Chapter

7

Protista and Fungi

At the end of this chapter the students will be able to:

- Explain protists as a diverse group of eukaryotes that has 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 for 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 the 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 mycorrhizae 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

Protists are the simplest eukaryotes.. Protists are not animals, plants, or fungi. The protist kingdom is sometimes called the "trash can" kingdom. It includes all eukaryotes that don't fit in one of the other three eukaryote kingdoms: Animalia, Plantae, or Fungi. The protist kingdom is very diverse. There are thought to be between 60,000 and 200,000 protist species. Many have yet to be identified. Protists range from single-celled amoebas to multicellular seaweed. Protists may be similar to animals, plants, or fungi. Scientists think that protists are the oldest eukaryotes. If so, they must have evolved from prokaryotic cells. Fungi include some of the most important organisms, both in terms of their ecological and economic roles. By breaking down dead organic material, they continue the cycle of nutrients through ecosystems. In this chapter you will study a brief over view of the kingdom Protista and Kingdom fungi.

7.1 Protista

Most of the protists are unicellular but some are multi-cellular or colonial. Many have mitochondria although some never possessed any while some have later lost them. It is thought that ancestral prokaryotic cells, which then became mitochondria in the eukaryotic cells. The process is called **endosymbiosis.** Many protists possess chloroplast for photosynthesis. Chloroplast may also have originated this way with eukaryotic cells engulfing photosynthetic bacteria. The common ancestry of protista seems doubtful. The group of organisms has long independent evolutionary history stretching as far back as two million years. They seem to have a polyphyletic origin. Some groups are probably placed together more for convenience than as a reflection of close kinship. But the genome analysis, added to other criteria, enables us to postulate some groupings.

Protista can be categorized into three main groups:

a. Animal like Protists (Protozoa)

b. Plant like Protists

c. Fungi like Protists

a. Animal like Protists (Protozoa)

These organisms are called protozoans and they share some common traits with animals. All animal-like protists are heterotrophs and are motile. Animal-like protists are unicellular and they are divided into four basic groups based on how they move and live. Some are also parasites that can cause diseases. The Protozoa is often divided into 4 groups which are discussed below.

1. Zooflagellates or kinetoplastids

These protists move by using their whip-like flagella. Many of these protists live in the bodies of other organisms. They could harm their host by having a parasitic relationship or at other times they are mutualistic with their host. Trypanosomes is a parasite which is a cause of many serious human diseases. The most familiar being trypanosomiasis, also known as African sleeping diseases.

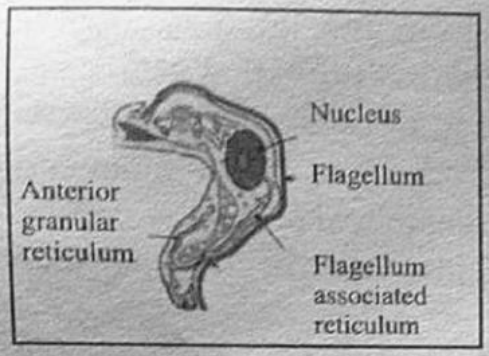

Fig: 7.1 Structure of *Trypanosomes* Fig: 7.2 Termites feed upon wood

One of the example of mutualistic relationship in this group is between termites and trichonymph. Termites feed upon wood but they cannot digest it due to the absence of a specific enzyme which brings about the breakdown to digest the wood eaten by termite. Trichonymph lives in the digestive tract of termites and produce an enzyme that helps in the digestion of wood.

2. Amoeboid protozoan or sarcodines

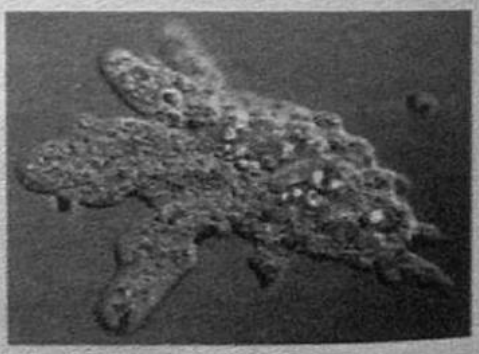

Fig: 7.3 Ameoba

Their organ of locomotion are pseudopodia which are temporary protoplasmic outgrowths. These are also used for engulfing food articles. Sarcodines are mostly free-living, found in fresh water, sea water and on damp soil. One of the familiar example is amoeba. It is soft, shapeless masses of cytoplasm. The change in shape is brought about by cytoplasmic streaming which forms cell extensions called pseudopodia.. The prey is digested by enzymes and the digested parts are absorbed into the cytoplasm. Amoeba reproduces by binary fission. Many species are parasites of animals and humans causing dysentery.

.3. Apicomplexes or sporozoans

Apicomplexes are spore-forming parasites of animals. They are called apicomplexes because of unique arrangement of fibrils, microtubules, vacuoles and other cell organelles at one end of the cell. The best-known apicomplex is the malarial parasite Plasmodium. Female Anopheles mosquito is the carrier of Plasmodium.

hen an infected female Anopheles mosquito bites a person, sprorozoites are cted into the blood stream. Sporozoites are carried to the liver where they stay divide forming large number of merozoites. Merozoites emerge from the liver invade red blood cells and start producing more merozoites within these cells. infected red blood cells burst releasing the merozoites which again enter other blood cells. The host at this stage starts showing the symptoms of malaria uding chill and fever accompanied by nausea, vomiting and severe headache.

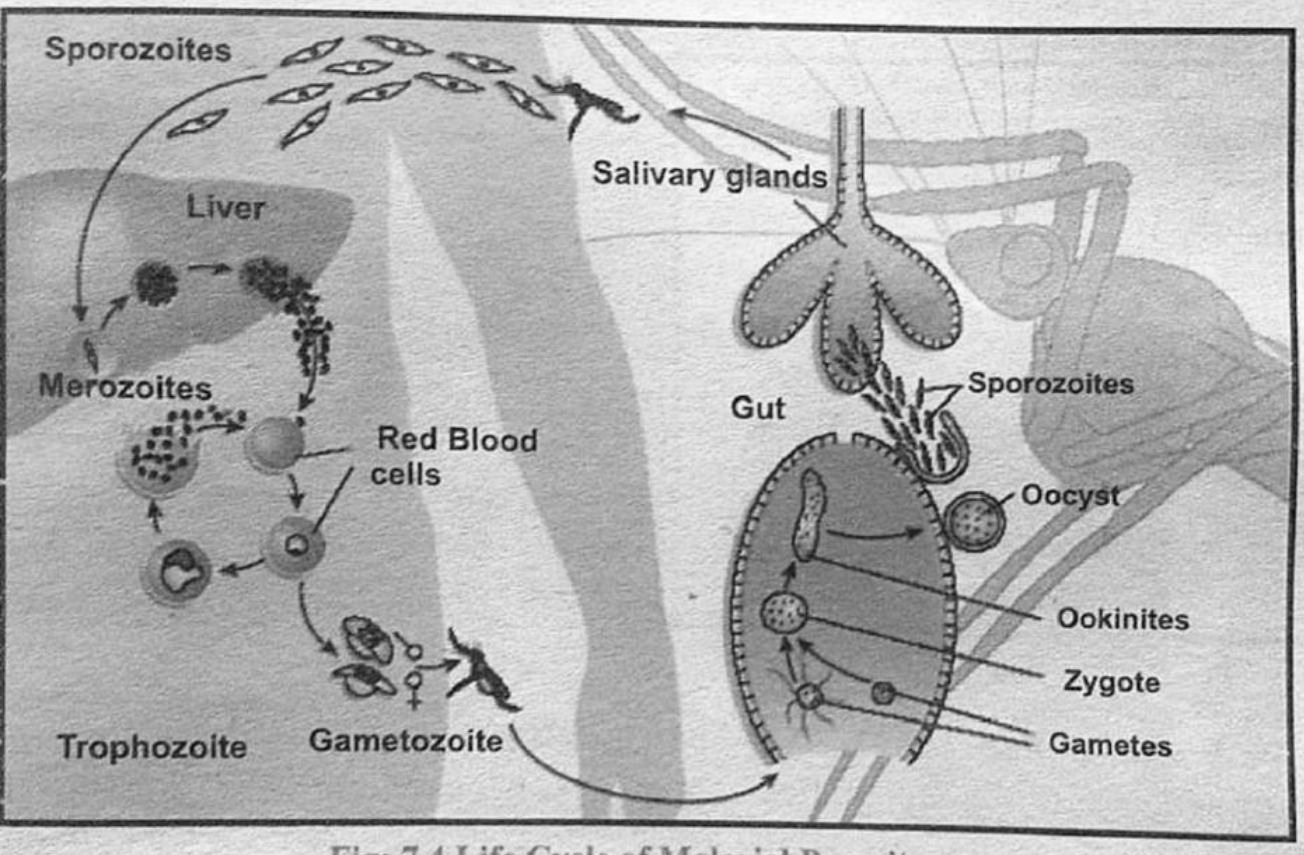

Fig: 7.4 Life Cycle of Malarial Parasite

Some of the merozoites develop into male and female gametes. If the cted human host is again bitten by a female Anopheles mosquito, these gametes aken up by the mosquito and sexual reproduction starts. The male gamete lizes the female gamete to produce a zygote. The zygote reaches the mid gut of nosquito and then encysts forming an oocyst. The oocyst produces a number of ozoites and transfer to the salivary glands of the mosquito. When this mosquito a healthy person, the sporozoites are discharged into the body of the host and a cycle stands.

Ciliates

Ciliates protozoan develop a number of cilia during a part or whole of the life e. They use cilia for locomotion and driving food. Cilia are usually arranged in itudinal rows or in spirals around the cell. Ciliates possess cellular organelles perform functions similar to the organs of multicellular organisms.

All ciliates have two different types of nuclei within the cells. Small micronuclei and larger macronuclei. Macronuclei are essential for the physiological function whereas micronuclei are needed only for sexual reproduction.Ciliates form vacuoles for ingesting food and regulating water balance. Paramecium, a well know ciliate, sweeps the food into its gullet, from there it passes it into the vacuole where enzyme and hydrochloric acid help in digestion. The digested material is absorbed into the body and the vacuole empties its waste material into the anal pore located in the pellicle. The waste material then leaves the cell by exocytosis.

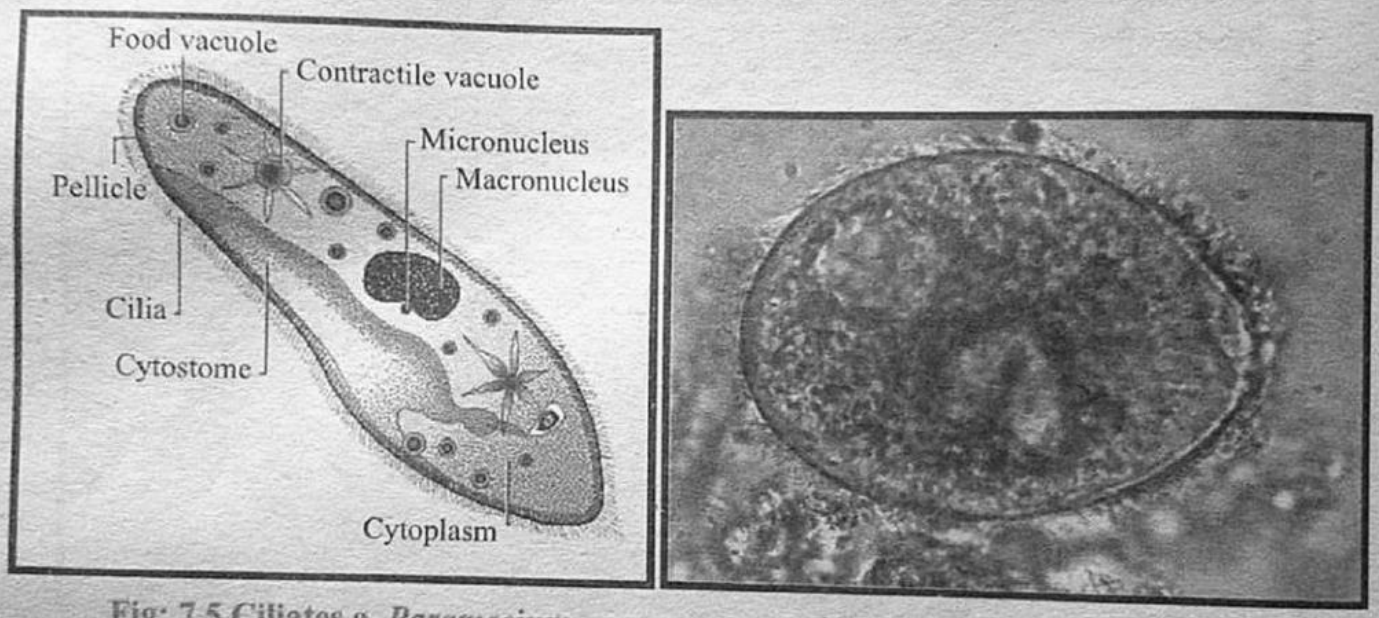

Fig: 7.5 Ciliates a. *Paramecium* b. *Balantidum coli.*

Paramecium reproduces asexually by transverse fission. It also undergoes a type of sexual reproduction called conjugation. Most ciliates live in freshwater or saltwater but they do not infect other organisms. However, *Balantidum coli* inhabits intestinal tracts of pigs and rats. People working in slaughter houses may become infected by *Balantidum coli.*

b. Plant like Portists

Plant like protists are divided into the following important groups:

1. Dinoflagellates

Dinoflagellates are unicellular autotrophs possessing chlorophyll a and c in addition to carotenoids. They live in both marine and freshwater environments. The cell wall is generally missing but when present, it is hard and made up of cellulose. They have two flagella of unequal size inserted laterally. The two flagella beat in two grooves, one encircling the cell like a belt and the other perpendicular to it.

Fig: 7.6 Dinoflagellate .

t, the encircling flagellum causes the organism to spin like a top; the r flagellum makes the organism move in a particular direction. In the , the poisonous and destructive "red tides" occurs frequently. These ciated with great population explosions or "blooms" of dinoflagellates : the colour of the water to red.

diatom is made up of two shells made of silica which are strikingly and :ally marked. The shells of diatoms are like small boxes with lids, one ell fitting inside the other. Their chloroplasts containing chlorophyll a l as cartenoids, resemble those of dinoflagellates. The shells of fossil n form thick deposits on the ocean floor which is called diatomaceous s used in water filters, paints and nail polishes. Most diatoms reproduce xual reproduction is not common.

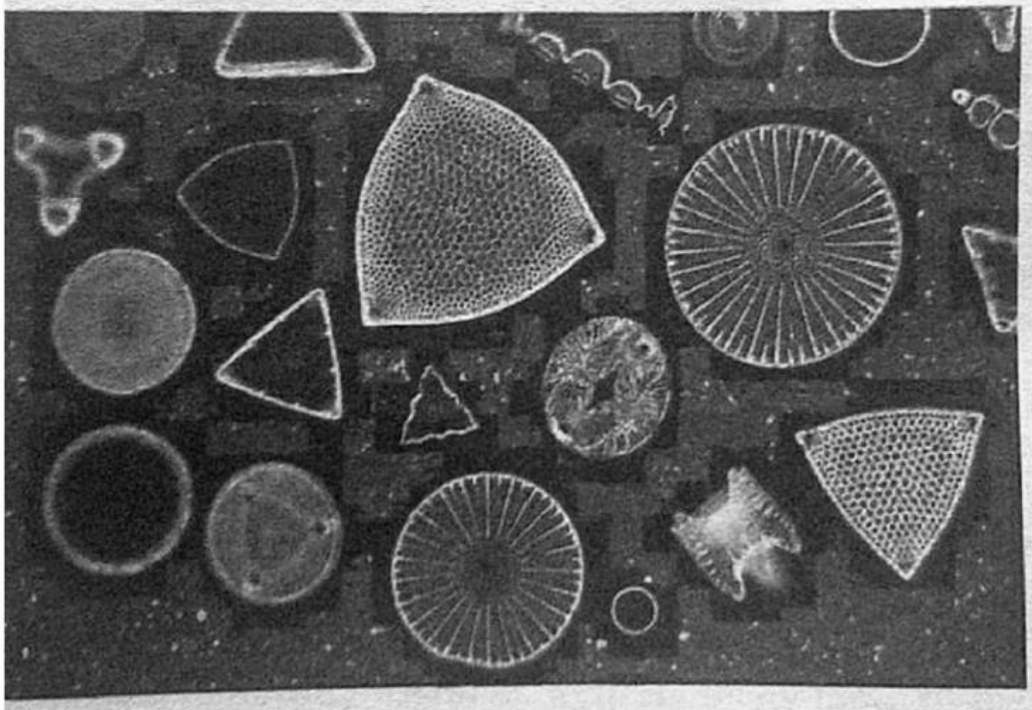

Fig: 7.7 Diatom Gallery

ıe

algae are the most conspicuous seaweeds. They possess air bladders m afloat during high tides. The life cycle of brown algae is marked by of generations between a diploid sporophyte and a haploid Kelps are brown algae possessing large leaf-like thallus. They are ce of food for fish, bird and other marine animals. Some genera of ength of about 100 meters. They are attached to the rocks on ocean root-like structure called holdfast.

4. Rhodophyta

The reddish colour of the algae is due to red accessory pigment called phycoerythrin which masks the green colour of chlorophyll. But red algae do not always appear red. Some exhibit different colours depending upon the type and amount of photosynthetic pigments present in their chloroplasts. The red algae play a major role in the formation of coral reefs and produce glue-like substances such as agar and carrageenan that make economically important.

5. Chlorophyta

Chlorophyta include both unicellular and multicellular forms. Most forms are aquatic but some live on moist places on land. They show many similarities to land plants; they store food as starch, cell wall is made up of cellulose and possess similar chloroplast structure containing chlorophylls a and b. it is because of these similarities that chlorophyta are considered ancestors of plants.

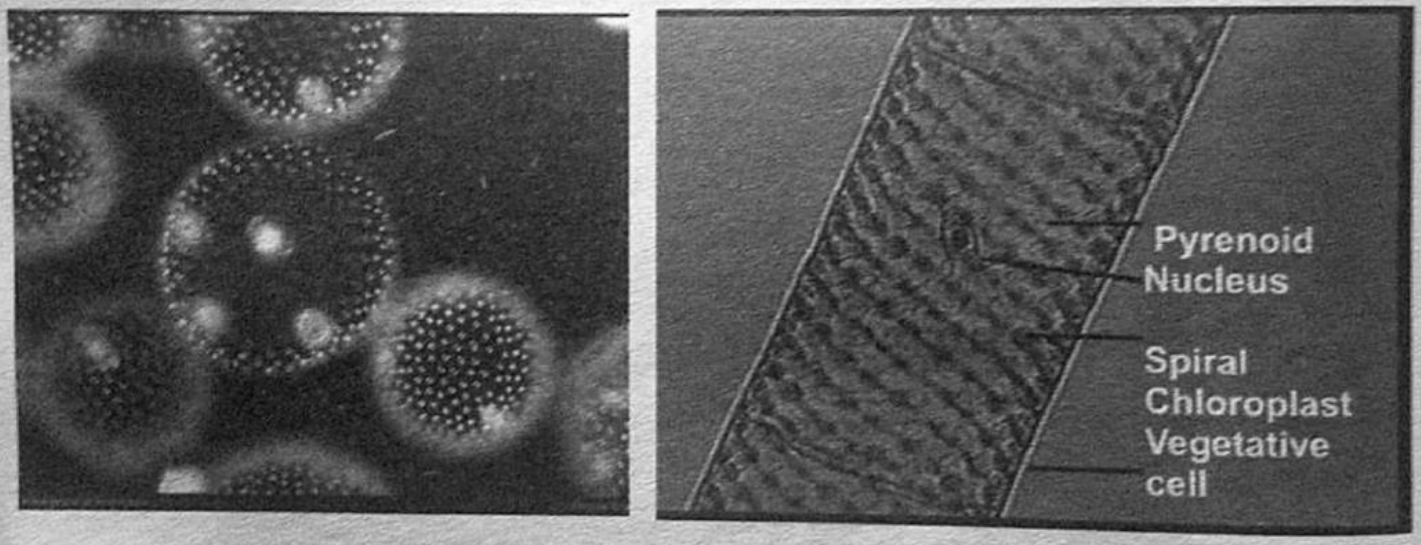

Fig: 7.8 a. Volvox b. Spirogyra filament

Chlamydomonas is a unicellular genus whereas volvox represents the colonial form. Spirogyra is a multicellular, filamentous green alga inhabiting the freshwater. Each cell of spirogyra contains one or more spiral chloroplasts. Asexual reproduction occurs through zoospores. Sexual reproduction is conjugation.

c. Fungus like Protists

Main groups of this category of protests are given below.

1. Plasmodial slime molds (Myxomycota)

Slime mold takes many forms. The most common forms on turf resemble small purple or black ball attached to a blade of grass or a readily noticeable creamy-white, yellow-orange, purple, or gray jelly-like mass situated on the lawn.

The colonies of slime mold living on logs and bark mulch can be strikingly colorful in yellow, orange or red. At one stage of their life cycle, they form a mass called a plasmodium which grows in size but does not become multicellular and remains a single mass of cytoplasm which is not divided by plasma membrane. It contains many diploid nuclei.

This "supercell" (plasmodium) is the product of mitotic nuclear divisions which are not followed by cytokinesis.

The cytoplasm in plasmodium streams back-and-forth which helps in distributing nutrients and oxygen. The plasmodium extends pseudopodia through moist soil, leaf litter or rotting logs engulfing and digesting food particles, bacteria and yeasts by phagocytosis. When the food or moisture exhausts, the plasmodium stops growing, moves to a new area and produces fruit bodies containing spores. Meiosis occurs in flagellate gametes. The gametes fuse in pairs and form a new plasmodium by mitosis.

2. Oomycota (water molds)

All the members of oomycota are either parasites or saprophytes. They are distinguished from other protists by their zoospores which bear two unequal flagella, one pointed forward and the other backward. Because of some similarities, oomycota were previously placed with fungi, but there exist many differences between the two groups. In oomycota cell wall is made up of cellulose whereas it is of chitin in fungi. Although oomycota descended from plastid bearing ancestors, yet they do not possess plastids and cannot bring about photosynthesis. Water molds living as parasites on aquatic animals produce white fuzz on the body of their host.

Importance of Protista to Humans

Protista play fundamental role in the ecosystem of world. These organisms form the foundation for food chains, produce the oxygen we breathe and play important role in nutrient recycling. Some protists are harmful but many more are beneficial. Many are economically useful as well. As many more of these unique organisms are discovered, humans will certainly enjoy the new uses and benefits protista provide.

Algae are the protista which play the most beneficial role for humans. Many form the basis of food chain which drives the wheel of life on earth. They prepare food for other organisms through photosynthesis. It has been estimated that upto one-quarter of world's photosynthesis is performed by algae and its associates. The planktons play a major role in photosynthesis in aquatic ecosystem. The vast majority of planktons in the ocean consist of various protists.

Protista are also responsible for decomposing the organic matter and recycling the nutrients. Euglena is used to treat sewage because of its ability to switch from an autotrophic to a heterotrophic mode of nutrition. Protists form a wide range of symbiotic relationship with other organisms. *Trichonympha* lives in the digestive system of terminates and produces cellulose, an enzyme that enables termites to digest wood.

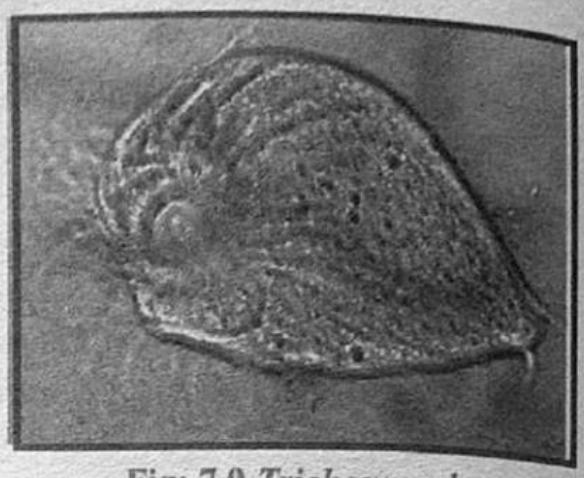

Fig: 7.9 *Trichonympha*

Animal-like protists are responsible for diseases such as malaria, amoebic dysentery, African sleeping sickness and giardiasis in humans. *Phytophthora infestans* causes late blight of potato and great potato famine of Ireland in 1840s was due to the destruction of potato crop by this protist.

Some protists have medicinal and industrial uses. Carrageenan, a glue-like substance from algae is used to produce a thicknening agent in ice cream, pudding and dairy products. Chemicals from algae are used to manufacture waxes, plastics and lubricants. Other chemicals made from protists are utilized in medicines used in the treatment of ulcers, hypertension and arthritis.Many species of red algae are consumed as food in some countries. Red algae are rich in vitamins and minerals.

7.2 Kingdom Fungi

Fungi were regarded as plants because of the presence of certain characters since the last many decades, but detailed studies have revealed a set of characteristics that distinguish fungi from plants. Fungi lack chlorophyll, while the plants have this pigment; wall of a fungal cell is made up of a carbohydrate called chitin not found in plant cell walls; though generally filamentous, fungi are not truly multicellular like plants, because the cytoplasm of one fungal cell is continuous through pores with the cytoplasm of adjacent cells; and fungi are heterotrophic eukaryotes, while plants are autotrophic. It is mainly because of these reasons that fungi are placed in their own kingdom fungi.

Fungi are generally saprophytes and are the most important decomposers in terrestrial ecosystem. Many fungi are also known as parasites of animals and plants. They are found everywhere. They also develop symbiotic association with other organism. Recent finding are that fungi are more closely related to animals than plants. It is believed that fungi evolved from a unicellular flagellated ancestor. The ancestors of fungi and animals diverged into separate lineages about one billion years ago.

Do You Know?

Armillaria ostoyae
(Honey Mushroom)
World's largest organism

A single mycelium can produce upto one kilometers long new hyphae in one day. World's largest organism is a fungus called Armillaria Ostoyae (honey mushroom) growing on stumps and roots of trees in Seattle, Washington. A single colony of fungus covers 8.9 km^2 areas. It weighs 100 tons and is about 1000 years old. Most parts of the fungus lie hidden beneath the ground. It periodically produces edible fruit bodies (mushroom) above the ground.

7.2.1 General Characteristics of Fungi

1. Fungi are heterotrophic

Fungi obtain their food by secreting digestive enzyme into substrates. Then they absorb the organic molecules released by the enzymatic action.

2. Fungi have several cell types

Multicellular fungi are filamentous and the filaments are in the form of long slender structures called hyphae. Sometimes the filamentous form is lost and the hyphae are arranged in complex structures such as mushrooms.

3. Chitin cell wall

The cell walls of fungi are made up of chitin, a nitrogen containing polysaccharide, which is more resistant to decomposition than cellulose.

4. Nuclear mitosis

Mitosis in fungi is different from that in plants and animals. The nuclear envelope does not break and reform. Mitosis occurs in nucleus with nuclear membrane intact.

7.2.2 Classes of Fungi and their Diagnostic Features

a. Zygomycota

The members of the class are all terrestrial. They possess coenocytic hyphae. They live on decaying organic material. Zygomycota are characterized by the formation of sexual spores called zygospores formed by the mating hyphae. Both sexual and asexually produced sopores are dispersed by air.

Some members of the class are responsible for the rotting of bread, peaches, strawberries and sweet potato during storage; other live as parasites or symbionts of animals. *Rhizopus stolonifer*, the common bread mold, is an important member of zygomycota. The hyphae form a white or grey mycelium on bread. In asexual phase upright sporangiophores arise each of which bears a sporangium at its tip. Thousands of spores are formed in each sporangium. The haploid spores are dispersed by air. Spores, when land on moist food, grow into new mycelia.

b. Ascomycota

The characteristic feature of ascomycota is the production of sexual spores called the ascospores within saclike asci (singular, ascus); thus, they are commonly called sac fungi. Unlike zygomycota, the most ascomycota bear their sexual states in fruit bodies called ascocarps which range in size from microscopic to macroscopic. Asci are produced in ascopcarps. Most of the ascomycota also reproduce asexually by means of conidia, produced in chains at the end of a conidiophores.

Some of the ascomycota parasitize crops and ornamental plants causing powdery mildew.

Certain members of the class are extremely beneficial. Many ascomycota are the decomposers of plant material. More than 40% live with green algae and cyanobacteria in beneficial symbiotic associations forming lichens. Some form mycorrihizae with roots of higher plants. Penicillin, the wonder drug, is obtained from a fungus called pencillium. Yeast is useful for both bakers and brewers.

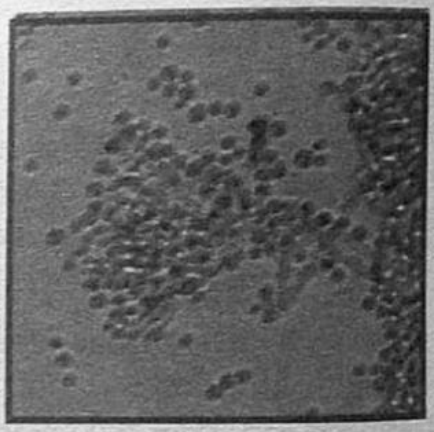

Fig: 7.10 Pencillium

c. Basidiomycota

Basidiomycota not only include mushrooms, puffballs and shelf fungi but also important pathogen like rusts and smuts. They are also known as club fungi because of their club-shaped basidia. The mycelium in basidiomycota exists in three forms i.e. primary, secondary and tertiary mycelium. Primary mycelium is also called monokaryon in which each cell is unicucleate possessing a halploid nucleus. Secondary mycelium is formed by an interaction with primary mycelium.

It consists of dikaryotic cells in which each cell possesses two haploid nuclei. When the mycelium becomes more complex and gives rise to fruit bodies (basidiocarps), it is called tertiary mycelium. Club-shaped basidia are arranged inside a fruit body called basidiocarp. Karyogamy occurs in basidium which is followed by meiosis forming four haploid nuclei which are incorporated in basidiospores.

Sexual reproduction occurs through classical methods found in other groups of fungi. Sexual reproduction in basidiomycota differs from all other groups of fungi. No reproductive structures such as antheridia and oogoina are formed. The sexual reproduction involves the conversion of monokaryotoc phase to dikaryotic phase by various methods.

7.2.3 Importance of Fungi

1. Fungi in pharmaceutical industry

Fungi have been used medicinally since ancient times. Ergotamine obtained from *claviceps purpurea* is used to facilitate delivery of babies and also used to relieve migraine headache. Pencillin, the first discovered antibiotic is produced by pencillium chrysogenum and other related species. Cephalosporin is most widely used broad spectrum antibiotic, obtained from cephalosporium acremonium and related species. Griseofulvin is an antibiotic used effectively against fungal infections of hair, nails, skin, athlete's foot and ringworm.

It is obtained from a species of *Pencillium.* Broad spectrum antibiotic cyclosporine used as a immunosuppressant drug in organ transplantation is also a fungal product.

2. Fungi in food industry

Yeast has been used by humans throughout recorded history. *Saccharomyces cerevisiae,* (yeast) is used in baking and wine making industry. It has got the ability to ferment carbohydrates, breaking down glucose to produce ethanol and carbon dioxide. It is fundamental to the production of bakery products, bear and wine.

3. Fungi used in research projects

Yeasts are mostly used in the biological research projects due to their rapidly increasing generation time and increasing pool of genetic and biological information. In soft drink industry *aspergillus* sp. is used to produce citric acid for colas.

4. Edible fungi

Mushroom is considered popular food throughout the world. Mushroom pizzas are famous for their taste. The peculiar flavor and taste of certain types of cheese come from the fungi used in the processing. The ascocarp of *Morchella esculanta* (a morel) and *Tuber melanosporum* (a truffle) are highly prized for their complex flavor.

Fig: 7.11 Mushrooms

Ectomycorrhizae of some plant families are also edible. Yeast is also used as a nutritional supplement because it contains high levels of B vitamins and about 50 percent of yeast is protein.

5. Symbiosis

Fungi develop many symbiotic associations with other organisms lichens and mycorrhizae are the examples of this relationship.

a. Lichens

In a lichen, a fungus develops a symbiotic association with an alga in which alga is the photosynthetic partner. It is an excellent example of mutualism in which both the partners are benefited. Most of the visible body of the lichen consists of its fungal partner. Interspersed with the hyphae of the fungus, there are found cyanobacteria, green algae or sometimes both. Specialized fungal hyphae penetrate the cell walls of algal partner and transfer nutrients directly to fungus. Biological signals sent out by fungus direct its algal partner to produce metabolic substances that it does not produce when growing independent of fungus.Lichens are known as pioneers in ecological succession in extremely harsh habitats. Lichens are often strikingly colored because of pigments that play a role in protecting the photosynthetic partner from the destructive action of the sun's rays. These pigments can be extracted from lichens and used as natural dyes.

Fig: 7.12 Lichens are common primary colonizers of surfaces. This rock surface has a variety of lichens growing together and adjacent with one another.

b. Mycorrhizae

The roots of about 80% of all known species of vascular plants normally are involved in mutualistic symbiotic relationships with fungi. The association is called mycorrhizae. The fungus in a mycorrhiza increases total surface area of root system for soil contact and absorption.

Mycorrhiza helps in the direct transfer of phosphorus, zinc, copper and other nutrients from the soil into the roots. The vascular plant supplies organic carbon to the fungus.

There are two principal types of mycorrhizae. In endomycorrhizae, the fungal hyphae penetrate the outer cells of the plant root, forming coils, swellings and minute branches and also extend out into the surrounding soil. In ectomycorrhizae, the hyphae surround but do not penetrate the cell walls of the roots.

6. Fungi as recycler

Fungi and bacteria are the principal decomposers in biosphere. Saprophytes exceed parasites in number in the ecosystem. They decompose the organic matter and release the substances locked in the dead bodies of plants and animals for circulation in the ecosystem. They possess a powerful enzyme system which helps in breaking down tough organic compounds like lignin, a major constituent of wood. The substances thus released become available to the next generation of organisms. Fungi recycle the 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 scavenger.

7. Fungi as food spoilers

Fungi also destroy food which is not properly preserved. It includes bread, jams, cooked food etc. Fungi secrete substances into the food which make the food unpalatable, carcinogenic and poisonous.

8. Pathogenic fungi

. Fungi can cause different fatal disease in living organisms. Some of the significant pathogenic effects of fungi are discussed below.

Fig: 7.13 Powdery mildew on a leaf

a. Plant diseases

Fungal diseases of plants are known to us since ancient times. Fungi are the serious agricultural pests. Most common fungal diseases of cereals are rusts and smuts caused by species of *Puccinia* and *Ustilago* respectively. Sometimes about 50 percent of world's fruit harvest is lost to fungal attack each year. Peach leaf curl, pear leaf spot and mildews are the diseases of fruits. Red rot of sugarcane, potato blight, late blight of tomato and many more diseases of plants are caused by fungi.

b. Animal diseases

Ringworms in dogs and horses are caused by the species of *Trichophyton* and *Microsporum*. *Aspergillus* sp. cause abortion in many animals *Saprolegnia parasitica* is the parasite of carp and salmon fish.

Fig: 7.14 Ringworm in dog.

c. Fungal diseases

Almost all parts of human body are infected by fungi especially the skin. Rhizopus and Mucor species cause the infection of lungs, brain and gastric tissues. The cause of dandruff is *Microsporum furfur*. *Candida sp.* cause throat and mouth diseases, pulmonary infection, diseases of nails and genital organs. *Neurospora and Fusarium* cause infection of corneal tissue of eye. Aspergillosis, whose symptoms resemble those of tuberculosis, is caused by *Aspergillus sp*. Athletet's foot is also a fungal disease.

KEY POINTS

- The kingdom protista consists of prokaryotic organisms including unicellular , colonial or very simple multicellular ones.
- In the coastal areas, the poisonous and destructive "red tides" are associated with great population explosions or "blooms" of dinoflagellates which change the colour of the water to red.
- Apicomplexes have unique arrangement of fibrils, microtubules, vacuoles and other cell organelles at one end of the cell. The best-known apicomplex is the malarial parasite Plasmodium.
- Kelps are brown algae possessing large leaf-like thallus.
- The shells of fossil diatoms often form thick deposits on the ocean floor which is called diatomaceous earth.
- Oomycota are either parasites or saprophytes. They are distinguished from other protists by their zoospores which bear two unequal flagella, one pointed forward and the other backward.
- The reddish colour of the algae is due to red accessory pigment called phycoerythrin which masks the green colour of chlorophyll.
- Chlorophyta show many similarities to land plants; they store food as starch, cell wall is made up of cellulose and possess similar chloroplast structure containing chlorophylls a and b. Because of these similarities that chlorophyta are considered ancestors of plants.
- Choanoflagellide are most likely the common ancestor of the sponges and all animals. They include three groups i.e. Amoebas, Forminaifera and Plasmodial slime molds.
- Algae are the protista which play the most beneficial role for humans.

EXERCISE

A. Choose the correct option of each statement and encircle it.

1. The protist which lives in the gut of termites and digests wood belongs to the group:
   a. Euglenozoa b. Kinetoplastid
   c. Stramenopila d. Rhodophyta
2. Which of the following is the infective stage of malarial parasite?
   a. Merozoite b. Sprorzite
   c. Oocyst d. Ookinite
3. Plasmodium of slime molds contains:
   a. One haploid nucleus b. Two diploid nuclei
   c. Many haploid nuclei d. Many diploid nuclei
4. Symptoms of malaria appear when:
   a. Gametes are produced b. Red blood cells burst
   c. Sporoazoites enter the liver d. Oocyst is formed
5. Presence of air bladder is associated with which of the following organism?
   a. Paramecium b. Euglena
   c. Volvox d. Kelps
6. In nuclear mitosis of fungi, the nuclear membrane:
   a. dissolves b. remains intact
   c. shrinks d. fuses with genetical material
7. Dikaryon is a cell in fungi containing:
   a. one diploid nucleus b. Two diploid nuclei
   c. One haploid and one diploid nucle d. Two haploid nuclei
8. Mitochon dria most likely evolved by:
   a. Photosynthetic cyanobacterium b. Cytoskeletal elements
   c. Endosymbiosis d. Membrane proliferation
9. The closest relative of fungi are probably:
   a. Slime molds b. mosses
   c. Green algae d. Animals
10. What term describes the close association of a fungus with the root of a tree?
    a. Rhizoid b. Llichen
    c. Mycorrhiza d. Endophyte

11. Members of which phylum produce a club shaped structure that contains spores?

a. Chytridiomycota
b. Basidiomycota
c. Glomeromycota
d. Ascomycota

2. Write short answers of the following questions.

1. What were the consequences of cells undergoing the process of endosymbiosis?
2. What do you understand by red tides?
3. Why asexual reproduction is critical for the survival of fungi?
4. Why fungi are considered a threat for crops?
5. Discuss the role of algae in maintaining the oxygen balance in the biosphere.
6. What do you understand by symbiosis?
7. How will you justify the name scavengers given to fungi?
8. Discuss the medicinal importance of *claviceps purpurea*.
9. Discuss the economic importance of yeast.

C. Write answers of the following questions in detail.

1. Describe the salient features of class ascomycota.
2. Discuss the general characteristics of fungi.
3. Given an account of the class basidiomycota.
4. Discuss the beneficial aspect of fungi.
5. Given an account of human and animals diseases caused by fungi.

Projects:

- Collect five sample of algae from your local environment. Preserve them in glass bottles. Take guidance from your teacher for their scientific identification.
- Collect some local mushrooms from your environment and make a list of edible and poisonous mushrooms.
- Search some fungi which are source of antibiotic.