asexual reproduction: *Ulothrix* reproduce asexually by formation of (i) Zoospore, (ii) Aplanospore, (iii) Akinetes and (iv) Palmella stage.

(i) By zoospores formation: The cell of filament under favourable conditions produces the zoospores. The zoospores are produced by ordinary cells of the filament whose contents divide into 2, 4, 8 and 16 parts. Zoospores are-

(a) Macrozoospores which are slightly flattened and have four flagella and

(b) Microzoospores which are ovoid and have four or two flagella.

Each zoospore is uni nucleate and has a chloroplast in broader part of spore and the apical part consists protoplasm and flagella. After liberation the spores swim for sometime and come to rest, attach themselves and grow out directly into new filament.

(ii) By aplanospores formation: Occasionally the development zoospores stop just before development of cilia. In such cases non motile thin walled aplanospores are produced instead of motile zoospores. These aplanospores may germinate inside the parent cell or may be liberated outside. They then develop into new filament.

(iii) By akinetes formation: Sometimes in unfavourable conditions cell of the filament forms a single rounded thick walled structure called akinete. Akinetes are double walled with exospore and

endospore. On return of favourable conditions the exospore and endospore ruptures and it develops into new filament.

(iv) **By Palmella stage formation:** Sometimes the contents of cell divide and their walls become mucilaginous. These cell either directly form new filaments or they give rise to zoospores which form new filaments.

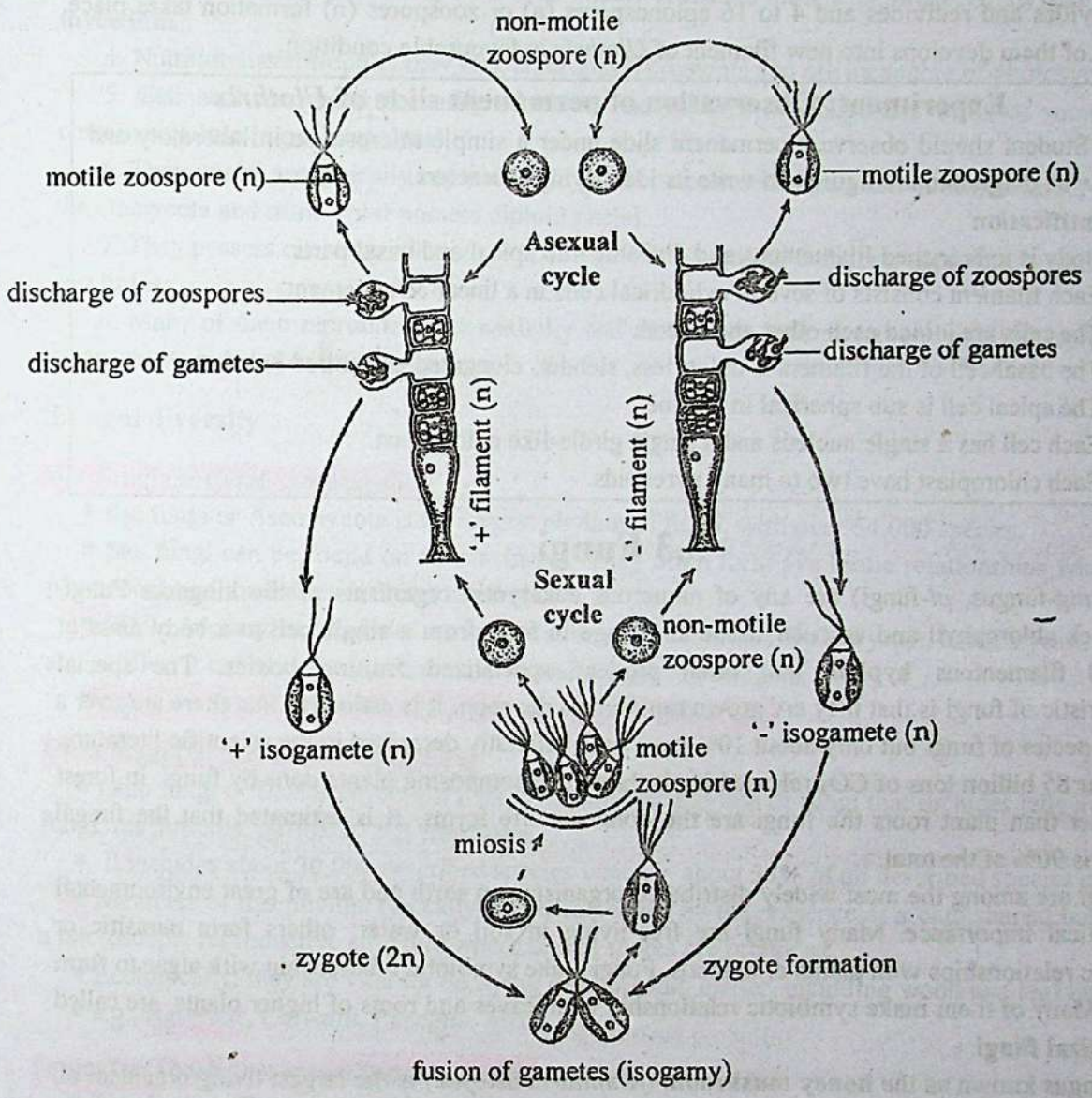

Fig 5.6 Life cycle of *Ulothrix*

3. **Sexual reproduction:** *Ulothrix* reproduce sexually by isogamy method. *Ulothrix* are heterothelic, because gametes produced only in different filaments (+ and -) are fuse. Each parental cell of *Ulothrix* except holdfast can produce gametes. The gamete producing cells of the filament are called **gametengia**. Each gametengium can produce 8, 16, 32, or 64 gametes by divisions on the same manner as zoospores are produced. Gametes of *Ulothrix* are called isogametes. Isogametes are

ovoid and biflagellate. Each has chloroplast and a single pyrenoid. Isogametes come out of parent cell in membranous vesicle. Very soon the vesicle disappears and gametes move freely in the water.

Gametes fuse in pairs and quadricflagellate zygospores or zygotes (2n) are developed. The cilia of zygotes are withdrawn, it becomes round and a thick wall is secreted around it. Zygote after a definite resting period increases in size and its nucleus divides by reduction division. Protoplast of zygote divides and redivides and 4 to 16 aplonospores (n) or zoospores (n) formation takes place. Each one of them develops into new filament of *Ulothrix* in favourable condition.

Experiment: Observation of permanent slide of *Ulothrix*

Student should observe a permanent slide under a simple microscope in laboratory and draw its diagrammatic figure and write its identifying characters.

Identification

1. Body is unbranched filamentous and divisible into apical and basal parts.
2. Each filament consists of several cylindrical cells in a linear arrangement.
3. The cells are joined each other end to end.
4. The basal cell of the filament is colourless, slender, elongated and called holdfast.
5. The apical cell is sub spherical in outline.
6. Each cell has a single nucleus and a single girdle-like chloroplast.
7. Each chloroplast have two to many pyrenoids.

5.3 Fungi

Fungi (*sing*-fungus, *pl*-fungi) are any of numerous eukaryotic organisms of the kingdom Fungi, which lack chlorophyll and vascular tissue and range in form from a single cell to a body mass of branched filamentous **hyphae** that often produce specialized fruiting bodies. The special characteristic of fungi is that they are grown rapidly and die soon. It is estimated that there are over a million species of fungi but only about 10% have been officially described in the scientific literature. Each year 85 billion tons of CO_2 released in air through decomposing plants done by fungi. In forest soils other than plant roots the fungi are the dominant life forms. It is estimated that the fungal biomass is 90% of the total.

Fungi are among the most widely distributed organisms on earth and are of great environmental and medical importance. Many fungi are free-living in soil or water; others form parasitic or symbiotic relationships with plants or animals. Fungi make symbiotic relationship with algae to form **lichen.** Many of them make symbiotic relationship with leaves and roots of higher plants, are called **mycorrhizal fungi.**

A fungus known as the **honey mushroom** (*Armillaria ostoyae*) is the largest living organism on the planet. It is believed to be about 2400 years old and covers over 2000 acres. Interestingly enough, it kills trees as it spreads.

Some fungi are bioluminescent (*Armillaria mellea*) and can even glow in the dark. Some fungi are toxic. Some are so toxic that they can cause instant death in animals and humans. Deadly fungi often contain a substance known as **amatoxins.**

The study of fungi in a discipline of botany is called **mycology.** Scientists who specialize in the study of fungi are called **mycologists.** The fungi include the yeasts, rusts, smuts, mildews, molds, mushrooms, and toadstools.

Characteristics of fungi

1. Fungi are saprophytic, parasitic or symbiotic organisms that get their nutrition through absorption.
2. They are unicellular (yeast) or multicellular eukaryotic organisms.
3. Multicellular body mostly filamentous composed of individual microscopic filaments called **hyphae**, which exhibit apical growth and which branched into a network of hyphae called a **mycelium.**
4. Nutrition heterotrophic, they lack chlorophyll pigments and are incapable of photosynthesis.
5. Cell wall composed primarily of **chitin** and **glucans**, although the walls of some species contain cellulose (*e.g.* Oomycetes).
6. Their nuclei are typically haploid and hyphal compartments are often multinucleated, although the Oomycota and some yeast possess diploid nuclei.
7. They possess characteristic range of storage compounds as trehalose, glycogen, sugar alcohols and lipids.
8. Many of them reproduce both sexually and asexually. Both sexual and asexual reproduction often results in the production of spores.

Fungal diversity

Sac fungi (Division-Ascomycota)

- Sac fungi or Ascomycota is the largest phylum of fungi, with over 64,000 species.
- Sac fungi can be found on all continents. They often form symbiotic relationships with algae, plant roots, and the leaves or stems of plants.
- While Ascomycota includes many useful organisms such as fission yeast, baker's yeast, morels, and truffles, it can also account for most animal and plant pathogens.
- e.g., *Candida, Penicillium, Saccharomyces, Aspergillus* etc.

Club fungi (Division-Basidiomycota)

- Club fungi or Basidiomycota is a large and diverse phylum of fungi that includes jelly and shelf fungi, mushrooms, puffballs, and stinkhorns.
- It includes about 30,000 described species which is about 37% of all described species of fungi.
- Members of this phylum typically are characterized by the presence of a club shaped **basidium,** a microscopic reproductive structure where sexual spores are produced.
- Ecologically, they are vital for decaying dead organic matter, including wood and leaf litter.
- e.g., *Agaricus*, *Calvatia*, *Puccinia, Mixia* etc.

Imperfect fungi (Division-Deuteromycota)

- The division Deuteromycota is also called the **fungi imperfecti** or **imperfect fungi** referring to our "imperfect" knowledge of their complete life cycles.
- Asexual reproduction is by means of **conidia**, sexual life cycle that is either unknown or absent.
- There are about 25,000 species that have been classified in the deuteromycota.
- Some fungi of this group producing the antibiotic penicillin and some cause athlete's foot and yeast infections.
- e.g., *Penicillium*, *Dermea, Lecanicillium*, *Pochonia* etc.

Zygote fungi (Division Zygomycota)

- Zygote fungi or Zygomycota is a division of fungi with approximately 1050 known species.
- They are mostly terrestrial in habitat, living in soil or on decaying plant or animal material.
- The identifying characteristic of the Zygomycota is the formation of a zygospore during sexual reproduction.
- The most familiar fungus of this group is the **mold** that invade fruits, breads and other food products
- Many species of zygomycetes can be used in important industrial processes.
- e.g., *Rhizopus, Mucor, Mortierella, Blakeslea* etc.

Egg fungi (Division Oomycota)

- Egg fungi or Oomycota are also often referred to as **water molds** comprises more than 500 species.
- "Oomycota" means "egg fungi", refers to the large round **oogonia,** structures containing the female gametes, that are characteristic of the oomycetes.
- Many oomycetes species are economically important, aggressive plant pathogens, some species can cause disease in fish,
- e.g., *Saprolegnia, Apodachlya, Albugo, Lagenidium* etc.

Structure of fungi

1. Vegetative structure: The vegetative structure or thallus of fungi may be unicellular or multicellular filamentous. Generally unicellular fungi are called yeasts. Multicellular fungi are composed of individual microscopic filaments called **hyphae** (sing-hypha), which exhibit apical growth and which branched into a network of hyphae called a **mycelium.** The hyphae of parasitic fungi modified as special food absorbing organ called **haustorium** within the host body.

The hyphae may be hyaline (colourless), coloured, simple or branched, septate or aseptate. The protoplasm of the hypha may be continuous without cross walls and is called **aseptate hypha** or with transverse partitions or septa and is known as **septate hypha.** An aseptate hypha is nothing but a multinucleate tube like structure, called **coenocytes,** e.g. *Agaricus*. In septate hypha, septa have a central pore and septa are thus perforated or porous. Sometimes pore may be absent in the septa or more than one pores may be present. Sometimes the mycelium takes different forms in different species which may be of prosenchyma, pseduparenchyma, sclerotium, stroma, rhizomorph etc.

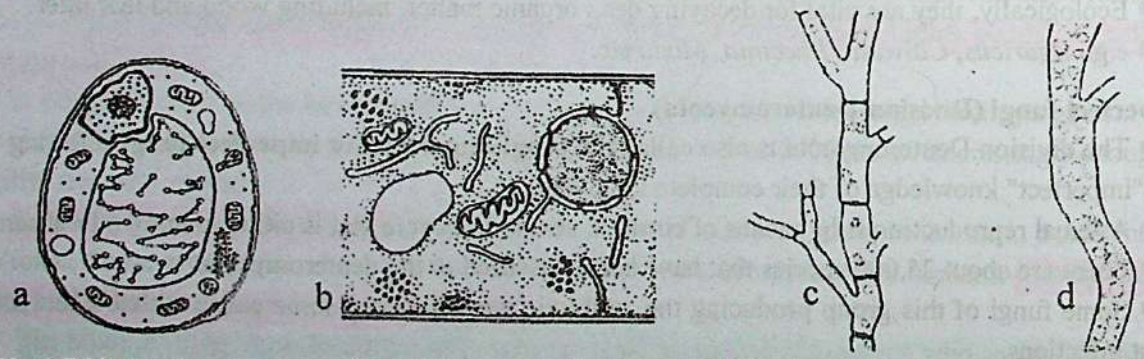

Fig 5.7 Vegetative structure of fungi (a) unicellular (yeast), (b) hyphae, (c) septate mycelium, (d) coenocytic mycelium.

2. Cellular structure: Fungi have a filamentous cell structure that is essentially undifferentiated and is a type of eukaryotic cell. Fungal cells are organized in a little different from animal and plant cells. They have chitin cell walls rather than cellulose (Oomycetes have cellulose, a glucose polymer, instead) and have no chloroplasts.

The fungal cell wall is a dynamic structure that protects the cell from changes in osmotic pressure and other environmental stresses. The cell wall in mycelial fungi varies in thickness from 50 nm (1nm=1 billionths of a meter) to 250 nanometers (nm). The cell wall has four main biochemical constituents: (i) chitin, (ii) glucan, (iii) protein and (iv) melanin. Beneath the cell wall there is plasma membrane which encircles the protoplast. In some cases there are small vesicular or tubular structure in between cell wall and plasma membrane. These structures are known as **lomasomes.**

The protoplasm of fungal cell may be granular or reticular. It contains all organelles and vacuoles as found in other eukaryotic cell. Most of the fungal cells contain glycogen as reserve food. But they also contain storage product of alcohol, mannitol, protein and oil dots.

Reproduction of fungi

Features of fungal reproduction

- Most fungi reproduce asexually and sexually, some vegetatively.
- Fungi reproduce asexually when environmental conditions are favourable.
- Fungi reproduce sexually when environmental conditions are unfavourable.
- No male or female fungi, but two mating types-plus (+) and minus (-).
- Fruiting bodies are modified hyphae that make asexual spores.
- Spores are haploid cells with dehydrated cytoplasm and a protective coat capable of developing into new individuals.
- Wind, animals, water, and insects spread fungal spores.

Method of fungal reproduction

Fungi exhibit three major modes of reproduction: **(i) vegetative, (ii) asexual** and **(iii) sexual**. In vegetative and asexual reproduction there is no gamete formation but it happens in sexual reproduction. When whole thallus of a fungus becomes converted into a reproductive cell (gamete) is called **holocarpic fungi** but when fungal thallus differentiates into distinct vegetative and reproductive portions is called **eucarpic fungi**.

1. Vegetative reproduction: It is the type of reproduction which involves the somatic portion of the fungal thallus. It occurs by the following methods.

(i) Fragmentation: In this process, the mycelium breaks into two or more similar fragments either accidentally or due to some external force. Each fragment grows into a new mycelium.

(ii) Binary fission: In this process, the parent cell splits into two equal halves, each of which develops into a new individual. Fission is also common in yeast.

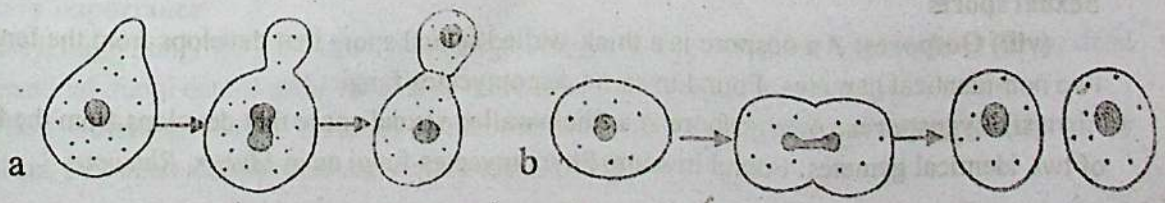

Fig 5.8 Vegetative reproduction of fungi (a) Budding, (b) Binary fission

(iii) Budding: The parent cell produces one or more projections called buds, which later develop necessary structures and detach to grow into new individuals. Budding is common in unicellular forms like yeast.

2. Asexual reproduction: It is the type of reproduction in which special reproductive structures called spores or propagates are formed. The fungal spores always result from mitosis and hence are described as **mitospores.** Following are the types of spores produced in different groups of fungi:

Asexual spores

(i) Zoospores: They are naked, 1-2 flagellated, motile spores produced inside structures called **zoosporangia**. These spores do not have a cell wall. Such spores are produced in lower fungi such as *Achyla* and *Saprolegnia*.

(ii) Aplanospores: These are non-motile spores produced inside structures called sporangia in fungi such as *Rhizopus* and *Mucor*. These spores are dispersed by wind.

(iii) Chlamydospores: These are thick walled resting spores which arise directly from hyphal cells. They store reserve food. e.g., *Mucor, Fusarium.*

(iv) Oidia: These are spore like structures formed by the breaking up of hypha cells. They do not store reserve food and hence cannot survive under unfavourable conditions. Such spores are produced in *Rhizopus, Coprinus.*

(v) Conidia: These are non-motile spores produced singly or in chains at the tip of the hypha branches that are called conidiophores. Such spores are produced in fungi like *Aspergillus* and *Penicillium.*

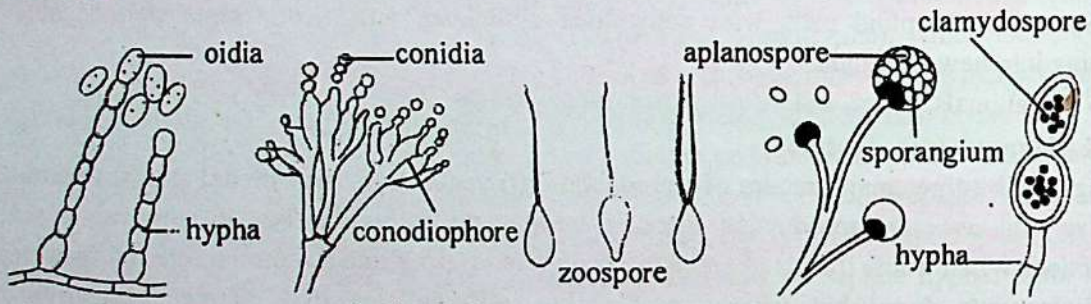

Fig 5.9 Different asexual spore of fungi

Asexual spores but related to sexual reproduction cycle

(vi) Ascopores: An ascospore is a spore contained in an ascus or that was produced inside an ascus. Typically, a single ascus will contain eight ascospores. This kind of spore is specific to fungi classified as ascomycetes. e.g. *Saccharomyces.*

(vii) Basidiospores: A basidiospore is a reproductive spore produced by Basidiomycete fungi. They are produced by specialized fungal cells called basidia. e.g-*Agaricus, Puccinia.*

Sexual spores

(viii) Oospores: An oospore is a thick-walled sexual spore that develops from the fertilization of two non-identical gametes. Found in some Ascomycetes fungi.

(xi) Zygospores: A zygospore is a thick-walled sexual spore that develops from the fertilization of two identical gametes. Found in some Phycomycetes fungi as in *Mucor, Rhizopus.*

3. Sexual reproduction: Sexual reproduction is known to occur in all groups of fungi except the fungi imperfecti or dueteromycetes. It may involve fusion of gametes, gametangia or hyphae. The process may involve only fusion of cytoplasm or fusion of nuclei or production of meiotic spores.

Sexual fusions in fungi are of different types, as follows:

(i) Planogametic copulation: Here motile gametes called planogametes undergo fusion.

When both the gametes are motile and morphologically similar, the fusion process is called isogamy, *e.g., Synchytrium.*

When both the gametes are motile but differ in their size, the fusion process is called anisogamy, *e.g., Allomyces.*

When one gamete (male) is smaller and motile and the other (female) gamete is larger and non motile, the fusion process is called heterogamy.

(ii) Gametangial contact: Here, gamete bearing structures called gametangia come closer to each other and develop a fertilization tube through which the male gamete migrates into the female gametangium. e.g. *Phytophthora, Albugo.*

(iii) Gametangial copulation: Here, the gametangia fuse with each other, lose their identity and develop into a zygospore. e.g. *Mucor, Rhizopus.*

(iv) Spermatisation: In some fungi e.g. *Puccinia,* tiny unicellular spore like structures called spermatia are formed. They get transferred to female gametangia through various agencies.

(v) Somatogamy: In examples like *Agaricus,* fusion occurs between two somatic cells and involves only plasmogamy. This results in the formation of dikaryotic hyphae. Hence, the process is called **dikaryotization.**

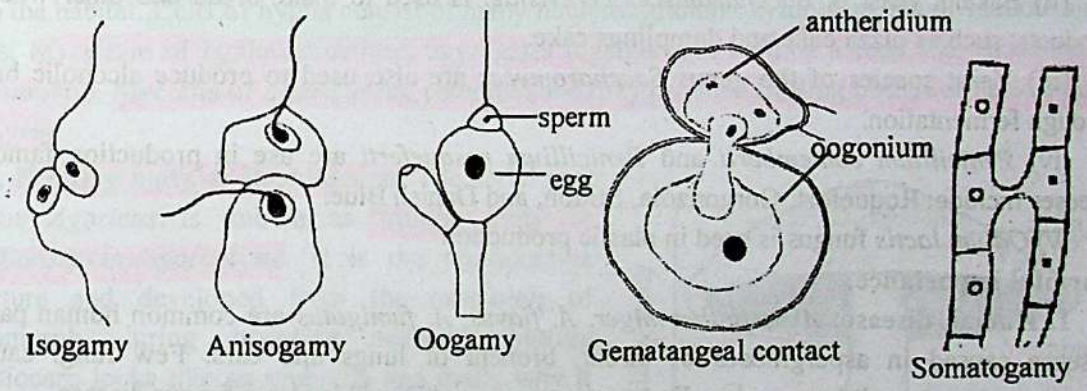

Fig 5.10 Different types of sexual reproduction of fungi

Importance of Fungi

The Kingdom Fungi includes some of the most important organisms, both in terms of their ecological and economic roles. They are important in an enormous variety of ways:

Beneficiary importance

1. Recycling: Fungi play a major role in recycling organic material. By breaking down dead organic material, fungi continue the recycle of nutrients through ecosystems.

2. Plant nutrition: Most vascular plants could not grow without the symbiotic fungi, or mycorrhizae, that inhabit their roots and supply essential nutrients.

3. Food: Fungi are also important directly as food for humans. Many mushrooms (*Agaricus, Volvarella*), morels (*Morchella*), truffles (*Tuber*) etc are edible and different species are cultivated for sale worldwide.

4. Medicines: Penicillin, perhaps the most famous of all antibiotic drugs, is derived from a common fungus called *Penicillium.* **Alexander Fleming** in 1929 discovered penicillin from the fungus species *Penicillium notatum.* Now a day's penicillin is commercially produced from *Penicillium chrysogenum.* The antifungal drug **griseofulvin** is produced from *Penicillium griseofulvum.*

5. Biocontrol agent: Some species of fungi (such as *Beauveria bassiana, Ascherronia deyroides, Isaria ferinosa, Empusa sepulchralis*) are able to suppress the growth of insects and nematodes that may cause harm to agricultural crops. Typically the fungi that can have such impacts are part of the group called **hyphomycetes.**

6. In research: A number of fungi, in particular the yeasts, are important "model organisms" for studying problems in genetics and molecular biology. The *AH109, PJ69-4 alpha, Y187* varieties of *Saccharomyces cerevisiae* are use in higher research in molecular biology. Gibberelin hormone derived from the fungus *Gibberella fujikuroi* is use in different experiment of plants. *Neurospora, Saccharomyces, Ascobolus* fungi are use in different fields of genetic research.

7. In food and industry:

(i) Fungi (*Aspergillus, Penicillium, Saccharomyces*) are used extensively to produce industrial chemicals like citric, gluconic, lactic, and malic acids, and industrial enzymes, such as lipases, cellulases, amylases, invertases, proteases and xylanases.

(ii) Baker's yeast or *Saccharomyces cerevisiae*, is used to make bread and other wheat-based products, such as pizza cake and dumplings cake.

(iii) Yeast species of the genus *Saccharomyces* are also used to produce alcoholic beverages through fermentation.

(iv) *Penicillium camemberti* and *Penicillium rosqueferti* are use in production famous blue cheeses include: Roquefort, Gorgonzola, Stilton, and Danish Blue.

(v) *Odium lactis* fungus is used in plastic production

Harmful importance

1. Human disease: *Asperigillus miger, A. fiavus, A. fumigatus* are common human pathogens. Disease caused in aspergilloses of throat, bronchi of lungs and ears. Few fungi cause skin discolouration. A well known skin disease ring worm or "Daad" is also a fungus disease.

2. Crop diseases: Most of our common crop plants are susceptible to fungal attack of one kind or another. Plant diseases caused by fungi include rusts, smuts, and leaf, root, and stem rots, and may cause severe damage to crops. Brown leaf spot disease of rice causes by fungus *Helminthosporium oryzae* which was responsible for the Bengal famine in 1942.

3. Animal disease: *Aspergillus, Mucor, Rhizopus, Cercospora* fungi can parasitize domestic animals causing diseases.

4. Food spoilage: *Rhizopus, Mucor, Aspergillus,* yeasts, *Penicillium* etc fungi are responsible for damage of fruit and fruit derived food, cooked food, breads, fish and meat, sweetmeat etc.

5. Destroying commodities: Some fungi attack commodities such as books, paper, wearing cloths, leathery goods, camera, microscope, radio, television, electric wearing etc.

6. Destroying wood and furniture: Many fungi cause very much loss to our timber trees by causing wood rot. *Armillaria mellea,* the honey mushroom causes red rot of apple and many forest trees. Many species of *Polypores* attack forest trees causing wood rot.

7. Infest culture media: *Penicillium* infested different culture media and create a barrier in research.

5.5 Genus-*Agaricus*

Systematic Position

Kingdom	: Fungi
Division	: Basidiomycota
Class	: Basidiomycetes
Order	: Agaricales
Family	: Agaricaceae
Genus	: *Agaricus*

Habit and habitat: *Agaricus* is a saprophytic fungus. It can grow on muddy soil, upper side of wood, compost manure, rotten straw, cow dung etc. It can grow well in rainy season. *Agaricus* has many species but *Agaricus campestris* is the familiar one. This species is commonly known as the field mushroom or, meadow mushroom. Sometimes it can grow as a circle within the grass field. This type of cycle is called **pericycle,** or **fairy ring**

Structure

The somatic structure of *Agaricus* divides in two parts, one is vegetative part or mycelium and another part is reproductive part or fruiting body.

1. Vegetative mycelium: Vegetative mycelium of *Agaricus* develops from the primary mycelium of germinating basidiospore. Mycelium has many branch and sub-branches, and grow within the moist soil. Haphae of mycelium are septate. Hyphae are white colour and take nutrients from the habitat. Cells of hypha consist of many nucleus, granular cytoplasm, small vacuole and oily drops. Mycelium of hypha sometimes aggregates together and formed a rope like structure called **rhizomorph.** Mycellia of *Agaricus* are perennial and they produce fruiting bodies or basidiocarps for long year.

2. Fruiting body or Basidiocarp: The aerial part of the *Agaricus* is known as fruiting body or bacidiocarp or sporophore. It is the reproductive structure and developed from the extension of rhizomorph during breeding seasons. Mature basidiocarp looks like an umbrella and that's why it is called **toad's umbrella.** Basidiocarp divides in two parts: (i) Stipe or stalk and (ii) Pileus or umbrella cap.

(i) Stipe: The basal stem or stalk-like part of the basidiocarp is the stipe. It is a cylindrical, 5-8 cm long and white coloured structure. The lower portion of stipe gradually taper. A ring like structure, **annulus** is present in the upper part of the stipe. The center of the stipe is hollow. The stipe is composed of sterile hyphal tissue. Its wall consists of outer dense cortex and inner loose medulla.

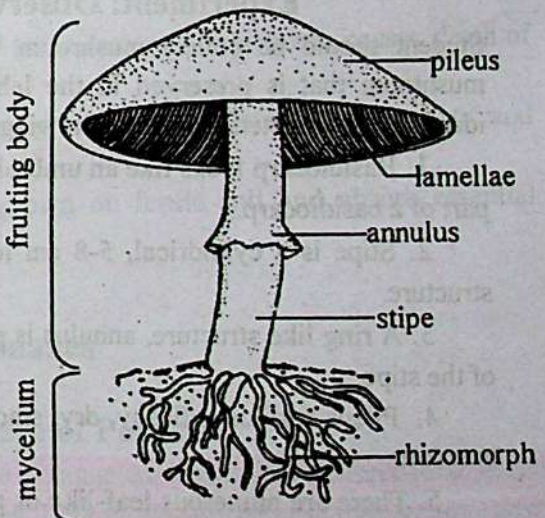

Fig 5.11 Somatic structure of *Agaricus*

(ii) Pileus: The pileus is the cap-like or umbrella-shaped part of a basidiocarp. It may be of 5-12.5 cm in diameter. Its surface is fleshy, dry, smooth and white or brown in colour. It edges may be plain or undulated. There are numerous leaf-like or plate-like structure hang on the underside of the pileus, called **lamellae.** They are arranged radially from the stipe towards the margin of the pileus.

In a transverse section of a lamella of *Agaricus* following structures are seen:

(a) Trama: It is the central fleshy part of a gill, consists of loosely woven elongated hyphae.

(b) Sub-hymenium: The narrow region of both side of trama is called sub hymenium. It is consists of some tightly woven small hyphae.

(c) Hymenium: It is the outer wide region of the gill containing spore bearing cells of the fungus. Hymenium comprises two types of cells- **paraphysis** are the sterile cells and **basidia** are the spore producing cells. Each basidium bears four elongated **sterigma** at its distal end which swallowed into basidiophores.

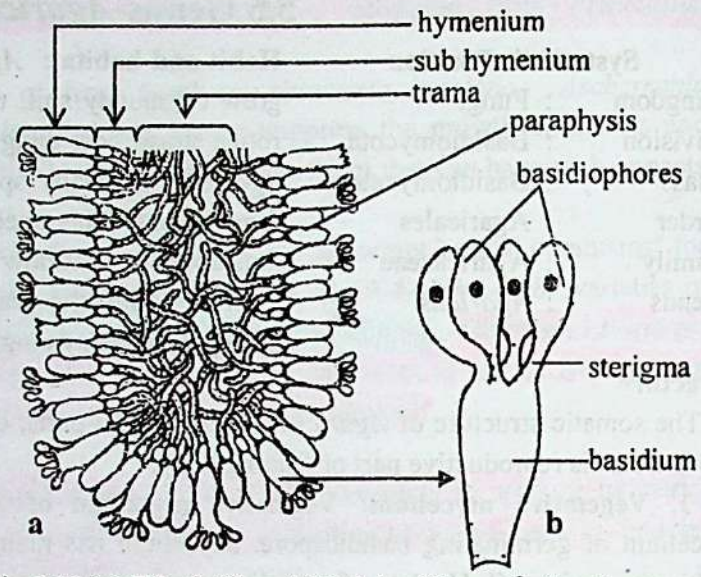

Fig 5.12 (a) TS of gill and (b) A basidium of *Agaricus*

Experiment: Observation of fruiting body of *Agaricus*

Student should be collect mushroom from nature. If it is impossible then they will observe mushroom that is preserved in the laboratory. They draw a labeled diagram and compare its identifying characters with the followings:

1. Basidiocarp looks like an umbrella; pileus is the cap-like part of a basidiocarp.
2. Stipe is a cylindrical, 5-8 cm long and white coloured structure.
3. A ring like structure, annulus is present in the upper part of the stipe.
4. Pileus surface is fleshy, dry, smooth and white or brown in colour.
5. There are numerous leaf-like or plate-like structure hang on the underside of the pileus, called lamellae.

Fig 5.13 Fruiting bodies of *Agaricus*

Economic importance of *Agaricus*

Useful aspects

1. As food: Mushrooms of the species *Agaricus campestris* and *Agaricus bisporus* used as food like vegetable. It is commercially cultivated in Bangladesh as well as many other countries. It has highly nutrious values. It contains huge amount of vitamins and minerals along with protein, carbohydrates and fat. It stored long time after prossesing. The soup of mushroom has popularity.

2. To eliminate poverty: Mushroom cultivation is a labour intensive cottege industry. It do not demands huge investment but provide work facilities for non-employed youths, disable persons which help in proverty eradication. In Bangdesh a large number of mushroom based cottege industries establishe at Savar and Manikgonj.

3. Earning of foreign currencies: In many countries mushrooms are very expensive foods. We can earn huge foreign currencies to develop this industry in large scale.

4. Decomposing: Many species of mushrooms take part in decomposition of natural organic dead bodies.

5. Pollution control: Mushrooms are used in removing industrial wastege, oil and pesticides from nature.

Nutritional value per 100 g (3.5 oz)	
Carbohydrates	4.3 g
Fat	0.1 g
Protein	2.5 g
Vitamins	
Thiamine (B1)	0.1 mg,
Riboflavin (B2)	0.5 mg,
Niacin (B3)	3.8 mg,
Pantothenic acid (B5)	1.5 mg,
Vitamin C	tracc
Minerals	
Calcium	18 mg
Phosphorus	120 mg
Potassium	448 mg
Sodium	6 mg
Zinc	1.1mg

6. Herbal properties: Mushrooms have many herbal properties. These are recognised as high valued herbal medicine for cancer, type 2 diabetes, high cholesterol, hardening of the arteries (arteriosclerosis), ongoing liver disease, bloodstream disorders, heart disease, weakened bones and digestive problems. These foods are suggested by doctors to pregnant women for their nutrious value.

Harmful aspects

1. Toxicity: Some species of mushrooms produced toxin materials which can causes death of human as well as other animals.

2. Destructive activities: Some species of mushrooms grown on wood, straw, bamboos etc. and reducing their life span.

3. Reducing soil fertility: The wild mushrooms grown on fertile soil and absorb essential nutrients of plants, thus reduced soil fertility in nature.

5.6 Fungal Diseases

1. Late blight rots disease of Potato

Late blight is a serious and widespread disease of the Solanaceae family. It is often called potato blight or tomato blight as it particularly affects these crops. Late blight was responsible, in large part, for the **'Irish Potato Famine'** in the 1845, which resulted about 10 lacs people died and 20 lacs migrated to other countries.

Causes of disease

This destructive fungal disease is caused by spores of *Phytophthora infestans* of Phycomycetes. *P. infestans* can also infect wild relatives of potatoes as well as tomatoes (*Lycopersicon esculentum*), petunias (*Petunia hybrida*) and a few other species of plants.

Infestation

The pathogen survives between crops on infected seed potatoes, cull potato piles and volunteer potatoes, all of which represent living host tissues. In season, the disease spreads by spores produced on infected plant material, such as transplants, volunteer potatoes, weeds and diseased crop debris. Sporangia can move between plants within fields by rain or water splashing or short distances in soil, Sporangia can also move long distances, possibly up to 100km, on the wind or in storm fronts. In Bangladesh this pathogen never affected severely, but in cold and moist weather the disease spread rapidly in our country.

Symptoms

Foliar symptoms

1. Dark, water-soaked lesions (spots) form on leaves, often moving in from leaf tips/margins toward the centre.
2. Young lesions may have a yellow edge or margin.
3. Within a couple of days, lesions usually turn brown or black in colour and may become brittle if they dry out.
4. A small amount of spore production (sporangia), which appears as fluffy, white growth on the edges of lesions, may occur at the edges of fresh lesions on the underside of affected leaves.
5. The disease develops rapidly and a significant proportion of the foliage may die back.
6. Lesions may also develop on stems, tomato fruit or potato tubers.

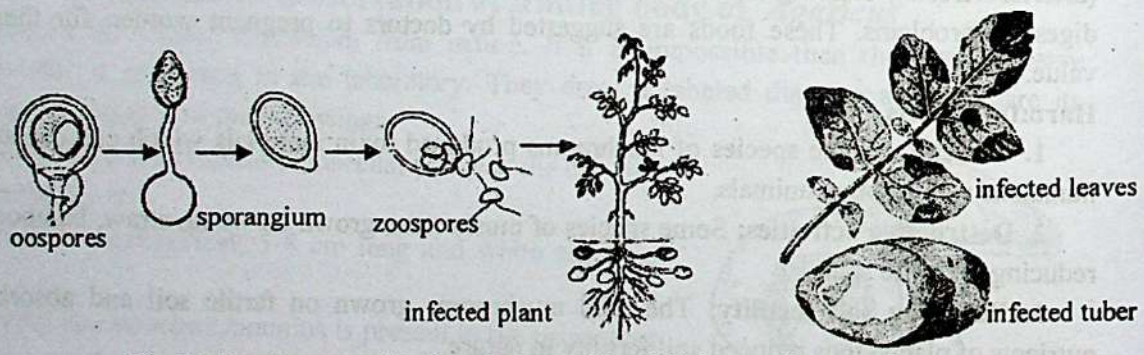

Fig 5.14 Pathogen and infested plant of late blight rot disease of potato

Tuber symptoms

1. Potato tubers may have reddish-brown, irregular, sunken lesions, often around the eyes.
2. Rot is reddish to tan-brown in colour.
3. Rot is dry and granular unless affected tissues are subsequently invaded by soft rot bacteria. The rot can penetrate deeply, *i.e.* 1-2cm.
4. The line between diseased and healthy tissues is sometimes not clearly defined.

Control measures

Prevention of late blight is important as there is little that can be done to save an infected crop, so it is well worth taking these precautions:

1. Disease-free seed tubers should be planted, and cull and volunteer potatoes should be destroyed.

2. Choose blight resistant potato varieties such as Abnaki, Belchip, Bake-King, Superior etc.

3. Always choose an open planting site with good airflow and leave sufficient space between plants.

4. Crop rotation will help to prevent a build up of disease.

5. Spray potato crops with a protective fungicide such as Bordeaux mixture, mancozeb @ 0.2% or Copper oxychloride @ 0.3% even before signs of blight become apparent.

6. Infected tubers should be removed before potatoes are stored.

2. Ringworm

Ringworm (*Daad* in Bengali) is a common fungal infection of the skin and is not due to a worm. The medical term for ringworm is *tinea*. The condition is further named for the site of the body where the infection occurs. Ringworm causes a scaly, crusted rash that may itch. Ringworm can be successfully treated with antifungal medications used either topically or orally.

The term ringworm is derived from the early belief that the infection was due to a worm, which it is not. Ringworm is a fungal infection in the skin. Nevertheless, the name ringworm remains. Some of these fungi produce round spots on the skin, but many do not.

Infestation

Ringworm occurs in people of all ages, but it is particularly common in children. Ringworm is contagious and can be passed from person to person by contact with infected skin areas or by sharing combs and brushes, other personal care items, or clothing. It is also possible become infected with ringworm after coming in contact with locker room or pool surfaces. The infection can also affect dogs and cats, and pets may transmit the infection to humans. It is common to have several areas of ringworm at once in different body areas.

Causes of ringworm

Although the world is full of yeasts, molds, and fungi, only a few cause skin problems. These agents are called the *dermatophytes*, which means "skin fungi." An infection with these fungi is sometimes known as *dermatophytosis*. Skin fungi can only live on the dead layer of keratin protein on top of the skin. Scientific names for the most common of the dermatophyte fungi that cause ringworm include *Trichophyton rubrum*, *Trichophyton tonsurans*, *Trichophyton interdigitale*, and/or *Trichophyton mentagrophytes*, *Microsporum canis*, and *Epidermophyton floccosum*.

Types of ringworm

The following are the different types of ringworm, or tinea:

1. **Tinea barbae**: Ringworm of the bearded area of the face and neck.

2. **Tinea capitis**: Ringworm of the scalp commonly affects children, mostly in late childhood or adolescence.

3. **Tinea corporis**: When fungus affects the skin of the body, it often produces the round spots of classic ringworm.

4. **Tinea cruris**: Tinea of the groin (jock itch) tends to have a reddish-brown colour and extends from the folds of the groin down onto one or both thighs.

5. **Tinea faciale**: Tinea on the face except in the area of the beard.

6. **Tinea manus**: Tinea involving the hands, particularly the palms and the spaces between the fingers.

7. **Tinea pedis**: Athlete's foot may cause scaling and inflammation in the toe webs, especially the one between the fourth and fifth toes.

8. **Tinea unguium**: Fungal infection can make the fingernails and, more often, the toenails yellow, thick, and crumbly.

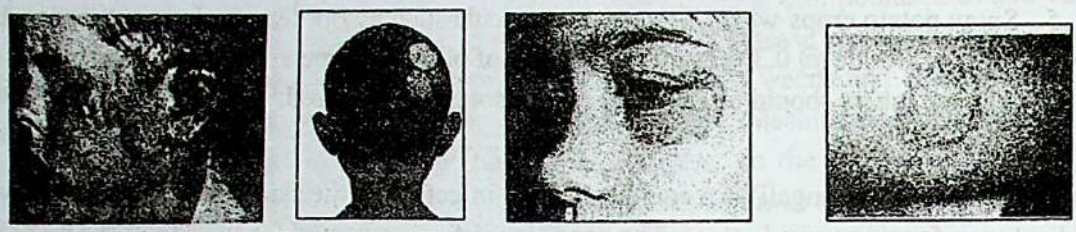

Fig 5.15 Different organs of tinea infection

Symptoms of Ringworm

The symptoms can include: (1) Itching and stinging. (2) Red scaly rash that is shaped like a ring (annular). (3) Cracking, splitting and peeling in the toe web spaces. (4) Blisters. (5) Yellow or white discolouration of the nails. (6) Bald spots on the scalp.

Prevention of Ringworm

1. After washing, dry the skin thoroughly, particularly between the toes and within skin folds.
2. Wear cotton socks instead of synthetics.
3. Make sure shoes fit correctly and are not too tight.
4. Apply an anti-fungal cream, like Lotrimin or Lamisil, or a prescription antifungal cream to the bottom of the feet, and on the nails, about twice a week.
5. Avoid walking barefoot, especially in bathrooms, locker rooms, gyms, on carpeting, and in public bathing areas.
6. Don't share towels or other personal items.
7. Stay away from infected people.
8. Discard old shoes, boots, slippers and sneakers. Do not share footwear with others.
9. Control diabetes as possible.

Risk factors for ringworm

Certain groups of people are more susceptible to a ringworm (tinea) infection. The people most at risk of ringworm are: children, people with lowered immunity, person who complete a antibiotic course recently, who get steroids, diabetes patients, obese person etc.

5.8 Lichen

Lichens are an extremely successful partnership between a fungus and an alga. It is a symbiosis between a fungus and an alga or cyanobacterium. The fungal partner of lichen referred as the **mycobiont**. The algal partner is called the **photobiont**. While most lichen partnerships consist of one mycobiont and one photobiont, that's not universal for there are lichens with more than one photobiont partner. Approximately 13,500 species of lichen have been described and identified worldwide and this number may be of 20,000.

Lichens can be found growing in almost all parts of the terrestrial world, from the ice-free polar areas to the tropics, from tropical rainforests to those desert areas free of mobile sand dunes. While generally terrestrial a few aquatic lichens are known.

Lichen symbiosis

Symbiotic association between the fungus and cyanobacteria (or algae) is a complex one. Fungal partner is responsible for the main structural framework of the lichen which is the 'thallus'. The photobiont stays inside the thallus and the mycobiont facilitates the gas exchange and light availability for the photobiont. Photobiont cells carry out photosynthesis and provide nutrients for mycobiont. The fungal partner in turn helps the photobiont with improved water and nutrient uptake and also helps to survive under extremely unfavorable environmental conditions as a unit.

Where lichen grows

The various habitats of lichens are as described below:

1. **Corticolous communities:** These develop on bark and contain fruticose and foliose species. These include the species of *Evernia, Parmelia* and *Usnea*.

2. **Follicolous communities:** Species like *Calicium, Cyphelium* and *Strigula* occurring on leaf are called as follicolous lichens.

3. **Saxicolous communities:** Lichen communities developed on rocky substratum are called as Saxicolous and these vary according to rock type. The species like *Caloplecta, Aspicilia* grow on hard lime stones.

4. **Terricolous communities:** The lichens of this community are growing on the ground or soil and often form a dominant component of the ground vegetation in the extreme environments. e.g *Cladonia floerkeana, Lecidea granulosa, Collema tenax*.

5. **Muscicolous communities:** These lichens grow on mosses. Some species like *Cladonia, Peltigera* grow along with mosses.

Types of lichen

Lichens are classified to three major groups based on their thallus structure. They are-

1. **Crustose lichens:** These types of lichens lack an organized thallus and are closely attached to the substratum. e.g. *Calicium, Ophioparma ventosa*.

2. **Foliose lichens:** The thallus in this case is loosely attached to the substratum by rhizines with distinct upper and lower surfaces. e.g. *Heterodermia, Physcia, Nephroma bellum*,

3. **Fruticose lichens:** These are hair like, shrubby, finger like or strap shaped. Here the lichen thallus is attached to the substratum at one point and remaining major portion is either growing erect or hanging. e.g. *Cladonias, Pilophorus acicularis*

4. **Squamulose lichen:** Scaly lichens made of numerous small rounded lobes, intermediate between foliose and crustose lichens. e.g. *Catapyrenium*.

5. **Leprose lichen:** Leprose lichens are of the simplest form. The fungal and algal components grow as powdery or granular patches with little or no organized structure; they do not form a smooth thallus. e.g. *Lepraria incana*.

Anatomy of lichen

The vertical section of the vegetative thallus usually shows three distinct layers –

1. **Cortical layer:** The uppermost layer is the cortical layer. The cortex serves as protective cover over the thallus surface.

2. **Algal component** The algal component (Phycobiont) in the lichen thallus is completely surrounded by the fungal tissues on all sides. This layer is responsible for the assimilation of carbon through the process of photosynthesis.

3. Medulla: The bottom most is the medulla. The bulk of the lichen thallus consists of medullary tissue which may be as much as 500 µm thick.

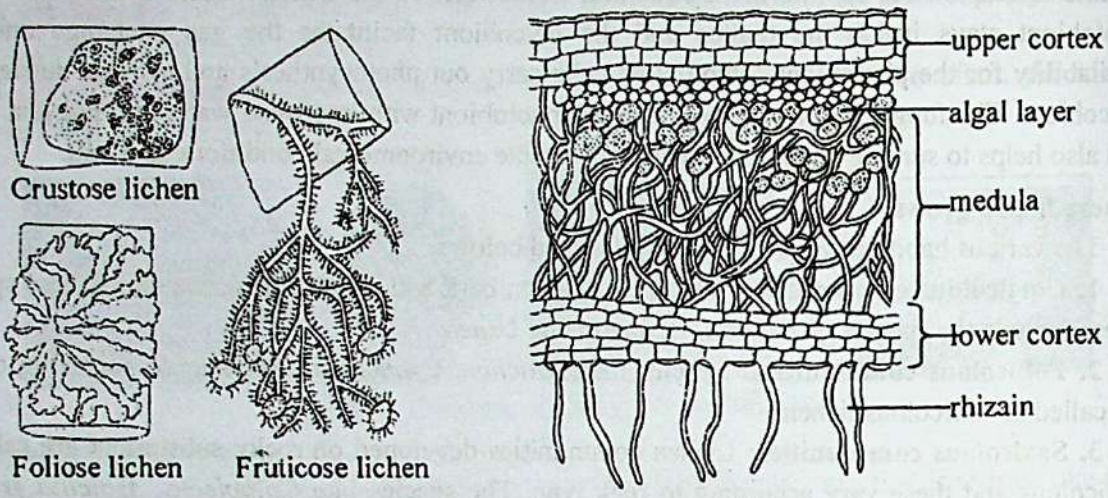

Fig 5.16 Lichen: (a) Types and (b) Internal structure

Economic importance of lichen

Lichens are economically important for several reasons.

Beneficiary aspects of lichen

1. Soil binders: Lichens are amongst the first organisms to colonize barren surfaces. Some lichens are very effective sand and soil binders and can help in dune stabilization and erosion control.

2. Food for animals: Lichens are common food for insects and slugs. Lichens (*Cladonia rangiferina*) are important as a food source for reindeer and caribou in the tundra and sub arctic forests.

3. Ecological indicators: Lichens are used as living indicators of environmental problems because of their sensitivity to atmospheric pollution.

4. Aesthetic value: Lichens are inherently beautiful and interesting in their own right. They add diversity, interest, colour, and intricacy to a forest.

5. Contribution to biodiversity. Lichens are a major component of the diversity in forests.

6. Medicinal importance:

(i) Usnic acid, stictic acid, vulpinic acid, etc. are some of the lichen products and have been proven to have antimicrobial effects.

(ii) Erythrin derived from *Rocella montagnei* lichen is use in angina (chest pain) treatment.

(iii) Lichen products Protolichesterinic acid, Lichenin, Isolichenin are use to resist cancer and tumor.

(iv) Lichen *Cetraria islandica, Peltigera and Cladonia* are use as medicine for tuberculosis, hydrophobia and hopping cough respectively

7. Cosmetic production: *Pseudevernia furfuracea* (Tree moss) and *Evernia prunastri* (oak moss) lichens are widely used in the manufacture of perfumes.

8. Chemical uses: Above 550 natural products such as lacanoric acid (from *Parmelia*), salagenic acid (from *Ramalina*), squamatic acid (from *Cladonia*), rhizokapic acid, usnic acid, ficion acid, calicin, lycanin, zeorin, benzail starch, zanthoms, tarpenoid etc. are produced from lichens.

9. **Dying purpose:** Archil and osein dyes from *Rocella tinctoria* lichen use in staining microscopic substances. Red and violent dyes are collected from the lichen *Ochrolechia androgyna*. Litmus paper made from lichens *Rocella* and *Lasallia*.

Harmful aspects of lichen

1. *Cladonia, Amphiloma, Usnea* etc. damage bark of their host plants.
2. Some species of lichens (e.g. *Parmelia molliuscula*) are toxic in nature. Animal will die who grazes these toxic lichens.
3. Lichens grow in the wall of building can damage the wall.
4. Lichen that grows on stone of monument can damage and reduces its visitor value.

Differences between algae and fungi

Algae	Fungi
1. The algae grow in water or damp soil and something as epiphytes rarely as endophytes.	1. The fungi grow in a wide variety of habitats; as parasites on plants and animals; as saprophytes on decaying organic matter in soil or water.
2. The algae possess chlorophyll.	2. The fungi lack chlorophyll.
3. The algae are autotrophic, able to synthesize their own food.	3. The fungi are heterotrophic, unable to synthesize their own organic food.
4. The algal thallus is composed of true parenchyma cells. The unit of structure of an algal thallus thus is a cell.	4. The fungal thallus is composed of a false parenchyma. The unit of structure of a fungal thallus or mycelium is a hypha and not a cell.
5. The cell wall in algae typically consists of cellulose.	5. The cell or hyphal wall generally consists of chitin.
6. The food reserve is chiefly in the form of cellulose and starch.	6. The reserve food invariably accumulates in the form of glycogen and oil globules.
7. The algae usually grow in habitats where light is available.	7. Fungi generally grow in darkness and dim light.

Did You Know?

- Algae produce more than 71% of the Earth's oxygen; they also help remove huge amounts of carbon dioxide.
- Fossilized algae are used to make dynamite.
- Maximum length, in feet, that kelp, the largest algae, can grow: 200.
- Scientists now believe that it was a single type of water-dwelling algae that came ashore hundreds of millions of years ago and kick-started the evolution of all terrestrial plant life.
- Algae can be turned into biofuel by cultivating special oily algae and crushing it (or adding chemicals) to extract the oil. The oil becomes biodiesel, which can then be used as a green fuel.
- It is estimated that there are over a million species of fungi but only about 10% have been officially described in the scientific literature.
- As agents of plant disease, fungi cause annual crop losses in excess of three billion dollars annually in North America.
- In forest soils other than plant roots the fungi are the dominant life forms. it is estimated that the fungus biomass is 90% of the total.

• In agricultural soils the biomass of fungi is equal to about 1250 kg per hectare and equals the weight of all other groups combined.

• Fungi recycle plants after they die and transform them into rich soil. If not for mushrooms and fungi, the Earth would be buried in several feet of debris and life on the planet would soon disappear.

• Under the right conditions, some mushrooms' spores can sit dormant for decades or even a century, and still grow.

Exercise

Multiple Choice Questions (Sample)

1. Which one is the aerial part of the *Agaricus*?
   a. Pileus b. Lamellae c. Basidiocarp d. Mycelium
2. In which of the following organism hyphae present?
   a. Algae b. Fungi c. Moss d. Fern
3. Which algae have the reserve food starch?
   a. Red algae b. Green algae c. Brown alge d. Yellow-brown algae
4. Which chloroplast has pyrenoid ?
   (a) *Nostoc* (b) *Ulothrix* (c) *Riccia* (d) *Cycas*

   Answer the questions No. 5 and 6 in support of following stem:-
   Generally higher plants bear some chloroplast but the diversity of chloroplast present in lower plants
5. The shape of chloroplast in plants mentioned first is-
   (a) star shaped (b) cup shaped (c) lens shaped (d) reticulate shaped
6. Which type of plants bear different chloroplast ?
   (a) Alagae (b) Fungi (c) Moss (d) Fern
7. Which one of the following is the simplest lichen?
   a. Leprose lichen b. Crustose lichen c. Foliose lichens d. Fruticose lichens
8. *Agaricus* is commonly called mushroom or umbrella of frog. The characteristics of this organism- i. It is a saprozoic fungus, ii. Its aerial part is called fruiting body, iii. It produced haploid basidiophores-Which one of the following is correct?
   a. i and ii b. i and iii c. ii and iii d. i, ii and iii

   Farmer Jalil's potato field epidemically attacked by some diseases. His potato plant drastically died after dark, water-soaked lesions form on leaves.
   Answer question no 8 and 9 in light of the above stem-
9. Which parasite or pathogen attacked Jalil's potato field?
   a. *Microsporum canis* c. *Penicillium notatum*
   b. *Phytophthora infestans* d. *Letharia vulpina*
10. Way of prevention of this disease-
    i. Use of disease-free seed tubers, ii. use of resistant potato varieties, iii. Spray potato crops with a protective pesticide,-Which one of the following is correct?
    a. i and ii b. i and iii c. ii and iii d. i, ii and iii
11. Unicellular motile algae is-