THE KINGDOMS MONERA, PROTOCTISTA AND FUNGI

The kingdoms Monera which includes all the bacteria and the protoctista which includes the protoza, the diatoms and some algae are in a way the lowest among the living world. All bacteria, majority of Protoctists and many fungi are microscopic and generally referred to as microorganisms. 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 it is the most primitive;
- describe the generalized structure of a bacterium and cyanobacterium;
- describe 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 causing protozoa;
- list the general characteristics of fungi with examples;
- describe the sturcutre and reproduciton of yeast, Rhizopus, mushroom, penicillium and its utility by 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 nuclear membrane), monera is the only prokaryotic kingdom.
- Bacteria were the first organisms to evolve on planet earth after life originated around 3.5 billion years ago and were the only organisms on earth for almost the next two billion years.
- All bacteria and cyanobacteria are single celled or unicellular (monere : single)
- Monerans are also the most numerous of all living organisms.

2.1.1 Structure of a bacterial cell

The single celled bacterium has a cell wall made of compound peptido-glycan covering the cell membrane; a single 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.](image)

Note the following parts of a bacterium in the figure (Fig. 2.1). Outer most 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.

**Pili (Singular : pilus)**

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

**Flagella**

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

**Plasma Meanbrane**

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 prokaryotes. Hence Monera is the prokaryotic kingdom. Apart from the chromosome many species of bacteria possess rings of DNA called plasmids, which replicate along with bacterial chromosome and bear genes for antibiotic resistance, sex factor etc.

Cell Organelles
Membrane bound organelles like endoplasmic reticulum, mitochondria, chloroplast, golgi complex are absent. Only 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 cell organelles. They have only the 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 and decaying 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 bacteria to divide into two by binary fission.
(ii) **Sexual Reproduction**

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

(a) Two conjugating (lie very close for exchange 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)

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Fig. 2.2 Binary Fission in Bacteria

Fig. 2.3 Conjugation in Bacteria
INTEXT QUESTIONS 2.1

1. Of what is the circular single chromosome of a bacterium made?
   ............................................................................................................................

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

3. What is the cell wall made of 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 reproduction in a bacteria?
   ............................................................................................................................

2.1.3 Beneficial and harmful bacteria

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

Diseases Caused By Bacteria

<table>
<thead>
<tr>
<th>Name of Bacterium</th>
<th>Diseases Caused</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Vibrio cholerae</td>
<td>Cholera</td>
</tr>
<tr>
<td>2. Salmonella typhi</td>
<td>Typhoid</td>
</tr>
<tr>
<td>3. Clostridium tetani</td>
<td>Tetanus</td>
</tr>
<tr>
<td>4. Corynebacterium diptheriae</td>
<td>Diphtheria</td>
</tr>
<tr>
<td>5. Mycobacterium tuberculosis</td>
<td>Tuberculosis</td>
</tr>
</tbody>
</table>

Beneficial Activities of Bacteria

<table>
<thead>
<tr>
<th>Name of bacterium</th>
<th>Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Rhizobium</td>
<td>Found in roots of legumes, (Peas, grams, Pulses etc) fixes atmospheric nitrogen as ammonia, which is then converted into useful amino acid.</td>
</tr>
<tr>
<td>2. Azotobacter</td>
<td>Makes the soil fertile. It fixes atmospheric nitrogen in the soil.</td>
</tr>
<tr>
<td>3. Streptomyces</td>
<td>Produces Streptomycin antibiotic.</td>
</tr>
<tr>
<td>4. Lactobacillus</td>
<td>Ferments lactose (milk sugar) to lactic acid. This helps in setting of milk into curd.</td>
</tr>
<tr>
<td>5. Methanogenic bacteria</td>
<td>Sewage treatment</td>
</tr>
</tbody>
</table>
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 releases during the process changed the earth’s atmosphere and gradually the level of oxygen increased in the earth’s atmosphere.

Differences between Bacteria and Cyanobacteria

<table>
<thead>
<tr>
<th>Bacteria</th>
<th>Cyanobacteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Smaller cells</td>
<td>1. Comparatively larger cells</td>
</tr>
<tr>
<td>2. May have flagella</td>
<td>2. Do not have flagella.</td>
</tr>
<tr>
<td>3. Some bacteria (green) carry out photosynthesis in a different way and do not release oxygen</td>
<td>3. They all carry out photosynthesis in the usual manner as in green plants and release oxygen</td>
</tr>
<tr>
<td>4. Sexual reproduction by conjugation.</td>
<td>4. Conjugation has not been observed.</td>
</tr>
</tbody>
</table>

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

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 Archaebacteria
Kingdom Monera includes two groups
1. Archaebacteria and
2. Eubacteria

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 live in salty conditions e.g. where hot sun concentrates sea water Eubacteria include cyanobacteria and all other bacteria.

2.2 KINGDOM PROTOCTISTA (UNICELLULAR EUKARYOTES)
- Protoctista are unicellular eukaryotes. Protozoa and diatoms and 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 have the 9 + 1 arrangement of microtubules.
- They reproduce both asexually and sexually.
- Some protoctists are beneficial to humans while 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*

2. Phylum Bacillariophyta : Example diatoms
   The algae belong to
3. Phylum Chlorophyta : Example *Chlorella*
4. Phylum Phaeophyta : Example Brown algae
5. Phylum Rhodophyta : Example Red algae
6. Phylum Oomycota : Example Phytophthora

2.2.2 Some examples of Protoctists

1. Amoeba
   *Amoeba* is commonly found in the mud in fresh water 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 absent in *Amoeba*. Asexual reproduction is by binary fission. (Fig. 2.5b)

2. *Entamoeba*

One common species is *Entamoeba histolytica* which causes amoebic dysentery in humans. It is amoeboid in form. 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, 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.](image)

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

4. *Euglena* – A fresh water Flagellate

*Euglena* is abundantly found in stagnant waters such as pools, ponds, ditches etc. 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.
Cytostome and Reservoir - the cell mouth leading into a tubular cytopharynx which opens into a vesicle called reservoir.

Stigma - 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 form 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.

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

Structurally the algae have a definite cell wall, cell membrane, a nucleus, cytoplasm and chloroplast. The chloroplast is cup-shaped in Chlamydomonas and ribbon-shaped in Spirogyra. Pyrenoid bodies are attached to chloroplasts.

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.

- Some algae can fix atmospheric nitrogen, so they are a source of natural fertilizer for the plants.

- A group of algae (diatoms) deposit silica in their walls. After their death these algae are preserved as fossils. Their deposits in large amounts are used as filters, and for lining of furnaces.
INTEXT QUESTIONS 2.3

1. Protoctists are single celled like the Monera. 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 part of the protoctists does respiration occur?

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

............................................................................................................................

6. Name two kinds of locomotion found in protoctista.

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2.3 KINGDOM FUNGI

2.3.1 Position of Fungi
During warm humid days slices of bread, chapati, leather belts or shoes, etc. develop 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 parts into root, stem and leaves. They are now included, in a separate Kingdom Fungi.

2.3.2 Characteristics of Fungi
- Fungi are **multicellular eukaryotes**
- Fungi exist as slender thread like filaments called hyphae. Hypha has many nuclei. Yeast, however, is single celled.
- The 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 up to several kilometers.
- They do not possess chlorophyll so their nutrition is by absorption.
- No flagellum at any stage of life cycle.
- Reproduction in fungi is both asexual by means of spores and sexual through conjugation (refer to Fig. 2.13, 2.14).

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

### 2.3.3 Four main kinds of Fungi

The fungi are of four main kinds

1. **Yeasts**, which are unicellular.
2. **Slime moulds**, which have irregular shape.
3. **Mushrooms** and **toadstools**, which are large enough to be seen by naked eyes.
4. **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 following 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](image)

**Nutrition**

Yeast is saprotrophic. It can directly absorb simple sugar (glucose) but for obtaining sucrose (cane sugar) it gives out the enzyme *zymase* 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

\[ C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2 + 2ATP \]

(glucose) (ethyl alcohol) (energy)

**Reproduction**

Yeast reproduces asexually by budding (Fig. 2.11).

**Sexual reproduction** may also occur by its conjugation between two yeast cells. The fused contents divide twice to produce four individuals with a thick wall around each. These are the spores. The spores may be carried by wind and germinate under suitable conditions to produce new yeast cells.

2. Slime Moulds

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

3. Mushrooms and Toadstools

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

4. Lichens

These are a combination of certain fungi and a green algae which live in a symbiotic (mutually beneficial) association: the green algae prepares food while the fungi gives protection.
INTEXT QUESTIONS 2.4

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

..........................................................................................................................................

2. 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 sugar cane, maize, cereals, vegetables suffers from diseases caused by fungi.

1. *Puccinia graminis* (Wheat Rust)

   It causes brown patches on leaf and stem of wheat. 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.
   
   – The whitish network is called mycelium.
   
   – The mycelium contains thread-like structures called *hyphae*.
   
   – The root-like structures 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 releases dark coloured spores. The spores scatter by wind and germinate after falling oil a suitable place. This is asexual reproduction.
Sexual reproduction (Fig. 2.14) takes place by conjugation between two neighbouring hyphae to produce a zygospore which after a period of rest produces a sporangium. When mature, the 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. Yeasts 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 gets 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 Fleming in 1927.
The Kingdoms Monera, Protoctista and Fungi

1. Name
   (i) the fungus from which Penicillin is extracted ..............................................
   (ii) a unicellular fungus. ....................................................................................
   (iii) The fungus which cause 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

- Protista includes protozoa, diatoms and other algae.
- They are unicellular eukaryotes and possess organelles like mitochondria, golgi, chloroplast, endoplasmic reticulum
- Protoctists are autotrophic, saprotrophic or parasitic.
- Protozoans have cilia and flagella for movement.
• They reproduce asexually as well as sexually.
• Examples of protoctists are Paramecium, Amoeba, malarial parasite, Chlorella, Euglena, Chlamydomonas, Spirogyra etc.
• Some protozoa 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 are used as filters and for lining furnaces.
• Diatoms form bulk of plankton 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 is present called plasmid.
• Bacteria exhibit four different kinds of nutrition - autotrophic, saprotrophic, symbiotic and parasitic.
• Cyanobacteria possess chlorophyll that helps in photosynthesis.
• Some bacteria fix atmospheric nitrogen to enrich soil, some help in sewage treatment.
• Certain bacteria cause diseases like cholera, typhoid, tetanus and tuberculosis etc.
• There are bacteria that survive in extreme environments like those with high temperature, high salinity, and presence of methane.
• Fungi are eukaryotic, 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 produce spores.
• Wheat rust (Puccinia graminis) causes brown patches on leaf and stem of wheat.
• Ringworm and athlete’s foot are two common fungal diseases of humans.
• Certain mushrooms are edible.
• Yeast is used in making bread, beer, etc.
The Kingdoms Monera, Protoctista and Fungi

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

**TERMINAL QUESTIONS**

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 feature 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.

**ANSWER 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 reproduction by conjugation. Cyanobacteria - large cells, no flagella, no, conjugation.

2.3 1. Protoctista are Eukaryotes/ posses 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

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