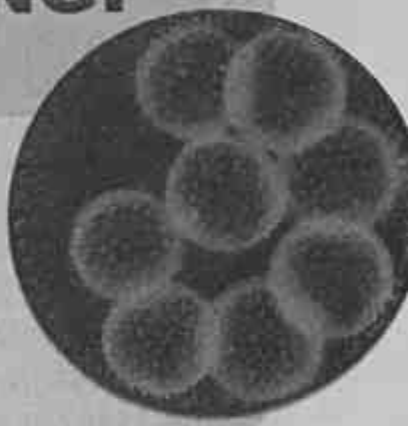
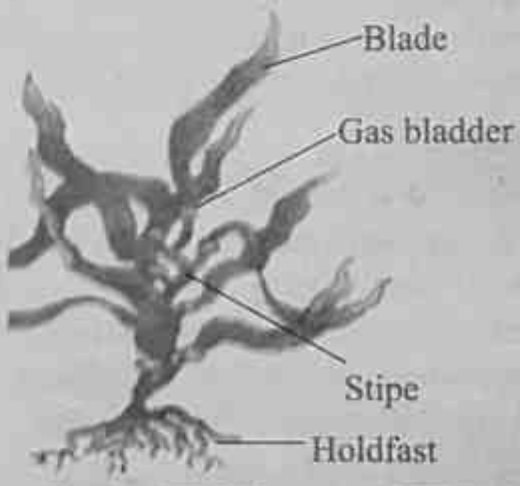
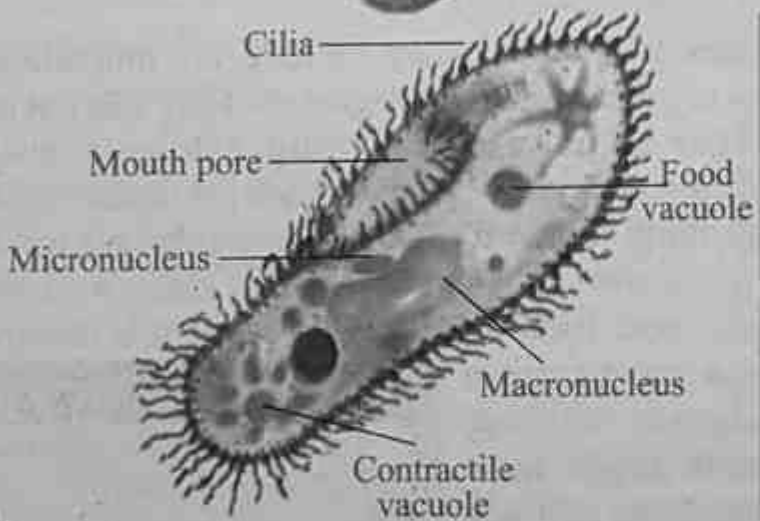
UNIT 7 PROTISTS AND FUNGI



Major Concepts

7.1 Protists: The Evolutionary Relationships
7.2 Major Groups of Protists
7.3 General Characteristics of Fungi
7.4 Diversity Among Fungi
7.5 Importance of Fungi





Students Learning Outcomes

On completion of this unit students will be able to:

- Explain protists as a diverse group of eukaryotes that have polyphyletic origin and defined only by exclusion from other groups.
- Describe the salient features with examples of protozoa, algae, Myxomycota and oomycota as the major groups of protists.
- Justify how protists are important to humans.
- List the characteristics that distinguish fungi from other groups and give reasons why fungi are classified in a separate kingdom.
- Classify fungi into Zygomycota, Ascomycota and Basidiomycota and give diagnostic features of each group.
- Explain yeast as unicellular fungi that are used for baking and brewing and are also becoming very important for genetic research.
- Name a few fungi from which antibiotics are obtained.
- Explain the mutualism established in mycorrhiza and lichen associations.
- Give examples of edible fungi.
- Describe the ecological impact of fungi causing decomposition and recycling of materials.
- Explain the pathogenic role of fungi.

Introduction

The word protist is derived from Greek word "*protistos*" which means "very first". **The protists are very first eukaryotes,** much more complex than prokaryotes. There is a vast variety of aquatic **eukaryotes** which have different morphology, reproductive system, types of nutrition, life styles and have evolved from prokaryotes. Fungi are non-motile, **achlorophyllous** , spore bearing organisms with chitin containing cell wall, live either parasitic, saprophytic or symbiotic mode of life.

7.1 Protists: The Evolutionary Relationship

Protists were very first eukaryotes to evolve. They include all unicellular eukaryotes and some simple multicellular organisms of diverse groups. They can not be considered as fungi, animals or plants. They are **polyphyletic group,** belong to many tribes. They exhibit similarities and differences with plants (such as autotrophic unicellular and multicellular algae), with fungi (heterotrophic slime molds and water molds) and heterotrophic animals like (protozoans). Thus they do not share a single common ancestor. Margulis and Schwartz have listed 27 phyla, to place this diverse assemblage of organisms. Their size varies from microscopic protozoans and unicellular algae to very large brown algae 'Kelps' more than 60 meters in length. Most protists are unicellular, some simple multicellular (without specialized tissues) and few are colonial (i.e., loose aggregation of cells). Some protists are **coenocytes** that is multinucleated cell but not multicellular.

Symbiosis

A mutually beneficial partnership between two different organisms (species) of different kinds, especially where one lives in or on another organism.

How do protists get their nutrients?

Some protists are plant-like **autotrophic** (photosynthetic algae), some are **ingestive heterotrophs** like animals (protozoans and slime molds) and some are fungi-like **absorptive heterotrophs** (water molds).

Different modes of life:

Some protists are **free living** (Amoeba, Paramecium), many are symbiotic either **mutualist** (Trichonympha and Colonympha) or parasitic (*Plasmodium*). Most are aquatic (either fresh water or marine algae). They also make up a part of the **plankton,** (can not resist water current, i.e., floating) none of these are **nekton** (which can resist water current, i.e, can swim against water current).

How do protists reproduce?

All protists exhibit asexual reproduction, many also reproduce sexually (exhibit **meiosis and syngamy**, i.e., the fusion of gametes). Most don't contain multicellular sex organs. There is no embryo or blastula stages in protists.

Types of locomotion:

Few are sessile while most are motile at some stage of their life, locomote either by **pseudopodia** (*Amoeba*) or **flagella** (Euglena) or **cilia** (*Paramecium*). Some have two or more means of locomotion (i.e. both flagella and pseudopodia).

Many protists (especially algae) are palatable thus they are most abundant source of food for animals and human.

Evolution of Protists:

All protists have evolved from prokaryotes (Monera) while fungi, plants and animals have evolved from protists. Some protists like euglena and slime mold exhibit characters of plants, animals and fungi.

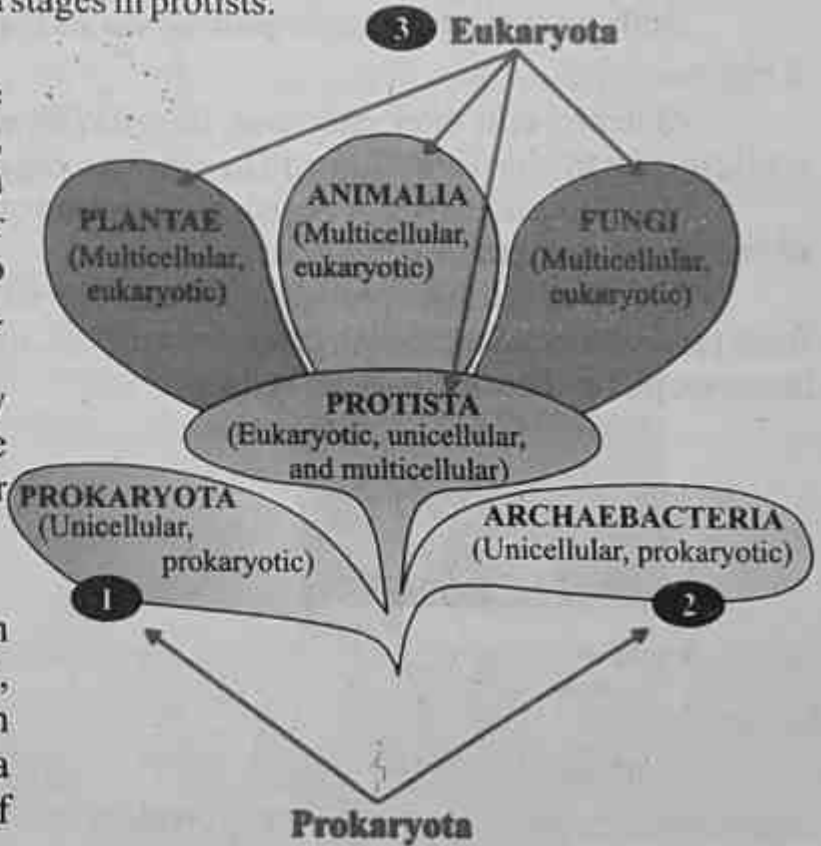


Fig. 7.1 Evolutionary Tree

7.2 Major Groups of Protists

The Protists are placed into following major groups **protozoans, algae, myxomycota** and **oomycota.** The salient features of these groups are given below.

Tit bits

The term protozoa was introduced in 1818 by Germen Zoologist George August Goldfuss.

7.2.1 Protozoa: The Animal-like protists

Protozoans are animal-like unicellular protists which ingest food and have no cell

wall. The word protozoan is derived from two Latin words "*Proto*" means first "*Zoan*" means animal.

They are polyphyletic group with following salient features.

Habitat: Mostly aquatic (either fresh water or marine such as actinopods, foraminifera). Many are parasitic, e.g., *Trypanosoma, Plasmodium, Entamoeba* etc. Their **body** is single mass of protoplasm with almost all cellular structures of a typical cell, within which it performs all features of life such as nutrition, locomotion, reproduction, respiration, excretion, homeostasis etc.

Entamoeba histolytica

Intestinal parasite causes amoebic dysentery in human while Naegleria brain eating parasite causes meningoencephalitis, inhabit in warm fresh water.

The **vacuoles** in protozoans are either for ingestion, digestion and egestion (such as food vacuole) or in fresh water species **contractile vacuole** for excretion (removal of water and nitrogenous wastes).

Reproduction:

Both asexual and sexual reproduction takes place in protists.

Locomotion:

Either by cilia (*Paramecium*), flagella (*Trypanosoma*), or pseudopodia (*Amoeba*) while most parasitic forms have no locomotary organelles (*Plasmodium*).

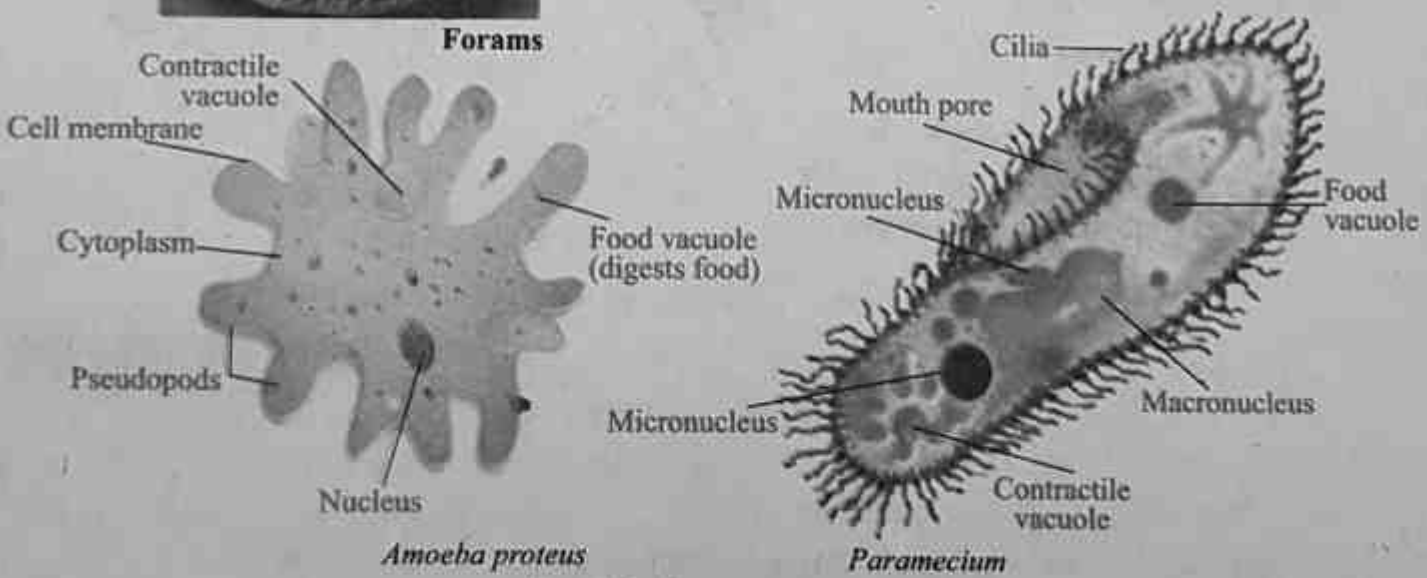
Many protozoans can **regenerate** and form **cyst** to overcome unfavourable conditions.

Tit bits

The shell of fossils of foraminifera, together with red algae and corals created vast lime stone in the ocean.

It is believed that probably animals have evolved from protozoans because both groups are motile, ingestive heterotrophs and do not possess cell wall.

Forams



Amoeba proteus *Paramecium*

Fig. 7.2 Some protozoans

Common groups of protozoans:

> **Thallus**
> *A plant or plant like body with no distinction between root, stem or leaves, and no vascular tissues, e.g., algae, fungi and bryophytes.*

1. **Amoebas** are mostly free living, locomote and feed with the help of pseudopodia, possess many food vacuoles and contractile vacuoles. e.g., *Amoeba proteus, Entamoeba histolytica and Naegleria fowleri.*
2. **Zooflagellates** (flagellum: whip) locomote by flagella, their body is covered with a proteinous pellicle, e.g. ***Trichonympha***, a complex mutualist flagellate, live in the gut of termites and other wood or cellulose eating insects, help in digestion of wood, it contains bacterium that produces cellulase.

Trypanosoma, human flagellated parasite, causes a disease known as sleeping sickness. **Choanoflagellates;** (choano; collar) sessile stalk flagellate found both in marine and fresh water. Their flagellum is surrounded by delicate collar (like choanocyte cells in sponges).

3. **Ciliates** (cilium; eyelashes) are completely or partially surrounded by hair-like extensions known as cilia, e.g., *Paramecium.*
4. **Foraminifera** and **Actinopods** are marine protozoans, foraminifera (foramin; pore; ferrous: bearing) produce calcareous and porous shell, e.g., *Forams* while actinopods (actines: rays; podus: legs) produce siliceous shell.
5. **Apicomplexans** are a large group of parasitic protozoa. They are mostly pathogenic e.g., *Plasmodium* causes malaria, they are called apicomplexan because of unique arrangement of fibrils, microtubules, vacuoles and other cell organelles at one end of the cells. They have no locomotary organs and they move by flexing. They need two hosts to complete their life cycle.

7.2.2 Algae: The Plant-like Protists

Algae are mostly aquatic found in marine and fresh water ponds, lakes, moist soil, streams, hot springs, polar ice, moist rocks and trees. Their plant body may be unicellular or multicellular, some are filamentous. The filaments are either unicellular or multicellular.The multinucleated filaments lack cross walls (i.e. coenocytic) or distinct cells. Many multicellular algae possess leaf-like or branched body called thallus. The chlorophyll *a*, carotenoids, xanthophylls and phycoerythrin are their photosynthetic pigments. The life cycle of algae is extremely varied, many have isomorphic alternation of generation. All algae except red algae exhibit flagella in some stage of their life cycle.

How do algae differ from plants?

Their sex organs are mostly unicellular. There is no embryo formation in algae and having simple unorganized body.

Major groups of algae:

1. **Euglenoids** are unicellular fresh water organisms. Their body is covered by proteinous pellicle e.g., *Euglena*.
2. **Dinoflagellates** are also unicellular, vary in colour from yellow, green to brown.

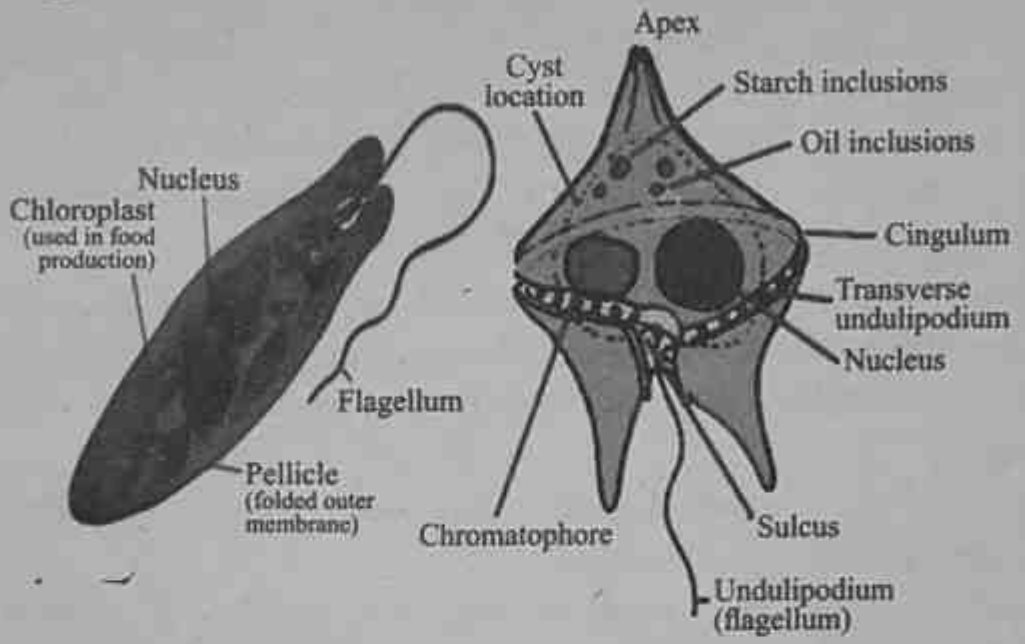


Fig. 7.3 Euglena and Dinoflagellate

3. **Diatoms**: Usually unicellular, found in fresh water and marine, and are most numerous algae found in oceans. They are called pastures of sea because they are important source of food in marine food webs. The body shape is like a box, because cell wall possess two halves, the larger half acts as lid for smaller half.
4. **Brown algae:** Multicellular plant-like algae live in colder marine water. They are largest of all algae, range from small form with simple filaments to giant "kelps" (upto 75 meters in length).

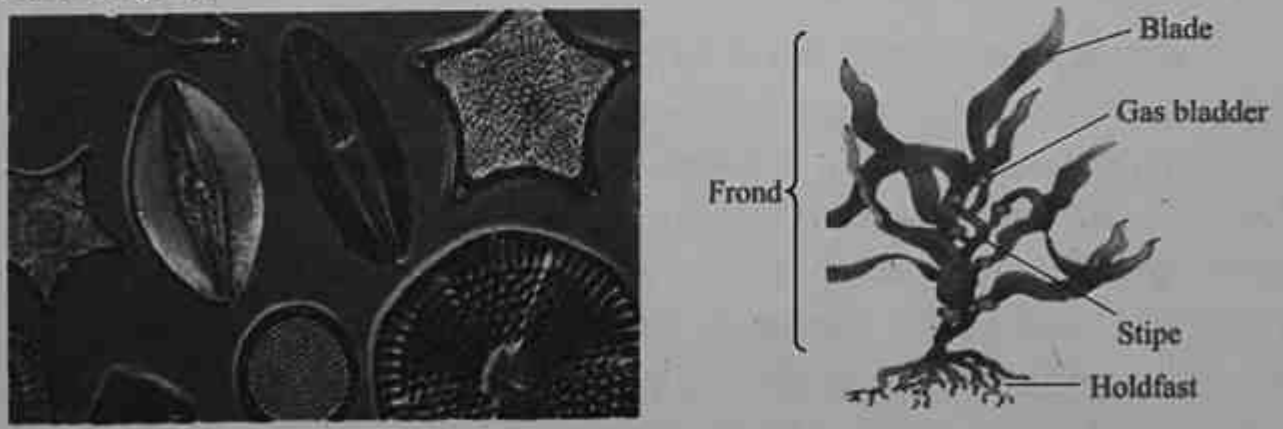


Fig. 7.4 Diatoms and Kelp

5. **Red algae:** Mostly multicellular some unicellular prefer warm sea water. In size they may be up to one meter long and attached to the rock or other submerged objects by a root-like basal hold fast.

6. **Green algae:** May be unicellular (such as *Chlorella and chlamydomonas*), Colonial (*Volvox*) or multicellular and filamentous (*Spirogyra* and *Ulva*). Mostly marine, some fresh water and few terrestrial. Mostly green, some may be orange, red or rust colour.

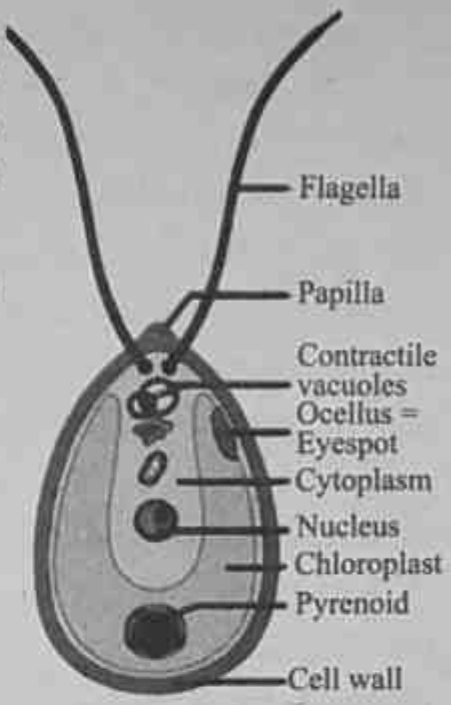


Fig. 7.5 Chlamydomonas

7.2.3 Fungi-like protists: Myxomycota and Oomycota

Myxomycota: Slime Molds:

The slime molds take many forms, during their life cycle and resemble other types of protists. They have mobile amoeba like feeding stage and stationary filamentous, saprotrophic fungi like reproductive stage produces spores. The acellular slime mold consists of a mass of cytoplasm *(Plasmodium)* containing thousands of diploid nuclei that is multinucleated and covered by slime sheath. Therefore, also called plasmodial slime mold. Sporangia are their reproductive structures which during unfavourable conditions produce spores by meiosis. In plasmodial slime mold, spores release a haploid flagellated cell or an amoeboid cell. Eventually two cells fuse to form a diploid zygote that feeds and grows, producing a multinucleated *Plasmodium* once again by mitosis. Slime molds differ from fungi due to the presence of motile stage in their life cycle e.g., *Physarum polycephalum* is an example of plasmodial slime molds.

Tit bits

Hyphae are filamentous thread like structures in fungi, which give the mycelium quite a large surface area per volume of cytoplasm. This facilitates absorption of nutrients.

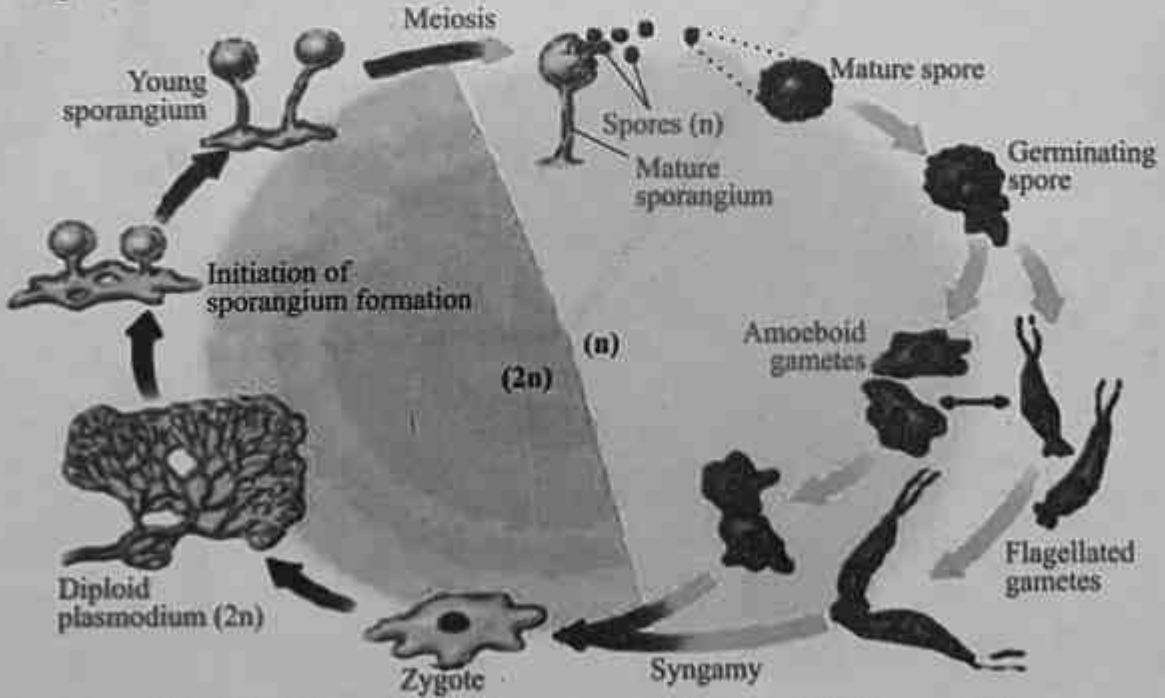


Fig. 7.6 Life cycle of Myxomycete (Plasmodial slime mold)

Oomycota: (The water molds):

Oomycetes are either parasites or saprotrophs which feed on humus. Their cell wall unlike fungi **contains cellulose** instead of chitin while like fungi possess filamentous structure called **hyphae**. The hyphae are **aseptate (coenocyte)** that is without intercellular septum or cell wall between nuclei. They asexually produce zoospores in their sporangium, which are biflagellates and motile. All oomycotes also exhibit sexual reproduction. There are two types of gametangia. The female gametangia is called **oogonium** while male gametangia is called an **antheridium**. The gametangia produce gametes by meiosis, thus show gametic meiosis. The male gametes flow from antheridium to oogonium lead to the fusion of one or more pairs of male nuclei with eggs to form zygotes (resulting in a diploid phase). The zygotes soon covered by a thick cell wall known as oospores. Due to this special kind of thick cell wall on **oospores** their phylum is named oomycota, e.g., water molds, white rust and downy mildews.

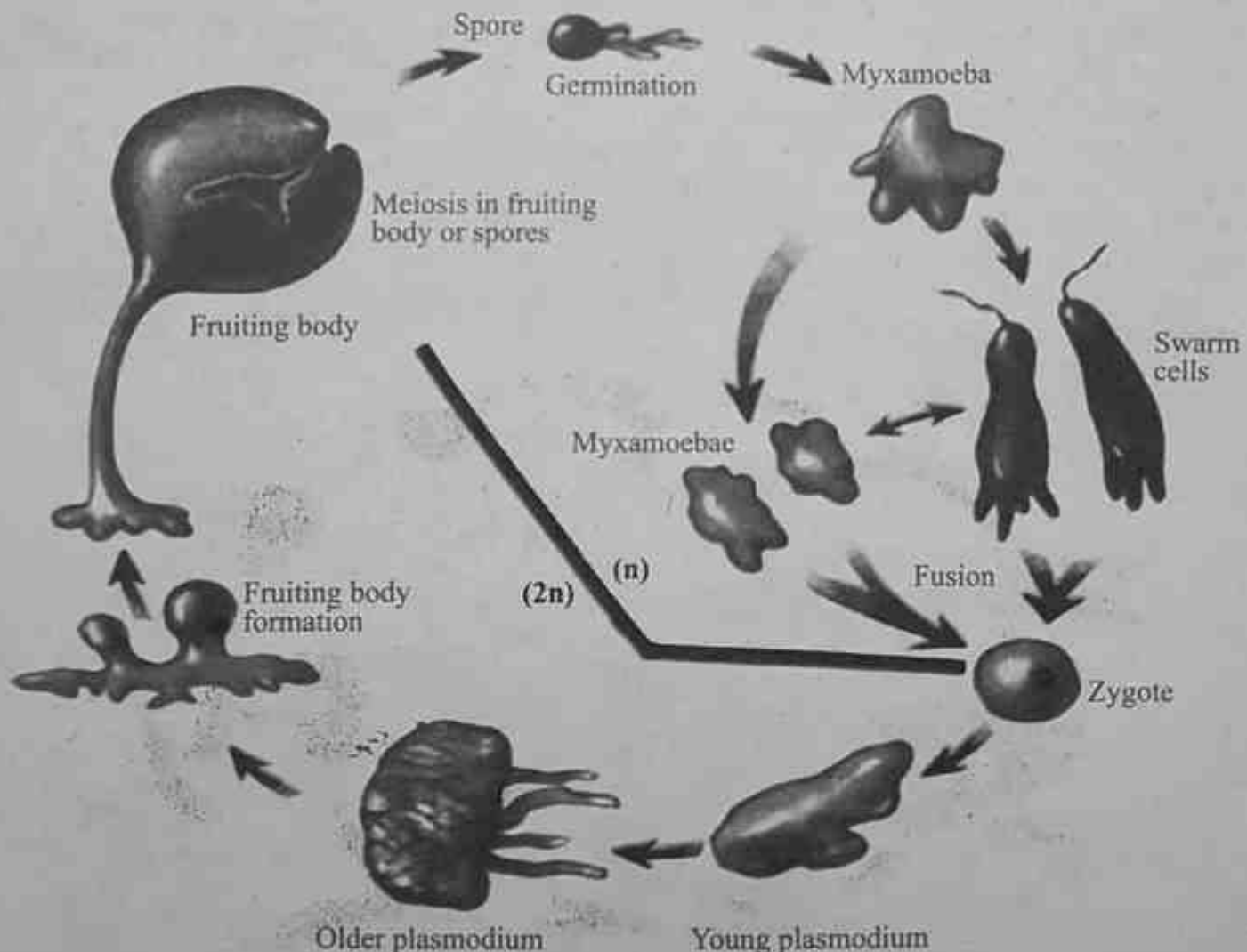


Fig. 7.7 Life Cycle of Oomycota

7.2.4 Importance of Protists to Humans

Protists are both useful and harmful to human.

Useful protists:

Dinoflagellates: They are great source of food for small marine and fresh water animals which are used as **palatable** food by humans.

Diatoms are also **source of oxygen** for aquatic animals. Brown algae is used as food and **fertilizer** in many countries, from it we also get **vitamin A,C,D and E.**

Red algae is used as source of **agar (algine)** which is produced from the mucilaginous cell wall. Agar is used to make capsules for vitamins and drugs, dental impressions, base for cosmetics and also used in laboratory as culture media for bacterial growth.

Antiseptic role: Algae is used in medicines, *Chlorella* is used for the synthesis of antibiotics, its agar is also used for stomach diseases. *Chlorella* has been used as an experimental organism in research for photosynthesis.

Green algae are important producers and is used as experimental organisms for photosynthesis in research laboratories (Such as *Chlorella*).

Algae are used as new food source; **single cell protein (SCP)** is derived from algae. *Chlorella* is sold as "health food" especially in Taiwan and Japan. Protists are used for **study of genetics** and other physiological processes.

In aquatic ecosystems **zooplanktons** (protozoans) feed on **phytoplanktons** are the most important primary consumers in a food chain.

Harmful effects of protists:

In some places protists act as **pollutants.** Sometimes they become the reason of closing of pipes. *Phytophthora* causes late **blight disease** in potatoes. Many protozoans cause diseases in human beings, such as **malaria** is caused by *Plasmodium*. According to World Health Organization about one to two million people die each year from this infectious disease. *Entamoeba histolytica* causes amoebic dysentery while ***Trypanosoma*** causes African **sleeping sickness.** Many protozoans also cause diarrhea. ***Acanthamoeba,*** a protozoan causes eye infections in contact lense users.

7.3 Kingdom Fungi

Fungi are eukaryotic spore-bearing **thallophytes** which lack chlorophyll. They are either saprotrophic or parasitic and possess **chitinous** cell wall. They live both in dark and light environment. The study of fungi is called

Do you know?

Decomposers are mostly microbial heterotrophs that return constituents of organic substances to ecological cycles by feeding on and breaking down dead organisms and excreta.

Tit bits

Phytophthora infestans is an oomycote which is a plant pathogen. It causes late blight disease of potatoes. Plants show individual leaflets, with small brown dead and blighted areas.

Tit bits

***Dikaryotic or heterokaryotic** is a condition when two different haploid (+ and –) nuclei are present per cell, such as in Ascomycota and Basidiomycota.*

mycology and the person who studies fungi is called **mycologist**.

7.3.1 General characteristics of fungi

Fungi have wide range of habitat, may be aquatic or terrestrial, many are parasites of plants and animals. Fungi range in size from microscopic (such as yeast) to very large up to two meters (such as toadstool).

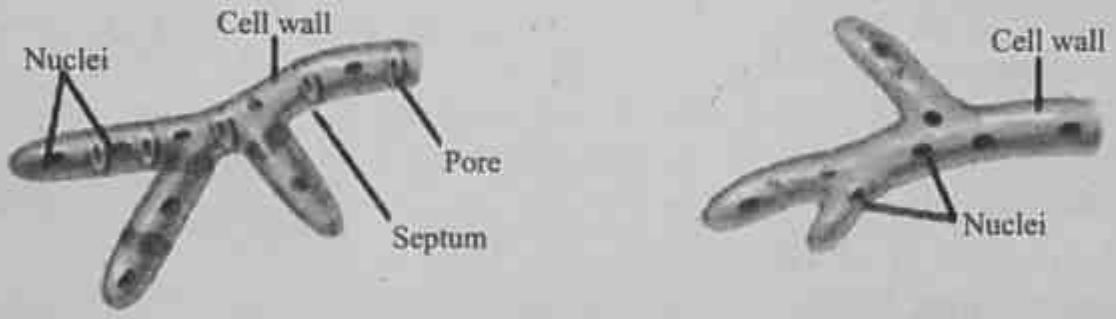
Modes of life in fungi:

They live as saprotrophs, parasites or mutualists, few are predatory.

> **Do you know?**
>
> *In meiosis: diploid (2n) cell is reduced into four haploid (n) daughter cells while in mitosis (2n) diploid parent cell divides into two diploid (2n) daughter cells.*

Fungi morphologically differ from other organisms:

Their plant body is **thallus** which is mostly multicellular structure known as mycelium (Gk. Filaments). **The mycelium** is an interwoven mass of thread-like filaments called **hyphae** (Gk. Web). There are two types of **hyphae, Non septate or aseptate** (coenocytic hyphae) are made of one cell with many nuclei that is no cross wall or septum between nuclei, e.g *Rhizopus*. **Septate hyphae** are made up of many cells separated by porous partition called septum, e.g., in *Penicillium*.



(a) Septate Hypha (b) Coenocytic Hypha

Fig. 7.8 Septate and Aseptate hyphae

Their **cell wall contains chitin**, which has high tensile strength and prevents osmotic bursting of cells. It has also more resistance to decay than cellulose and lignin (found in plants cell wall).

All fungi being **nutritionally absorptive heterotrophs,** digest organic food outside the body then absorb the digested food to body cells. Many are **decomposers.** They store carbohydrates in the form of glycogen. Fungi are non motile in all stages of their life i.e., lack flagella, move towards a food source by growing towards it. **Flagella** are also absent both in fungi and in red algae, thus most mycologists believe that fungi probably evolved from red algae. A fungus reproduces both asexually and sexually.

> **Tit bits**
>
> *Karyogamy is the fusion of nucleus while plasmogamy is fusion of cytoplasm. In some fungi karyogamy does not take place immediately after plasmogamy, e.g., Basidiomycota.*

Taxonomic status of fungi as a separate kingdom:

Fungi differ both from plants and animals in many characters.

Differences from plants: Fungi lack chlorophyll, they are absorptive heterotrophs rather than autotrophs, cell wall contains chitin instead of cellulose, glycogen is formed as stored form of carbohydrates instead of starch (in plants).

Fungi differ from animals having cell wall, absorptive heterotrophs rather than ingestive heterotrophs, non-motile, produce spores, no centrioles. Unlike plants and animals fungi show **"nuclear mitosis".**

> **Tit bits**
>
> *In nuclear mitosis, nuclear membrane remains and mitotic spindles form within nucleus then nuclear membrane pinches between the two clusters of daughter chromosome. In some fungi it dismantles later.*

Thus fungi are distinct from all other eukaryotes, therefore, they are placed in a separate kingdom that is kingdom fungi.

Diversity among Fungi:

The kingdom fungi contains more than 100,000 known species. Most of which are terrestrial, few are aquatic. Fungi are mostly multicellular, some are unicellular, varied in structure.

7.4 Classification of fungi

Classification of fungi is based on types of reproduction (either sexual or asexual), and types of hyphae. They are classified into three major groups i.e., Zygomycota, Ascomycota and Basidiomycota.

> **Activity**
>
> *Make a list of common fungal diseases and their causes in our country by searching internet sources. Also share your knowledge with your class fellows.*

Table 7.1 Phyla (Groups) of Fungi

Phylum	Common Names	Familiar Species	Number of species
Zygomycota	bread molds zygomycetes	*Mucor, Rhizopus, Pilobolus*	2,000
Ascomycota	sac fungi, truffles, morels, blue- green molds, powdery mildew, chestnut blight	*Penicillium, Saccharomyces, Morchella, Claviceps, Aspergillus*	32,000
Basidiomycota	basidiomycetes, mushrooms, rusts, smuts, puffballs, bracket fungi	*Agaricus, Puccinia, Ustilago, Polyporus, Boletus, Amanita*	22,300

7.4.1 Zygomycota (Conjugating Fungi)

> **Do you know?**
>
> *Yeast is used to synthesize vitamin B complex on commercial scale. It is also utilized in medicine as a source of enzymes.*

Phylum Zygomycota includes fungi in which diploid zygospores are formed examples; ***Rhizopus*** (black bread mold) and ***Mucor.*** These are saprobs generally grow on remains of plants, bakery products, fruits and vegetables, some are parasites of land protists. Their hyphae are aseptate, possess branching mycelium. The hyphae are of three types, rhizoid hyphae, stolon hyphae and sporangiophore hyphae.

Asexual reproduction: It takes place by conidia or spores.

Sexual reproduction:

In zygomycetes it takes place by conjugation. The haploid (n) cells from hyphae of different mating types fuse sexually to produce zygote, which develops into zygospore. The plus (+) and minus (-) strains hyphae produce hormones that stimulate the tip of hyphae to come together forming gametes producing structure called gametangia. The plus and minus nuclei fuse to form a diploid nucleus that is zygote. The zygote develops into a **zygospore.** The zygospore is thick walled and resistant to unfavourable conditions.

> **Tit bits**
>
> *Lichens act as original colonizers of new terrestrial environment.*

Germination:

At the return of favourable conditions, zygospore divides by meiosis. The wall of zygospore splits and hyphae grows upward. The tip of the hyphae develops into a sporangium which have many nuclei. The wall of the sporangium bursts and the spores are released. Each spore grows into new plus and minus strain of mycelium.

"Due to presence of conjugation and zygospore formation, they are called **conjugating Fungi or Zygomycota".**

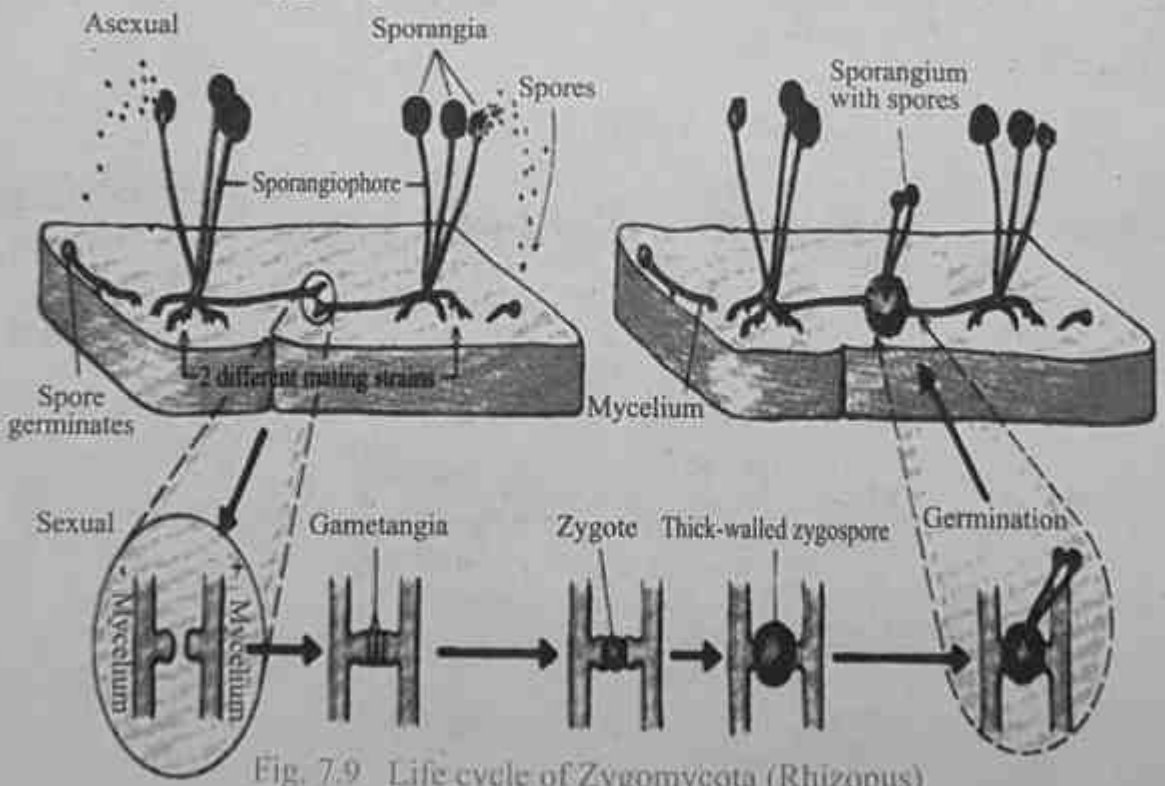


Fig. 7.9 Life cycle of Zygomycota (Rhizopus)

7.4.2 Ascomycota (Sac Fungi)

Do you know?

Now most mycologists think that lichen is not a mutualist association rather than a control parasitism of algal cells by the fungus.

The name Ascomycota or Sac fungi is given because their spores are produced within sacs called asci (ascus means sac).

Ascomycota is the **largest group** of fungi, containing about 30,000 species. Some examples are morels, truffles, yeasts and neurospora. Their hyphae are usually septate. The septa are porous so that cytoplasm can move between compartments. The sac fungi may be unicellular (Yeast) or multicellular (Truffles).

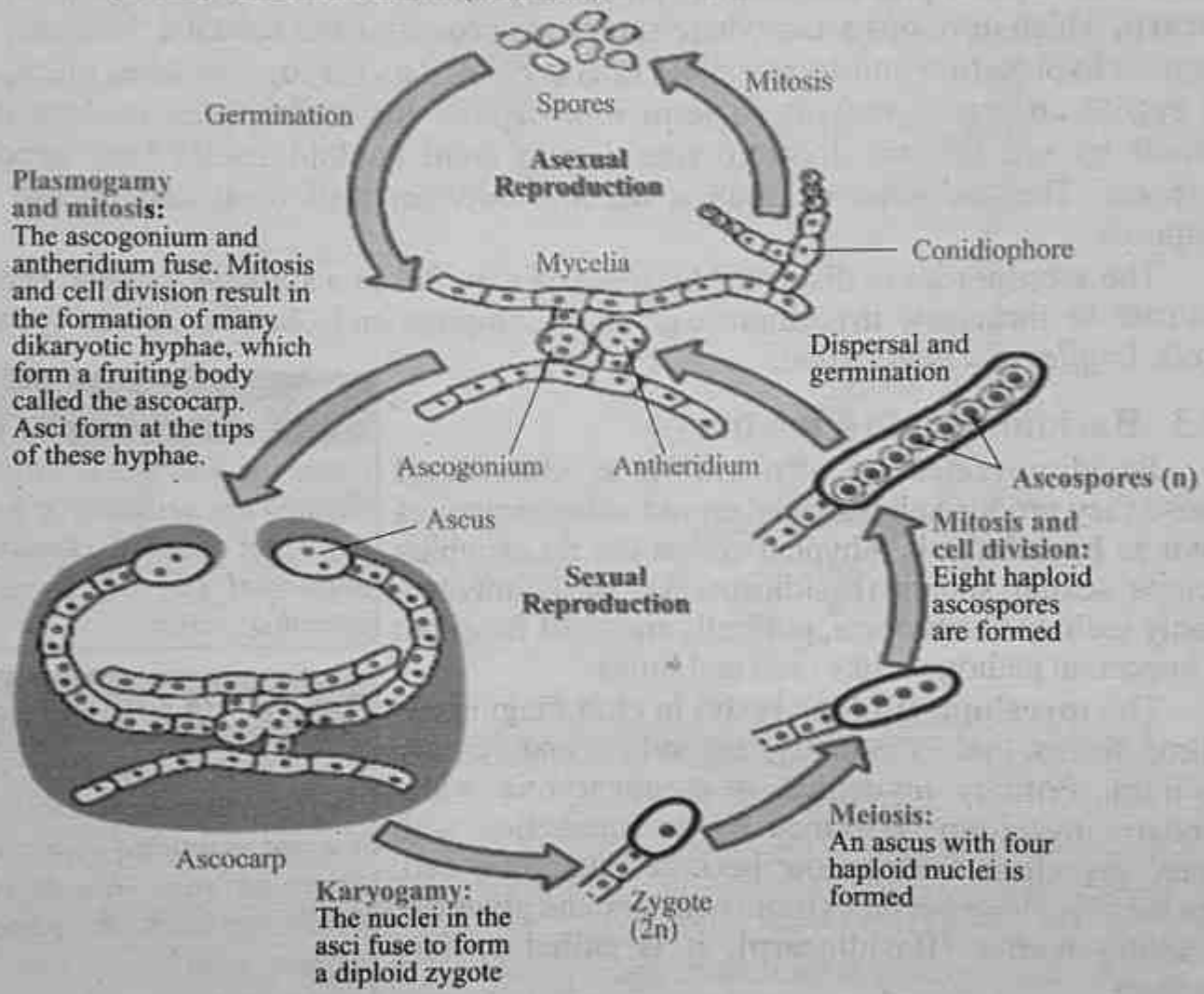


Fig. 7.10 Life cycle of Ascomycete

Reproduction:

Ascomycetes reproduce both asexually and sexually.

Asexual reproduction:

It takes place either by conidia or budding. The conidium; (Gk: dust) may be unicellular or multicellular, vary in shape and size, develop on the tips of erected modified hyphae called conidiophores. There are no sporangia in sac fungi. The colours of conidia vary in different species and it gives characteristic brown, blue, pink or other

tint to many of these fungi. **Bud** is an outgrowth, separates from parent body and grows as independent fungi e.g. unicellular yeast (yeast also reproduces asexually by **fission**).

Sexual reproduction in Ascomycota:

Sexual reproduction occurs by ascospores in both multicellular and unicellular sac fungi.

In sac fungi sexual activities begin when plus and minus strains produce multinucleated sexual bodies. The sexual bodies meet forming a connecting bridge. The nuclei migrate from one body to the next, but do not fuse, forming a new **dikaryotic** hyphae. The haploid plus and minus nuclei hyphae form a fruiting body known as **ascocarp,** which develops ascus where spores are produced and released. In ascus, the dikaryotic hyphae fuse and form diploid (2n) nucleus, i.e., karyogamy takes place, the (2n) zygote undergoes meiosis to form four haploid (n) nuclei, each nucleus then followed by one mitotic division, resulting in eight haploid nuclei later become ascospores. The asci after maturation become swollen, then burst and release the ascospores.

The ascospores are dispersed by wind, if they fall in a suitable location (host), germinate to form new mycelium. e.g., in *Neurospora* and *Saccharomyces* (yeast). *Morels, Truffles and Penicillium.*

7.4.3 Basidiomycota (club fungi)

Basidiomycetes are also known as **club fungi** because they produce club shaped reproductive structures known as **basidia.** It is a hyphal cell at the tip of which develops sexual spores (basidiospores). Basidiomycota not only include mushrooms, puffballs and shelf fungi but also important pathogens like rusts and smuts.

The **mycelium** (fruiting body) in club fungi exists in three forms that is primary, secondary and tertiary mycelium. Primary mycelium is monokaryotic while secondary mycelium is formed by an interaction with primary mycelium which now become dikaryotic cell. When the mycelium becomes more complex and gives rise to fruiting bodies (Basidiocarp), it is called tertiary mycelium.

Mushroom *(Agaricus)* consists of mass of white branched, thread-like separate hyphae that occurs mostly below the ground.

Do you know?

Humus in the soil is formed through the activities of both fungi and bacteria. Humus is essential for the proper growth of plants.

Do you know?

Rusts and smuts: *Rusts are involved in many rusty and orange coloured diseases, Spots on stem, leaves etc. Smuts are black, dusty spore masses similar to soot in wheat, corn etc.*
Rust is caused: *by Puccinia while smut by Ustilago species.*

Reproduction in club fungi (Basidiomycota):

Club fungi usually reproduce sexually, occasionally asexually by conidiophores. The mushroom itself is called fruiting body, consists of stalk and a cap. It is known as **basidiocarp.** The lower surface of the cap usually consists of many thin perpendicular plates called **gills**. They radiate from the stalk to the edges of cap. In the gills the haploid

nuclei of dikaryotic cells fuse to form diploid zygote.

Zygote is only diploid structure in their life cycle. Each zygote immediately undergoes meiosis to produce four (+) and (–) haploid basidiospores in the gills.

The gills burst and spores are released from the fruiting body and carried by wind or animals to a suitable moist land. Each " +ve and –ve" mycelia grow towards each other and cytoplasms fuse (plasmogamy) but nuclei do not fuse. Thus each cell of secondary mycelium contains two haploid nuclei, grows and forms compact mass called **buttons,** along the mycelia. Each button grows into a fruiting body (tertiary mycelium). The dikaryotic stage ends and a new diploid stage begins when (n + n) cells fuse to form zygote in the basidium.

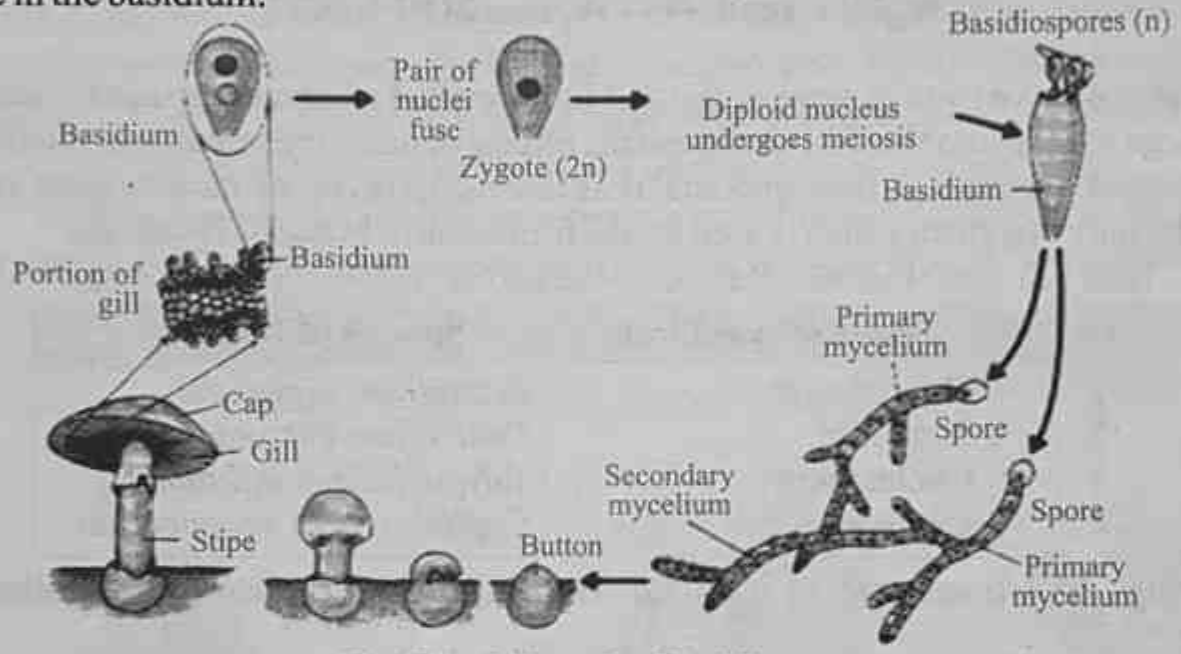


Fig. 7.11 Life cycle of Basidiomycota

Table 7.2 Comparison between Algae and Fungi

Algae	Fungi
They are autotrophic.	They are heterotrophic.
They are mostly aquatic .	They are mostly terrestrial.
Cell wall contains cellulose .	Cell wall is made up of chitin.
Their stored food is starch.	Their stored food is glycogen and oil.

7.5 Importance of Fungi

Fungi are both useful and harmful to human beings and other organisms. Many fungi are palatable, used as food, some help in making various chemicals. It also causes diseases in human beings and other living things. They spoil and decay our food and many other articles.

7.5.1 Importance of yeast

The *Saccharomyces cerevisiae* (yeast) have many benefits to mankind, such as

bread making.

For manufacturing bread yeast is mixed with white flour. The CO_2 produced by yeast become trapped in dough as bubbles, causing the dough to rise, this is what gives leaven bread its light texture. The CO_2 and alcohol produced by yeast is evaporated during baking. The flavour and quality of bread is attained by selecting different strains of yeast.

Brewing (Production of Alcohol) Ethyl alcohol (wine, beer) is prepared by the fermentation of cereals, potatoes, fruit, sugars etc.

$$C_6H_{12}O_6 + \text{yeast} \xrightarrow{\text{Enzymes}} \underset{\text{Ethanol}}{2C_2H_5OH} + 2CO_2$$

In genetic research: yeasts have been used in biological research; especially study of mutation, genetic recombination and to test the effects of many chemicals and medicines. Yeasts possess plasmids in their genome, thus like bacteria can be used as gene vector. Yeast is the only organism which is used for the formation of hepatitis B vaccine.

Table 7.3 Some important antibiotics obtained from different species of fungi

No.	Name of antibiotic	Species of fungus
1	Griseofulvin	*Penicillium nigricans*
2	Penicillin	*Penicillium chrysogenum*
3	Cyclosporins	*Tolypocladium inflatum*
4	Cephalosporin	*Cephalosporin acremonium*

Drugs like **lovastatin** is used for lowering blood cholesterol, **ergotine** for migraine.

7.5.2 Mutualist Role of Fungi (Lichens and Mycorrhizae)

Many fungi live in mutually beneficial relationship (Mutualism) with other organisms, in which both partners get benefit from each other. There are two types of mutualistic association in fungi, i.e., Lichens and Mycorrhizae.

Lichens and their types:

Lichens are associations of fungi (mostly sac fungi) with algae (often green algae and cyanobacteria), therefore, known as compound or **composite organisms.** The fungus provides support and prevent from desiccation, i.e., absorb water from air while in response, the algae partner provides food.

The body of lichen has three layers: the upper thin and tough layer which consists of fungal hyphae, the middle fungal hyphae interwoven with photosynthetic green algae and cyanobacteria while bottom layer consists of loosely packed fungal hyphae. There are three types of lichens.

1. **Crusticose Lichens:** Grow on damp rocks, bark of trees, these are compact lichens.
2. **Foliose Lichens:** These are leaf-like in shape.
3. **Fruticose Lichens:** These are shrub-like and branched, vary in colour, shape,

overall appearance and growth form.

Lichens prefer to grow in areas with low moisture and low temperature. They have great ability to absorb moisture and to get nutrients, therefore, they can survive in area with poor or no soil. Fruticose lichens absorb pollutants from air thus cannot grow where air is polluted. Thus their presence is a **bioindicator** that the air is healthy for humans to breath.

Mycorrhizae:

A mutualistic association between fungus and roots of the vascular plants (about 80%) in a mutual beneficial relationship is called mycorrhizae. The fungus gets sugar from plants and in response gives greater surface area for absorption of water and inorganic salts (P, Zn, Cu, etc.). Mycorrhizae help in better growth of plants, (95% of plants families have this relationship). There are two types of mycorrhizae.

1. **Endomycorrhizae:** In this type hyphae enters into the cell wall of outer cells of plant root forming coils, swelling and minute branches also extend out into surrounding soil.
2. **Ectomycorrhizae:** In this type of association, hyphae surround and extend between the cell wall (do not enter) of roots. They occur mostly with pines, firs etc.

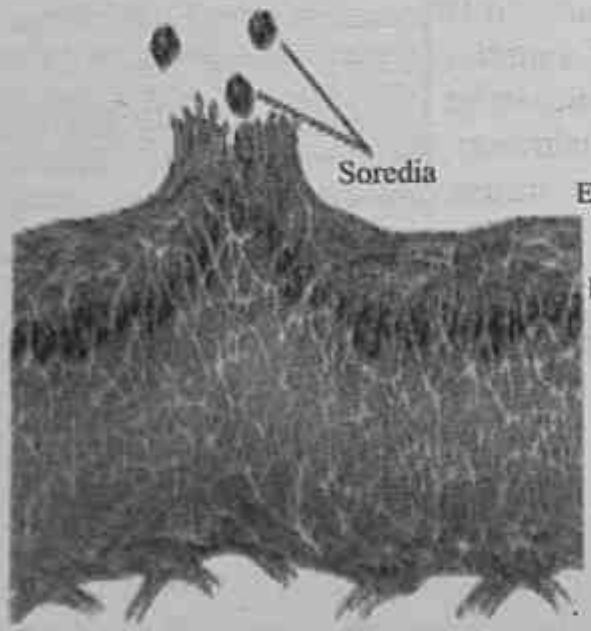


Fig. 7.12 Lichen

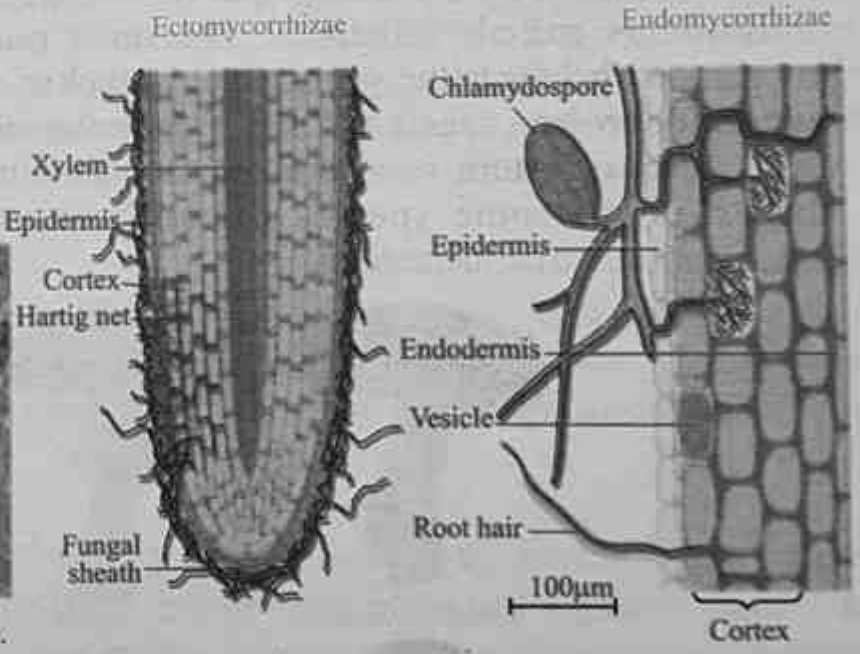


Fig. 7.13 Mycorrhizae

7.5.3 Edible Fungi

Mushrooms are considered popular food throughout world. Mushroom pizzas are famous for their taste. It also gives peculiar flavour and taste to certain types of cheese. About more than 200 species of mushrooms are edible.

Aspergillus tamarii is an example of edible mushrooms. The ascocarp of

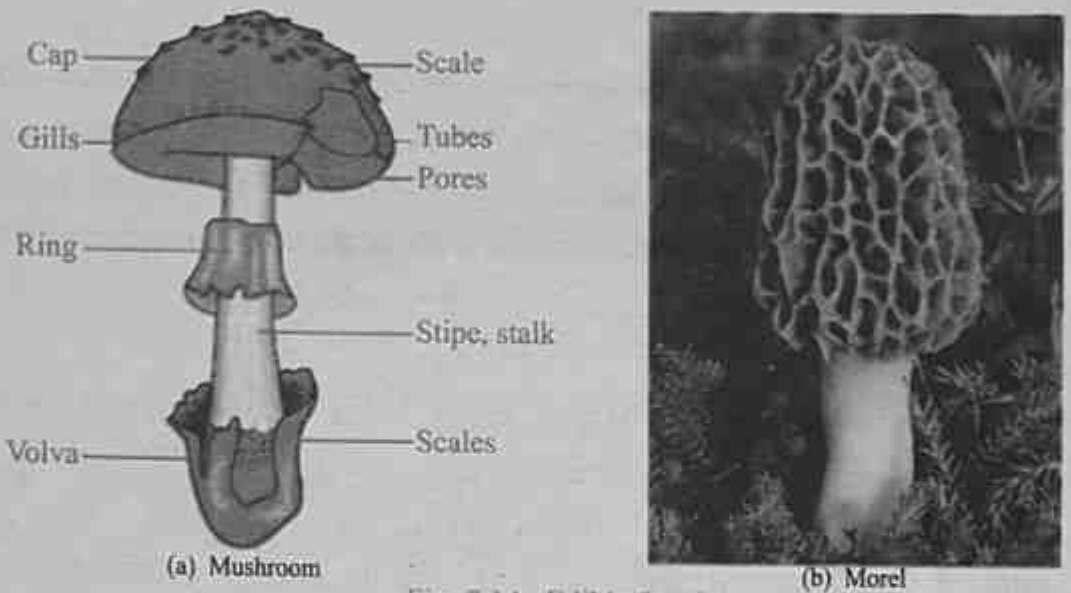


Fig. 7.14 Edible fungi

Morchella esculenta (a morel) and *Tuber melanosporum* (a truffle) are commercially cultivated and highly prized for their complex flavour.

Yeast is also used as nutritional supplement because it contains high level of vitamin B and about 50% of yeast is comprising of protein.

There are about 70 species of poisonous mushrooms called toadstools. The most poisonous mushrooms belong to the genus *Amanita* such as *Amanita virosa* (destroying angel) and *Amanita phalloides* can be fatal. Jack-o-lantern is also a poisonous mushroom. Ingestion of some species of mushrooms cause intoxication and hallucinations.

Do you know?

A pathogenic fungi named "Armillaria" may be considered as the largest organism. A single mycelium may produce one kilometer hyphae per day. It has been measured up to 15 hectares which belongs to group basidiomycota.

Fig. 7.15 Common Poisonous Mushrooms

7.5.4 Ecological impacts of Fungi

Decomposition and recycling of materials

Fungi and bacteria are the basic decomposers in biosphere. Both make significant contribution to the ecological balance of our world. They decompose organic matter and release the substances locked in dead bodies of animals and plants for circulation in the ecosystem.

Fungi possess **potent enzyme system** which helps in splitting tough organic compounds that can not be digested by most other living things, e.g., lignin (in wood). The released substances become available to the next generation of organisms. They also release large amount of CO_2 in the air by decomposition, which is used for the synthesis of organic food by green living things (plants, algae and cyanobacteria).

Thus fungi **recycle** nutrients in nature and are called recyclers. The fungi clean the earth by removing the organic matter and because of this characteristic they have earned the name "scavengers".

7.5.5 Pathogenic Role of Fungi

The pathogens are disease causing organisms. Many fungi are also pathogenic and cause diseases in plants, animals and human beings.

Plant diseases:

Fungi cause many plant diseases, some of which are very important. All plants are susceptible to many fungal infections. Most common fungal diseases of cereals are rusts and smuts caused by *Puccinia* and *Ustilago* respectively which belong to group basidiomycota. Sac fungi cause diseases like powdery mildews, apple scab, chest-nut blight, Dutch elm disease, red rot of sugar cane and brown rot which attack plums, peaches, apricots and cherries.

Fungal diseases of animals:

Fungi cause many diseases in animals, some of which are: Ring worms in dogs and horses are caused by the species of *Trichophyton rubrum* and *Microsporum audouinii*. *Aspergillus sp.* causes abortion in many animals. *Saprolegnia parasitica* is the parasite of carp and salmon fish.

Fungal diseases of human:

Fungi infect all parts of human body especially the skin. *Rhizopus* and *Mucor* species cause the infection of lungs (**Histoplasmosis**), brain and digestive tract. The cause of **dandruff** is *Microsporum furfur*. *Candida* species causes candidiasis (causes infection in the mucus membrane of the throat, mouth, vagina etc.). *Neurospora* and *Fusarium* cause infection of corneal tissues of eyes. *Aspergillus fumigatus* causes aspergillosis which like AIDS destroys immune system. *Aspergillus flavus* produces aflatoxin, a cancer causing mycotoxin in improperly stored grains of peanut, corn etc. Purple ergot rye causes **ergotism,** which causes nervous spasm, convulsion, psychotic delusion and even gangrene. Athlete's foot is caused by *Tinea pedis*.

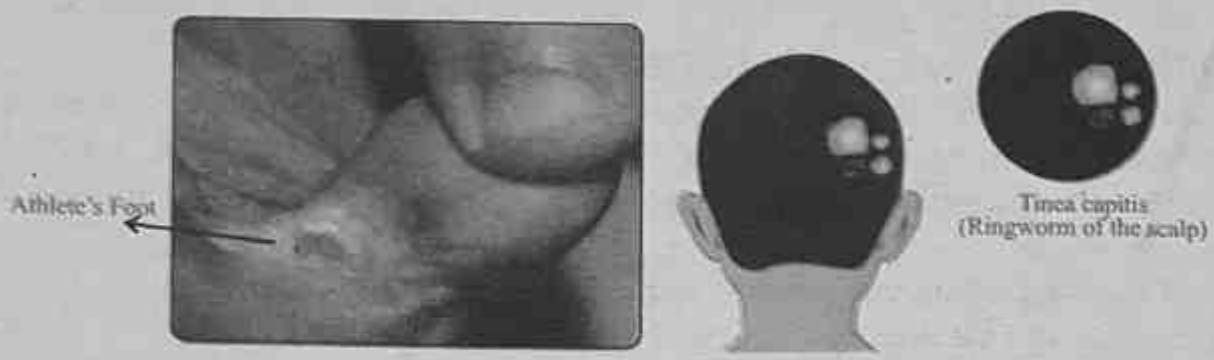


Fig. 7.16 Athlete's Foot and Ring worm

Critical Thinking

Protists are ancestors of plants, animals and fungi. what evidences you can provide to support this belief?

SUMMARY

- The kingdom protista is a polyphyletic group of organisims that do not share a single common ancestor.
- Kingdom Protista includes organisms that are animal-like, plant-like, and fungus-like.
- Protists may be unicellular or multicellular, and may be microscopic or very large.
- Most plantlike protists can make their own food through photosynthesis.
- Protozoa, animal-like protists have various structures that help them to move, such as flagella, pseudopodia, or cilia.
- Some animal-like protists can cause disease such as malaria.
- Fungus-like protists decompose organic matter. These protists have an important role in recycling nutrients through ecosystems. Unlike fungi, fungus-like protists can move during part of their life cycle. Fungus-like protists include slime molds and water molds.
- Fungi are eukaryotic organisms that appeared on land over 450 million years ago. They are heterotrophs and contain neither photosynthetic pigments such as chlorophylls nor organelles such as chloroplasts. Since they feed on decaying and dead matter, they are saprobes.
- Fungi are important decomposers and release essential elements into the environment. External enzymes digest nutrients that are absorbed by the body of the fungus called thallus.
- A thick cell wall made of chitin surrounds the fungal cell.
- Fungi can be unicellular as yeasts or develop a network of filaments called a mycelium, often described as mold.
- Most species of fungi multiply by asexual and sexual reproductive cycles, and display an alternation of generations.

- The divisions of fungi are the Zygomycota, Ascomycota and Basidiomycota.
- Fungi establish parasitic relationships with plants and animals. Fungal diseases can decimate crops and spoil food during storage.
- Fungi have colonized all environments on Earth but are most often found in cool, dark, moist places with a supply of decaying material.
- Many successful mutualistic relationships involve a fungus and another organism. They establish complex mycorrhizal associations with the roots of plants. Lichens are a symbiotic relationship between a fungus and a photosynthetic organism, usually an alga or cyanobacterium.

EXERCISE

Section I: Objective Questions

Multiple Choice Questions

A. Choose the best correct answer.

1. All members of which of the following group are single-celled.
   (a) Algae (b) Protozoa
   (c) Fungi (d) Helminths
2. Protists which absorb nutrients from dead organisms are called.
   (a) Photoautotrophs (b) Autotrophs
   (c) Saprobes (d) Heterotrophs
3. Phycoerythrin is found in which of the following algae.
   (a) Red (b) Green
   (c) Brown (d) All
4. Parasitic Protozoans that form spores at some stage in their life belong to:
   (a) Apicomplexans (b) Ciliates
   (c) Actinopods (d) Diatoms
5. Oomycetes show close relation with fungi and their cell wall contains:
   (a) Chitin (b) Muramic acid
   (c) Silica (d) Cellulose
6. Algae in which the body is differentiated into blade, stipe and hold fast belong to:
   (a) Kelps (b) Euglenoids
   (c) Golden algae (d) Green algae
7. In basidomycetes, fruiting body is made up of mycelium which is:
   (a) Polykaryotic (b) Monokaryotic
   (c) Trikaryotic (d) Dikaryotic

8. Zygomycetes have
   (a) Septate hyphae (b) Imperfect fungi
   (c) Coenocytic hyphae (d) Perfect fungi
9. Lichens are ecologically important as?
   (a) Decomposers (b) Bioindicators
   (c) Oxidizers (d) Pollutants

B. Fill in the blanks.

1. The feeding stage of a slime mold is called _____.
2. Both Fungi and animals mode of nutrition resemble because both are _____.
3. Spore bearing structures are called _____.
4. The basidiomycetes are also called _____.
5. Histoplasmosis is a serious infection of human _____.
6. The largest algae is called giant _____.
7. Plasmodium causes a disease called _____.

Section II : Short answers.

1. Give one characteristic of each type of protist that explains why it is animal-like, plant-like, or fungus-like.
2. What are three types of structures that help some protists move?
3. Name two animal-like protists that cause disease.
4. Explain how do hyphae help a fungus to absorb food?
5. Why are yeasts useful to scientific research?
6. Explain how does the decomposing activity of fungi carry both beneficial and harmful effects ?

Section III: Extensive Questions

1. Describe how algae differs from all the other eukaryotic organisms.
2. Describe the economic importance of yeast.
3. Explain the structure and reproduction of Ascomycota.
4. Explain the structure and reproduction of Zygomycota.
5. Write note on mycorhizae and lichens.
6. Describe Asexual and Sexual reproduction in Rhizopus.