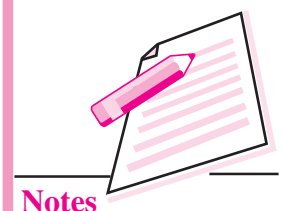


2

314en02

THE KINGDOMS MONERA, PROTOCTISTA AND FUNGI

The Kingdom Monera which includes all the bacteria including blue-green algae (cyanobacteria) and the Protoctista which includes the protozoa, the diatoms and some algae are in a way the simplest among the living world. All bacteria, majority of protoctists and many fungi are microscopic and generally referred to as micro-organisms. You will learn about the three kingdoms in this lesson.

OBJECTIVES

After completing this lesson, you will be able to :

- *state the basis for classifying certain organisms as members of kingdoms Monera, Protoctista and Fungi;*
- *emphasize the fact that Kingdom Monera is the only prokaryotic kingdom and also that it is the most primitive;*
- *describe the generalized structure of a bacterium and cyanobacterium;*
- *describle economic importance of bacteria with examples;*
- *recognize the status of cyanobacteria and justify its inclusion in kingdom Monera;*
- *describe the characteristics of Kingdom Protoctista (protista);*
- *describe the structure of Amoeba, Paramecium, Euglena and Plasmodium;*
- *describe the structure of diatoms;*
- *list the uses of protists to humans and mention the diseases caused by protozoa;*
- *list the general characteristics of fungi with examples;*
- *describe the strucutre and reproduciton of yeast, Rhizopus,* mushroom, *Penicillium and its utility for humans;*
- *explain what are mycorrhizae;*
- *describe the economic importance of fungi.*

2.1 KINGDOM MONERA

- Includes the bacteria and cyanobacteria (commonly called blue-green algae).
- Since only bacteria are prokaryotic (lacking a true nucleus, that is without a nuclear membrane), Monera is the only **prokaryotic** kingdom.
- Bacteria were the first cellular organisms to evolve on the planet earth after life originated around 3.5 billion years ago and were the **only** cellular organisms on earth for almost the next two billion years.
- Most bacteria are single celled or **unicellular** (monere : single) but actinomycetes and some cyanobacteria are multicellular and filamentons wherein filaments may be branched.
- Monerans are also the most numerous of all living cellular organisms.

2.1.1 Structure of a bacterial cell

The single celled bacterium has a cell wall made of the compound peptidoglycan covering the cell membrane; and a single circular (upring-like) chromosome. The cell has ribosomes but no membrane bound organelles. Let us get to know some details of these parts (Fig. 2.1).

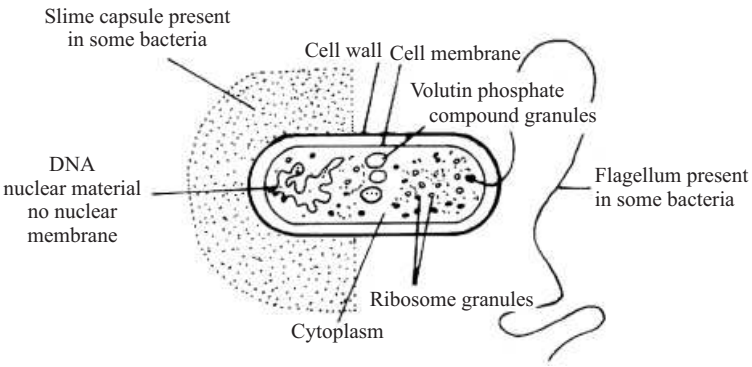


Fig. 2.1 Structure of a bacterium.

Note the following parts of a bacterium in the figure (Fig. 2.1). The outermost covering is the cell wall.

Cell wall

All prokaryotes have a rigid cell wall, which protects and gives shape to the cell. The cell wall is made up of a chemical, **peptidoglycan,** unique to bacteria, lipids, polysaccharides and some proteins.

Pili (Singular : pilus)

Pili are short and thin thread like tubular structures projecting out from the cell wall in some bacteria.

Flagella

Some bacteria move with the help of one or more flagella. Flagella are longer and thicker than pili. Their structure is different from flagella of eukaryotes.

Plasma Membrane

Plasma membrane, present below the cell wall, encloses the cytoplasm and other cell contents. It is made up of lipids and proteins, as in eukaryotes.

Genetic Material

One circular chromosome made of a double helical molecule of DNA is located in a region of the cytoplasm called **nucleoid**. Since the chromosome is not lodged within a true nucleus, bacteria are termed as prokaryotes. Hence Monera is the prokaryotic kingdom. Apart from the chromosome as several species of bacteria possess one or more additional rings of DNA called **plasmids**, which replicate along with bacterial chromosome and bear genes for antibiotic resistance and act as the sex factor or F-factor providing the property of male sex to the cell that bears the sex-factor or the F-factor.

Cell Organelles

Membrane bound organelles like endoplasmic reticulum, mitochondria, chloroplast, and golgi complex are **absent**. Only 70s *ribosomes* are present, which are different from those of eukaryotes (see lesson 1 and 4).

> Prokaryotes have no nuclear membrane around genetic material and no membrane bound cell organelles except mesosomes. They have only the 70s ribosomes.

2.1.2 Monera - General body functions

A. Nutrition

The four nutritional categories found in bacteria are :

(i) Autotrophs - synthesize their own organic food.

(ii) Saprotrophs - feed on dead organic matter.

(iii) Symbionts - use food from other living organisms with which they are associated for mutual benefit.

(iv) Parasites - absorb food from living organisms and cause harm to them

B. Respiration

Respiration in bacteria may be either

(i) aerobic i.e. using oxygen for respiration or

(ii) anaerobic i.e. respiration in the absence of oxygen.

Cellular respiration or breakdown of food to release energy occurs in **mesosomes** which are the inner extensions of the cell membrane.

C. Reproduction

(i) **Asexual Reproduction**

Bacteria reproduce asexually by **binary fission** (Fig. 2.2). Under favourable conditions it takes about 20 minutes for one bacterium cell to divide into two by binary fission.

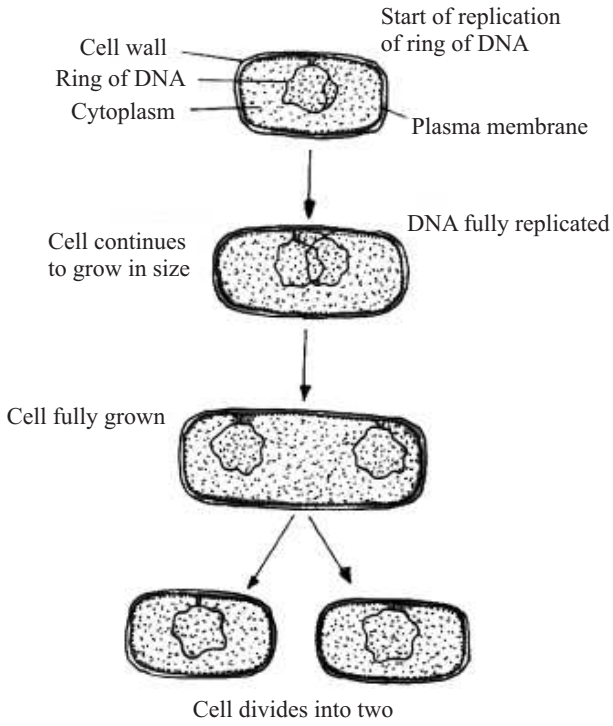


Fig. 2.2 Binary Fission in Bacteria

(ii) Sexual Recombination (=Genetic Recombination)

Some bacteria show a primitive mode of sexual reproduction. It is different from sexual reproduction in higher forms. The steps are:

(a) Two conjugating (lie very close for transfer of genes) bacteria are held together by pili.

(b) A segment of DNA strand is transferred from one bacterium to another bacterium. (Fig 2.3) or F-factor = sex-factor (fertilisty factor) is transferred from male donor cell to female (recipient) cell.

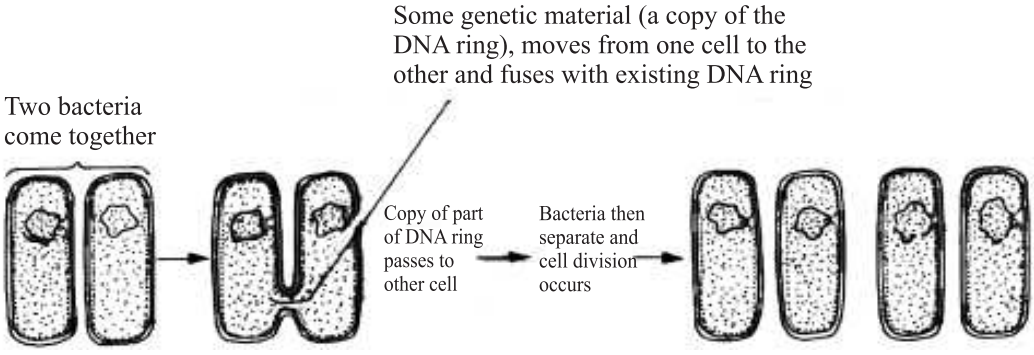


Fig. 2.3 Conjugation in Bacteria

INTEXT QUESTIONS 2.1

1. What is the chemical nature of the circular single chromosome of a bacterium?

   .....

2. Name the special region in the bacterial cell where genetic material lies.

   .....

3. What is the main component of cell wall in prokaryotes?

   .....

4. State one point of difference between flagella and pili.

   .....

5. Give one difference between aerobic and anaerobic bacteria

   .....

6. What is transferred during sexual recombination in a bacterium?

   .....

2.1.3 Beneficial and harmful bacteria

Many bacteria harm us by causing many diseases. On the other hand some bacteria are very useful.

Diseases Caused By Bacteria

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

Beneficial Activities of Bacteria

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

2.1.4 Cyanobacteria

These were earlier called the blue-green algae. (Fig. 2.4a) A very successful group on primitive earth, they could carry out photosynthesis and the oxygen released during the process changed the earth's atmosphere and gradually the level of oxygen increased in the earth's atmosphere.

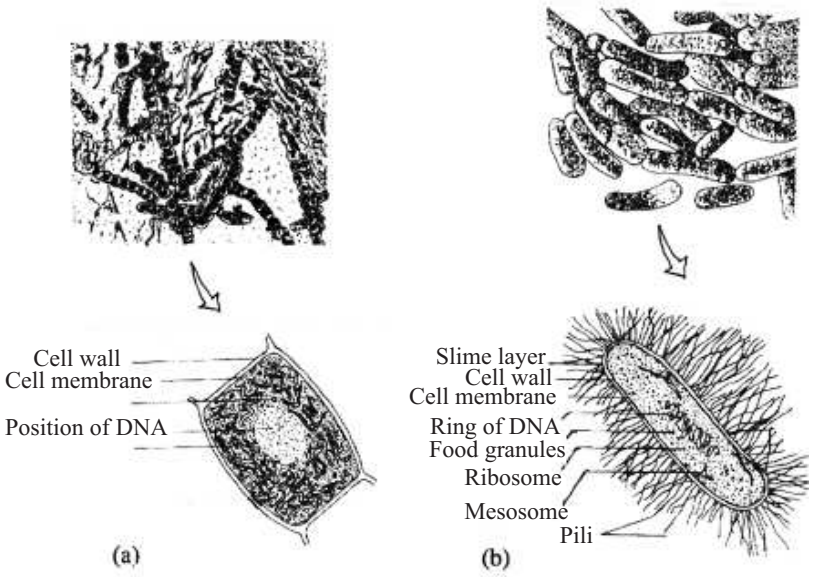


Fig. 2.4a-b Cyanobacteria (blue green algae)

Differences between Bacteria and Cyanobacteria

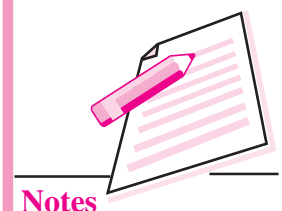
Bacteria	Cyanobacteria
1. Smaller cells	1. Comparatively larger cells
2. May have flagella	2. Do not have flagella.
3. Some bacteria (green) carry out photosynthesis in a different way and do not release oxygen (anoxygenic)	3. They all carry out photosynthesis in the usual manner as in green plants and release oxygen (oxygenic)
4. Sexual recombination by conjugation in some bacteria	4. Sexual recombination has been observed in some cyanobacteria.

INTEXT QUESTIONS 2.2

1. Name the bacteria that :

   (i) fix atmospheric nitrogen in the soil .....

   (ii) set milk into curd .....



(iii) cause tuberculosis .....

(vi) cause tetanus .....

2. Approximately how many bacteria may be obtained from one bacterium in an hour?

.....

3. Give any three differences between bacteria and cyanobacteria.

.....

2.1.5 Monera

Kingdom Monera includes three groups, viz.

1. Archaebacteria
2. Eubacteria, and
3. Cyanobacteria

Archaebacteria includes bacteria that live in unusual environments particularly at low levels of oxygen. Main types of Archaebacteria are

- **Methanogenic** bacteria that live in sewage and intestinal tracts of animals
- **Thermoacidophilic** bacteria that live in hot springs.
- **Halophilic** bacteria which live in salty conditions where hot sun concentrates sea water. Eubacteria include all other bacteria excluding cyanobacteria. All cyanobacteria are oxygenic photoautotrophs.

2.2 KINGDOM PROTOCTISTA (UNICELLULAR EUKARYOTES)

- Protoctista are **unicellular eukaryotes**. Protozoa, diatoms and unicellular algae are included in it.
- They have membrane bound organelles such as nucleus with chromosomes enclosed in nuclear membrane, mitochondria, chloroplast (in photosynthetic protoctists only), golgi bodies and endoplasmic reticulum.
- Mitochondria are the respiratory organelles.
- Protoctists are either photosynthetic, parasitic or saprotrophic.
- For locomotion, protoctists may have cilia or flagella (Fig. 2.5) having 9 + 2 microtubules unlike those of bacteria, which consist of only one spirally coiled protein, called flagellin.
- They reproduce both asexually and sexually.
- Some protoctists are beneficial to humans whereas the others are harmful.

2.2.1 Classification of Protoctista

The kingdom protoctista includes –

1. **Phylum Protozoa** which has the following four classes :

(i) Rhizopoda : Example, *Amoeba*

(ii) Flagellata : Example, *Euglena*

(iii) Ciliata : Example, *Paramecium*

(iv) Sporozoa : Example, *Plasmodium*

The protistan algae belong to

1. Phylum Bacillariophyta : Example diatoms
2. Phylum Chlorophyta : Example *Chlorella*

2.2.2 Some examples of Protoctists

1. *Amoeba*

Amoeba is commonly found in the mud, in freshwater ponds and ditches containing decaying leaves.(Fig. 2.5a)

– It has blunt pseudopodia for locomotion.

– It captures food by pseudopodia to form a food vacuole.

– It has a contractile vacuole for osmoregulation

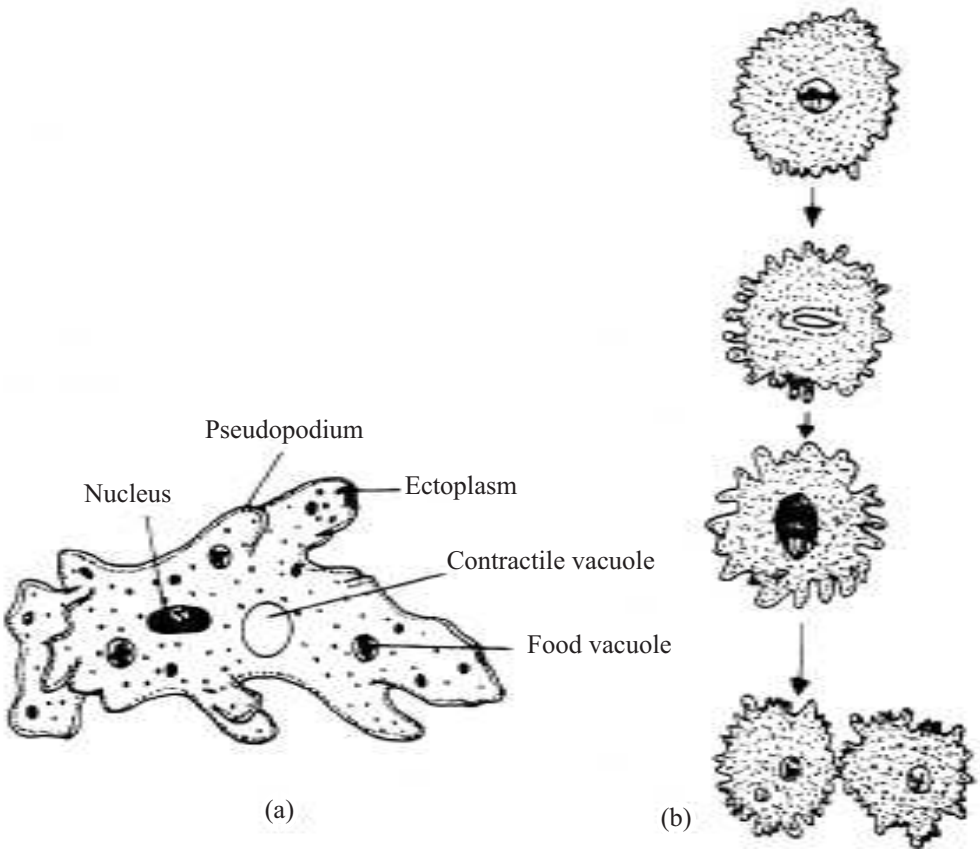


Fig. 2.5 Amoeba : (a) General Structure, (b) Amoeba showing binary fission.

Reproduction : Sexual reproduction is uncommon in *Amoeba*.

Asexual reproduction is by binary fission. (Fig. 2.5b)

2. *Entamoeba*

One common species is *Entamoeba histolytica* which caues amoebic dysentery in humans. It is amoeboid in form. The new host gets infected when the cyst is swallowed along with contaminated food or water. The cyst bursts and releases *Entamoeba* in the intestines where it causes local abscesses (open injury). The symptoms of amoebic dysentery are abdominal pain, nausea and presence of blood and mucus with stool.

3. *Plasmodium* (The malarial parasite)

The life cycle of *Plasmodium* has both asexual and sexual phases.

– The asexual phase is spent in the human blood.

– Sexual phase is spent in the female *Anopheles* mosquito Fig. 2.6.

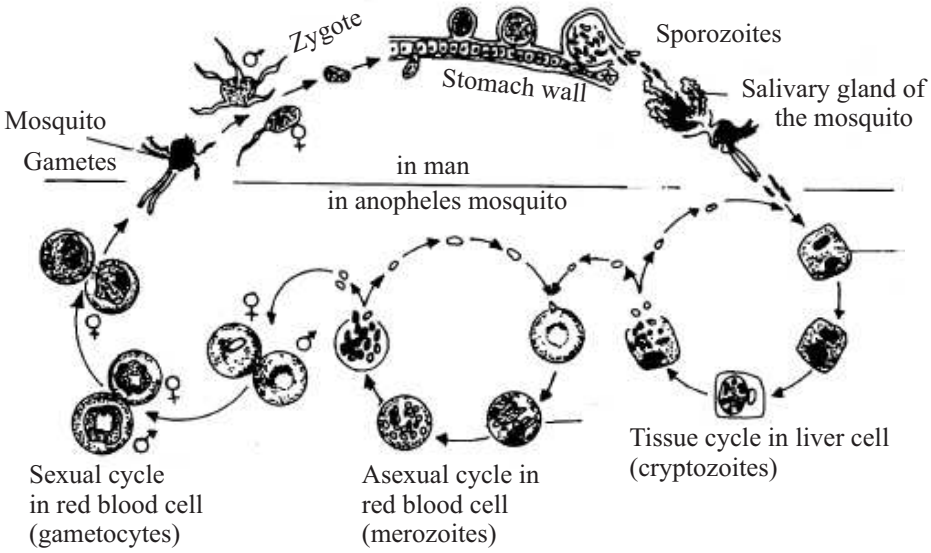


Fig. 2.6 The life cycle of Plasmodium in mosquito and man.

> **Male** *Anopheles* cannot cause malaria as it feeds on plant juices and not the human blood.

4. *Euglena* – A freshwater Flagellate

Euglena is abundantly found in stagnant waters such as pools, ponds and ditches containing decaying organic matter. (Fig. 2.7)

As seen in the Fig. 2.7, the organism has the following parts.

Pellicle - elastic body covering made up of protein.

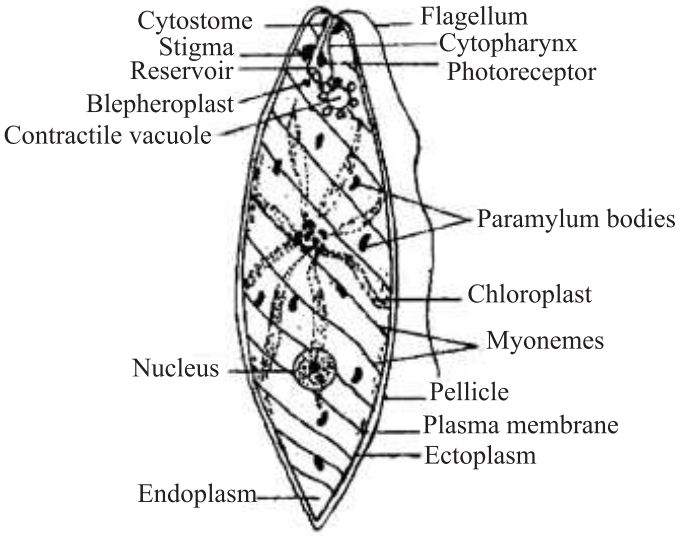


Fig 2.7 *Euglena* - General Structure

Cytostome and Reservoir - the cell mouth leading into a tubular cytopharynx which opens into a vesicle called reservoir.

Stigma or eyespot - a prominent red pigment spot. It is sensitive to light.

Contractile Vacuole - for osmoregulation.

Flagellum - for propulsion in water.

Chloroplast - contain green coloured chlorophyll for photosynthesis.

Reproduction - is by binary fission.

5. The Diatoms

– The diatoms are found in both fresh and salt water and in moist soil.

– Thousands of species of diatoms act as food for aquatic animals.

– Diatoms are either unicellular, colonial or filamentous and occur in a wide variety of shapes (Fig. 2.8).

– Each cell has a single prominent nucleus and plastids. They produce shells (cell walls) containing silica.

Fig. 2.8 Diatoms

6. Other Algae

– Algae can be unicellular e.g. *Chlamydomonas* (2.9a) or multi-cellular like *Spirogyra* (Fig. 2.9b)

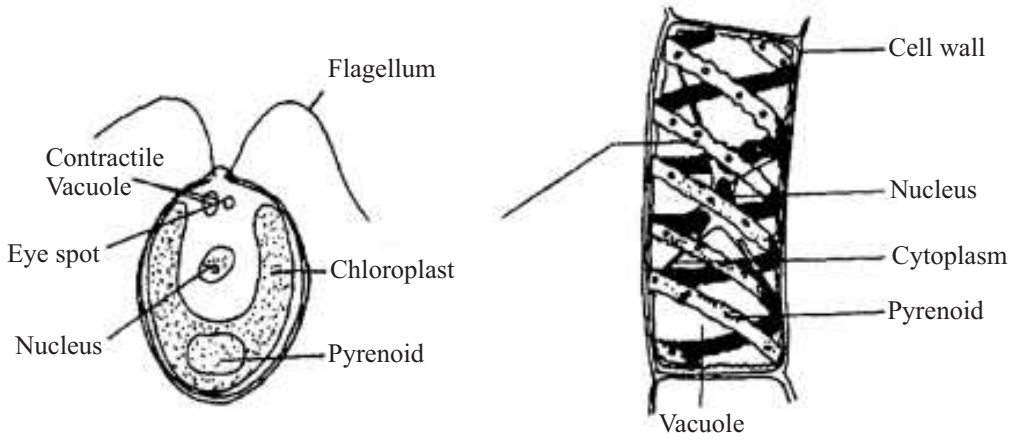


Fig. 2.9 (a) *Chlamydomonas* (b) *Spirogyra*

– Algae can prepare their own food by photosynthesis as they contain chlorophyll. Some algae have other pigments also e.g. blue pigment (Phycocyanin), a brown pigment (Fucoxanthin) or a red pigment (Phycoerythrin). Depending on the pigment present, the algae are called blue, green, brown or red algae.

Colour of the Red Sea is due to the dominant occurrence of a blue-green alga, *Trichodesmium erythraeus*

– Structurally the algae have a definite cell wall, cell membrane, a nucleus, cytoplasm and choloroplast. The chloroplast is cup-shaped in *Chlamydomonas* and ribbon-shaped in *Spirogyra*. Pyrenoids, the starch containing bodies are integral part of chloroplasts in green algae.

2.2.3 Usefulness of Algae

– Provide food for fish as part of phytoplankton (organisms floating on the water surface)

– These are rich sources of vitamins A and E.

– Many marine forms are important sources of iodine, potassium and other minerals.

– Blue-green algae increase the soil fertility by fixing atmospheric nitrogen.

– Blue-green algae that fix atmospheric nitrogen, are a source of natural fertilizer for the crop plants.

– A group of algae (diatoms) deposit silica in their walls. After their death these algae are preserved as fossils. Their siliceous deposits in large amounts result in the formation of diatomaceous earths that are used as filters, and for lining of furnaces.

INTEXT QUESTIONS 2.3

1. Protoctists are single celled like most of the Monerans. Why have they been put in a separate kingdom? Answer in one short sentence.

   .....

2. Name the protozoan which causes

   (i) Amoebic dysentery .....

   (ii) Malaria .....

3. Which is the kind of asexual reproduction found in Protoctista?

   .....

4. Through which organelle of the protoctists does respiration occur?

   .....

5. Name the organelle responsible for regulating water content (osmoregulation) in amoeba.

   .....

6. Name two kinds of locomotion found in protoctista.

   .....

2.3 KINGDOM FUNGI

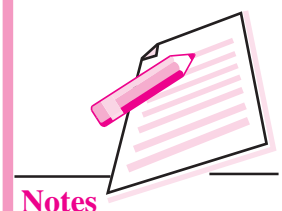
2.3.1 Position of Fungi

During warm humid days slices of bread, chapati, leather belts or shoes, develop a powdery layer on them. In lawns and flower beds, mushrooms come out. These are all fungi.

Fungi were earlier classified as plants without chlorophyll and without differentiation of their body into root, stem and leaves. They are now included, in a separate Kingdom called **Fungi.**

2.3.2 Characteristics of Fungi

- Fungi are heterotrophic unicellular or **multicellular eukaryotes**
- Fungi exist as slender thread like filaments called hyphae. Hypha may be one celled or multicelled and has, one or more nuclei. Yeast, however, is single celled, and uninucleate.
- Their cell walls are made of chitin
- A hypha may be divided into cells by partitions called septa.



- Septa have pores through which cytoplasm streams freely.
- A group of hyphae forming a network is called mycelium (mycetos meaning fungus; Fig. 2.10).
- Mycelia spread out on the substrate, or on the ground and even extend upto several kilometers.
- They do not possess chlorophyll as their nutrition is by absorption or feeding on dead organic matter.
- Aquatic fungi have flagellate gametes or flagellate spores
- Higher fungi do not have flagellum at any stage of life cycle.
- Reproduction in fungi is both asexual by means of flagelalte or non-flagellate spores and sexual through conjugation (refer to Fig. 2.13, 2.14).

Fungi are eukaryotic, unicellular or multicellular saprotrophs having filaments which grow through soil, wood and other substrates.

2.3.3 Five main kinds of Fungi

The fungi are of five main kinds

1. Myxomycetes, the **Slime moulds**, which have irregular shape.
2. Phycomycetes, are unicellular, filamentous and branched e.g. *Rhizopus and Phytophthora*.
3. Ascomycetes, are one celled (e.g. yeasts) or multicellular branched e.g. *Aspergillus, Penicillium,* and *Neurospora*.
4. Basidiomycetes, are multicellular, branched, and are represented by rusts, smuts, **Mushrooms** and **toadstools**, which are large enough to be seen by naked eyes.
5. Deuteromycetes, are multicellular filamentous branched fungi which reproduce only by asexual means e.g. *Alternaria*.
6. **Lichens and mycorrhizae** which exist in symbiotic associations.

1. Yeasts

Yeasts are fungi which do not produce any hyphae. These are generally in the form of single oval cells.

Fig. 2.10 shows the general structure of a yeast cell. Note the followmg features in it:

– ovoid cell.
– distinct cell wall and nucleus.
– one or more vacuoles in the cytoplasm.
– cytoplasm is granular and has glycogen and fat (oil) globules.

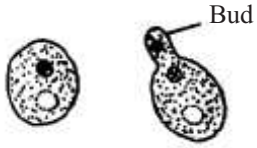


Fig. 2.10 A single cell of yeast

Nutrition

Yeast is saprotrophic. It can directly absorb simple sugar (glucose) but for obtaining sucrose (cane sugar) it gives out the enzyme invertase or sucrase which breaks down sucrose into simple sugars. The simple sugars are then simply absorbed into the cell.

Yeast respires anaerobically to yield energy as follows

$$\underset{\text{(glucose)}}{C_6H_{12}O_6} \longrightarrow \underset{\text{(ethyl alcohol)}}{2C_2H_5OH} + 2CO_2 + \underset{\text{(energy)}}{2ATP}$$

Reproduction

Yeast reproduces asexually by budding (Fig. 2.11).

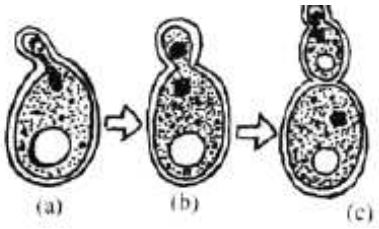


Fig. 2.11 Budding in yeast (a) A bud is forming and the nucleus is dividing; (b) Bud formed and the nucleus gets divided; (c) Further budding forms a chain

Sexual reproduction may also occur by conjugation between two yeast cells. The fused contents divide by one meiosis followed by one mitosis to produce eight cells with a thick wall around each. The 8-celled structure is called **ascus** and each cell is called **ascospore**. The ascospores may be carried by wind and germinate under suitable conditions to produce new yeast cells.

2. Myxomycetes (Slime Moulds)

These consist of a naked, creeping multinucleate mass of protoplasm sometimes covering up to several square metres. The nuclei are diploid

3. Basidiomycetes (Mushrooms and Toadstools)

The vegetative part of the mycelium lies embedded in the substratum (in ground or in wood) When conditions are favourable the umbrella like mushrooms grow out with a stalk and a cap. (Fig. 2.12)

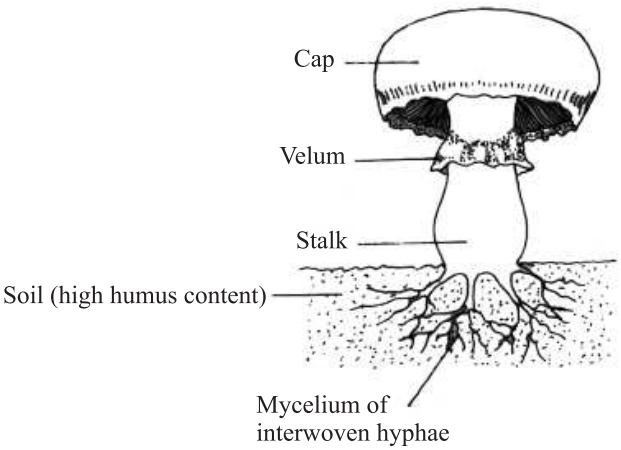
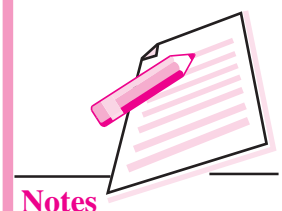


Fig. 2.12 A Mushroom



4. Lichens

These are a combination of a certain fungus and a green or blue green alga which live in a symbiotic (mutually beneficial) association : the green or blue green alga prepares food while the fungus gives protection, and absorbs water and minerals from the surroundings.

INTEXT QUESTIONS 2.4

1. Name the slender filaments that form the body of a fungus.

   .....

2. Which are the types of reproduction found in fungi?

   .....

3. Draw two small figures to show asexual reproduction in yeast.

   .....

4. Which are the four main kinds of fungi?

   1. ..... 2. .....

   3. ..... 4. .....

2.3.4 Economic importance of Fungi

A. Harmful Fungi

Several agricultural plants like sugarcane, maize, cereals and vegetables suffer from diseases caused by fungi.

1. *Puccinia graminis* (Wheat Rust)

It causes brown patches on leaf and stem of wheat plants. It decreases the yield of wheat and makes it unfit for human consumption.

2. *Rhizopus* or (Bread Mould) grows on bread (Fig. 2.13).

If the bread is exposed to warm and humid conditions a cottony mass develops in few days. This white cotton mass later develops a greyish black colour, because of black coloured spores.

- The whitish network is called mycelium.
- The mycelium contains thread like structures called *hyphae*.
- The root-like sturctures growing out of the hyphae penetrate the bread, and secrete digestive enzymes (extracellular digestion) and absorb the digested food.
- Greyish black colour of the mould develops due to formation of sporangium which after rupturing release dark coloured spores. The spores scatter by wind and germinate after falling on a suitable substractum. **This is asexual reproduction**.

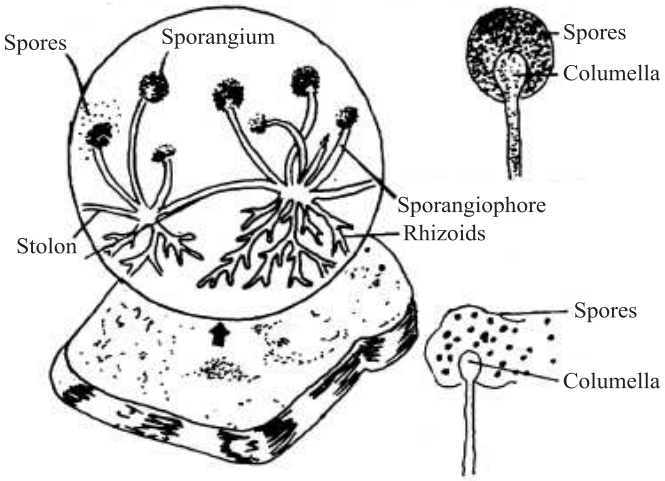


Fig. 2.13 Asexual reproduction in *Rhizopus*

Sexual reproduction (Fig. 2.14) takes place by conjugation between two neighbouring hyphae to produce a zygospore which after a period of rest undergoes meiosis followed by several mitotic cell divisions to produce a germ sporangium having a large number of haploid unicellular spores. The germ sporangium differs from asexual sporangium, as it does not have columella. When mature, the germ sporangium bursts to release spores which germinate on meeting favourable conditions and produce a new mycelium

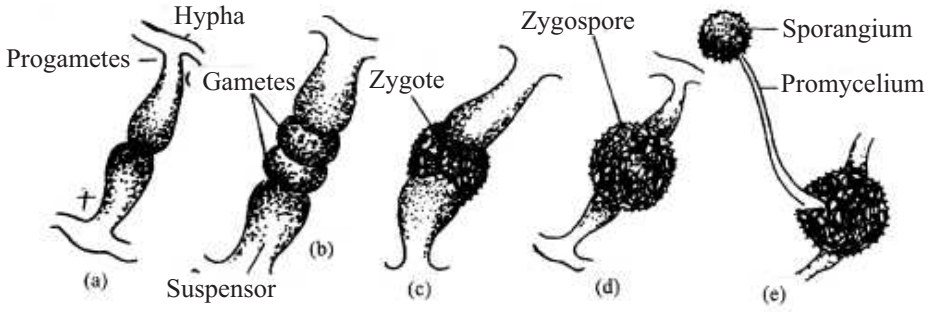


Fig. 2.14 Sexual reproduction in *Rhizopus*

3. In **human,** skin diseases like ringworm and athlete's foot are caused by fungi. Some ear infections are also caused by fungi.

B. Beneficial Fungi

– Certain Mushrooms (such as *Agaricus campestris*) are edible.
Yeast is used for fermentation during manufacture of bread, beer, soya sauce, cheese and wine.
– **Mycorrhizae** are fungi associated with roots of plants. Roots benefit in getting minerals from the environment while fungi get food from the plant in return through such association.
– *Neurospora* has been a favourite experimental material in Genetics.
– Various antibiotics are derived from fungi. Penicillin is obtained from *Penicillium notatum* (Fig. 2.15). Its antibiotic effect was discovered by chance by Alexander Flemming in 1927.

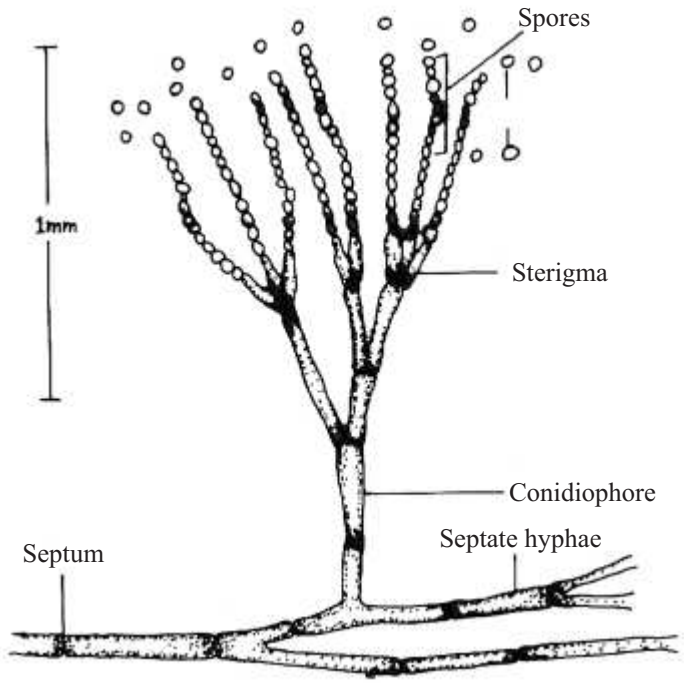


Fig. 2.15 *Penicillium*

INTEXT QUESTONS 2.5

1. Name
   (i) the fungus from which Penicillin is extracted .....
   (ii) a unicellular fungus. .....
   (iii) The fungus which causes wheat rust .....
   (iv) The whitish cottony mass, growing on stale bread. .....
   (v) Two common human diseases caused by fungi .....
2. Who discovered antibiotic properties of *Penicillium*?

   .....

WHAT YOU HAVE LEARNT

- Protoctista includes protozoa, diatoms and other unicellular algae.
- They are unicellular eukaryotes and possess organelles like mitochondria, golgi, bodies, chloroplast, endoplasmic reticulum
- Protoctists ae autotrophic, saprotrophic or parasitic.
- Protozoans may have pseudopodia, cilia and flagella for movement.

- They reproduce asexually as well as sexually.
- Examples of protoctists are *Paramecium*, *Amoeba*, malarial parasite, *Chlorella*, *Euglena*, *Chlamydomonas* and diatoms.
- Some protoza cause diseases. Algae provide food for fish, and are rich sources of some minerals and vitamins. Blue green algae fix atmospheric nitrogen. Walls of diatoms which have silica get deposited to form diatomaceous earths, which is used as filters and for lining the furnaces.
- Diatoms form bulk of plankton in ponds lakes and oceans, and are food for many aquatic organisms.
- Prokaryotes lack true nucleus. Genetic material in Prokaryotes is in the form of single circular DNA.
- DNA is placed in special region in a bacterial cell called nucleoid. A small ring of extra DNA present in some bacteria, is called plasmid or sex factor or F-factor (F = fertility)
- Bacteria exhibit four different kinds of nutrition - autotrophic, saprotrophic, symbiotic and parasitic.
- Cyanobacteria possess chlorophyll that helps in oxygenic photosynthesis.
- Some bacteria fix atmspheric nitrogen to enrich soil, some help in sewage treatment.
- Certain bacteria cause diseases like cholera, typhoid, tetanus and tuberculosis.
- There are bacteria that survive in extreme environments like high temperature, high salinity, and presence of methane.
- Fungi are eukaryotic, unicellular or multicellular saprotrophs.
- Fungi are of several kinds such as yeasts, slime moulds, mushrooms, lichens and mycorrhizae.
- Yeasts are unicellular, which commonly reproduce asexually by budding. Sexual reproduction occurs by conjugation.
- Slime moulds are naked, creeping multinucleate mass of protoplasm.
- Lichens are symbiotic combinations of fungi and algae.
- *Rhizopus* is the common bread mould that produces whitish network (mycelium) on stale bread, in warm humid weather.
- *Rhizopus* reproduces asexually by spores, and sexually by producing zygospore which in turn produces haploid spores after meiosis and repeated mitotic divisions.
- Wheat rust (*Puccinia graminis*) causes brown patches on leaf and stem of wheat plants.
- Ringworm and athelete's foot are two common fungal diseases of humans.
- Certain mushrooms are edible.
- Yeast is used for making bread and beer.

- *Neurospora* is used in experiments on genetics.
- *Penicillium notatum* yields penicillin.
- Various other fungi produce other antibiotics.

TERMINAL EXERCISES

1. Draw a labelled diagram of a typical bacterial cell.
2. List the different nutritional categories of bacteria and protoctists.
3. Draw the labelled diagrams to show binary fission in bacteria.
4. How does amoeba normally reproduce ? Draw diagrams to represent the process.
5. Draw a labelled diagram of *Euglena*.
6. What are the common features of diatoms which justify their inclusion in protoctists?
7. Write a paragraph on economic importance of the protoctists.
8. List any three characteristics of fungi.
9. What are mycorrhizae?
10. Name three harmful fungi mentioning their harmful effects.
11. Write a note on beneficial fungi.
12. Draw labelled diagrams of the following :
    (i) A series of stages in the budding of yeast.
    (ii) Magnified view of the bread mould growing on bread.

ANSWERS TO INTEXT QUESTIONS

2.1 1. DNA

2. Nucleoid
3. Peptidoglycan
4. Flagella are thicker and longer than pili/used in movement, used in conjugation.
5. Aerobic bacteria respires in presence of oxygen/the anaerobic bacteria respires in the absence of oxygen.
6. A fragment of DNA strand.

2.2 1. (i) *Azotobacter*
(ii) *Lactobacillus*
(iii) *Mycobacterium tuberculosis*
(iv) *Clostridium tetani*
2. Eight
3. Bacteria - smaller cells, flagella present, sexual recombination by conjugation. Cyanobacteria - large cells, no flagella, rare sexual recombination.

2.3 1. Protoctista are Eukaryotes/ possess true nucleus.
2. (i) *Entamoeba histolytica*
(ii) Malarial parasite or *Plasmodium*.
3. Binary fission
4. Mitochondria
5. Contractile vacuole
6. Flagellar, Pseudopodial or amoeboid (any two).

2.4 1. (i) mycelium
2. asexually, sexually
3. Refer diagram 2.12
4. (i) Yeast
(ii) Slime moulds
(iii) Mushrooms and Toadstools
(iv) Lichens
(v) *Aspergillus/Penicillium/Neurospora*

2.5 1. (i) *Penicillium notatum*
(ii) Yeast
(iii) *Puccinia graminis*
(iv) mycelium, *Rhizopus*
(v) spores
(vi) Ringworm, Athelete's foot
2. Alexander Flemming