Chapter

2

Biological Classification

Biological classification is the grouping of organisms into groups and sub groups based on their similarities and dissimilarities.

IMPORTANCE OF CLASSIFICATION

(i) It makes the study of large number of living organisms easy.
(ii) It gives an idea of whole range of diversity found in organisms.
(iii) It provides information about inter-relationships among organisms.
(iv) It gives an idea of evolution of various groups of organisms.
(v) It gives a system for identification of known and unknown organisms.

THREE TYPES OF CLASSIFICATION

(i) Artificial system of classification: It is a system of classification which uses one or two morphological characters for grouping of organisms.

- For example, **Aristotle** in 350 BC tried to classify the organisms on the basis of their form and habitat. He used simple morphological characters to classify plants. He divided plants into herbs, shrubs and trees. He divided animals into those with RBC's and those who do not have it.
- There are many other examples of ancient classification systems that are based mainly on superficial characteristics.
- Therefore this artificial system of classification has some serious drawbacks like:
  - ➢ The criteria used for classification are superficial and do not reflect the natural relationships.
  - ➢ The system does not reflect the evolutionary relationship between the organisms.
  - ➢ Many unrelated organisms are placed in the same group on the basis of their habitats (dwelling place) (For example, whales and fishes in the same group).
  - ➢ Closely related organisms have been placed in different groups because of the differences in their habitat, feeding habits, etc.

(ii) Natural system of classification: It is the system of classification which takes several morphological characters for grouping of organisms, so as to bring out natural similarities and dissimilarities and hence natural relationships among the organisms.

- The natural system of classification has specific advantages over the artificial system of classification.
  - ➢ It avoids the heterogeneous grouping of unrelated organisms.
  - ➢ It helps in placing only related groups of organisms together.
  - ➢ It indicates the natural relationships among organisms.
  - ➢ It also provides a clear view on the evolutionary relationship between different groups of living organisms.

(iii) Two kingdom classification: The natural system of classification was given by the Swedish biologist, **Carolus Linnaeus** (1707-1778).

Evolution of classification

1.	Two Kingdom Classificaiton (Carolus Linnaeus, 1758)	Kingdom: Plantae (All plants) Kingdom: Animalia (All animals)
2.	Three Kingdom Classification (Ernst Haeckel, 1866)	Kindgom: Protista (Unicelluar organisms) Kingdom: Plantae (Multicellular plants) Kingdom: Animalla (Multicellular animals)
3.	Four Kingdom Classification (Copeland, 1966)	Kingdom: Monera (Prokaryotic organisms) Kingdom: Protista (Primitive eukaryotes) Kingdom: Metaphyta (Advanced eukaryotic plants) Kingdom: Metazoa (Advanced eukaryotic animals)
4.	Five Kingdom Classification (Whittaker R.H., 1869)	Kingdom: Monera Kingdom: Protista Kingdom: Mycota (Exclusively for fungi) Kingdom: Metaphyta Kingdom: Metazoa

- Linnaeus is known as father of classification as he, for the first time, classified the living organisms in a systematic way.

TWO KINGDOM CLASSIFICATIONS

Linnaeus classified all the living organisms under two large kingdoms.

- **Kingdom Plantae:** This kingdom includes bacteria (Prokaryotes), photosynthetic plants and non-photosynthetic fungi.
- **Kingdom Animalia:** This kingdom includes unicellular protozoans and multi-cellular animals or metazoans.

Limitations of Two Kingdom System of Classification are

(i) Certain organisms like *Euglena* and Sponges, share the characteristics of both plants and animals.
For example,
- ➢ In *Euglena*, some species have chlorophyll and are autotrophic like plants. A few species of *Euglena* lack chloroplasts and are therefore colourless and non-photosynthetic (heterotrophic).
- ➢ They have a saprotrophic mode of nutrition, carrying out extra-cellular digestion. Other colourless forms ingest small food particles and carryout intracellular digestion (holozoic nutrition).
- ➢ *Euglena* is also characterized by the presence of an animal pigment as taxanthin in the eye spot.

(ii) Fungi and moulds were placed under Kingdom Plantae but they possess many characters not common to plants. Fungi lack chlorophyll. They are heterotrophic like animals.

(iii) Bacteria and Cyanobacteria (blue-green algae) have many similarities between them and are quite different from other organisms. Thus, it is difficult to place them in their plant or animal kingdom.

(iv) The status of virus whether they are living or non-living is a point of debate even today.

THREE KINGDOM CLASSIFICATION

- **Haeckel** in 1866 proposed three kingdom classifications.
- He divided the living organisms into three kingdoms: Plantae, Protista and Animalia.

FOUR KINGDOM CLASSIFICATION

- **Copeland** in 1956 created a separate kingdom of Monera. This divided the living world into four kingdoms- Monera, Protista, Plantae and Animalia.
- In this system fungi continued to remain with kingdom Plantae.

FIVE KINGDOM CLASSIFICATION

- **R.H. Whittaker** (1969), an American Taxonomist divided all the organisms into 5 kingdoms based on their evolutionary relationship among themselves.

The five kingdom classification is based on the following criteria
- Complexity of Cell structure – Prokaryote to Eukaryote
- Mode of nutrition – Autotrophs and heterotrophs
- Body organization - Unicellular or multi-cellular
- Phylogenetic or evolutionary relationship

The five kingdoms are

(a) Monera: Prokaryotes. E.g. Bacteria and cyanobacteria.

(b) Protista: Unicellular eukaryotes. E.g. Unicellular algae, diatoms and protozoa.

(c) Plantae: Multicellular producers. E.g. Plants.

(d) Fungi: Multicellular decomposers. E.g. Fungi and moulds.

(e) Animalia: Multicellular consumers, E.g. Animals.

Characteristics of Five Kingdom System of Classification

Characteristics	Five Kingdoms				
	Monera	Protista	Fungi	Plantae	Animalia
Cell type	Prokaryotic	Eukaryotic	Eukaryotic	Eukaryotic	Eukaryotic
Cell organization	Mostly unicellular	Mostly unicellular	Multicellular and unicellular	Mostly Multicellular (Tissue/ Organ system)	Mostly Multicellular (Tissue/ organ/organ system level)
Cell wall	Non-cellulosic (Polysaccharide + amino acid)	May or may not be present.	Present (without cellulose)	Present (cellulose)	Present
Mode of Nutrition	Autotrophic (Chemosynthetic and Photosynthetic) Heterotrophic (Saprophytic and Parasitic)	Autotrophic and Heterotrophic	Heterotrophic (Saprophytic and parasitic)	Autotrophic by photosynthesis	Heterotrophic by ingestion
Motility	Motile or non-motile	Motile or non-motile	Non motile	Mostly non-motile	Mostly motile
Reproduction	Conjugation/ Transduction/ Transformation or None	Syngamy and meiosis, conjugation or None	Fertilization and meiosis. Dikaryosis or none	Fertilization and meiosis	Fertilization and meiosis

Merits of five kingdom classification are

- It reflects better relationship among organisms with regard to levels of organization and mode of nutrition.
- It reflects better evolutionary trend indicating gradual evolution of complex organisms from simpler ones.
- It gives better placement to certain controversial groups like cyanobacteria, fungi, *Euglena,* etc.
- Separation of kingdom Fungi from plants seems to be justified as fungi bear own type of structural, physiological as well as biochemical characters.

Demerits of five kingdom classification are

- The position of virus is not clear.
- Kingdom Protista includes organisms having diverse form, structure and life cycle, hence does not seem to be proper grouping.
- Some organisms included under Protista (e.g. Dinoflagellates) are not eukaryotic rather mesokaryotic.
- Slime moulds placed under Protista differ considerably from the rest of protists.
- The three higher kingdoms are Plantae, Fungi and Animalia seem to be polyphyletic.

However, despite of all these demerits Whittaker's five kingdom system is widely accepted.

KINGDOM MONERA (Kingdom of prokaryotes)

This kingdom includes all prokaryotic organisms *i.e*. mycoplasma, bacteria, actinomycetes (filamentous bacteria) and cyanobacteria (commonly known as blue green algae).

- They are microscopic.
- Monera is the only prokaryotic kingdom. They do not possess a true nucleus. They lack membrane bound organelles.
- Bacteria were the first organisms to evolve on planet earth after life originated around 3.5 billion years ago. They are the most numerous of all living organisms.
- All bacteria and cyanobacteria are unicellular (Single-celled organisms).

The branch of study that deals with bacteria is called **Bacteriology**.

Shapes of bacteria

Bacteria are grouped under four categories based on their shape.

(i) Coccus (spherical): They can be further distinguished into
- **(a)** Monococcus (occur singly)
- **(b)** Diplococcus (occur in pairs)
- **(c)** Tetracoccus (occur in groups of four)
- **(d)** Streptococcus (occur in the form of a filament) and
- **(e)** Staphylococcus (occur in the form of sheets).

(ii) Bacillus (rod-shaped): They may be further distinguished into
- **(a)** Monobacillus (single)
- **(b)** Diplobacillus (in pairs)
- **(c)** Streptobacillus (in filamentous form) and
- **(d)** Palisade Bacillus (in the form of a stack)

(iii) Vibrio (comma shaped)

(iv) Sprillum (spiral shaped).

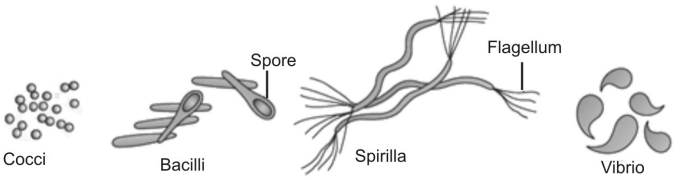


Fig. Bacteria of different shapes

Structure of a bacterial cell

- **Cell wall:** It is the outermost covering of the bacterial cell. Cell wall is rigid, which protects and gives shape to the cell. The cell wall is made of compound peptidoglycan.
- **Plasma Membrane:** Plasma membrane, present below the cell wall, encloses the cytoplasm and other cell contents. It is made up of lipids and proteins.
- **Pili:** 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 have 9+1 arrangement of microtubules. Flagella are longer and thicker than pili.

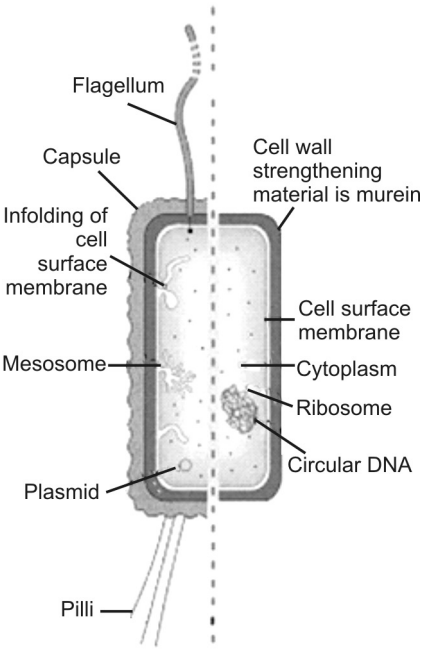


Fig. Structure of a bacterial cell

- **Genetic material (DNA):** Bacteria have one circular chromosome made of a double helical molecule of DNA. It is located in a region of the cytoplasm called nucleoid. Since the chromosome is not lodged within a true nucleus, bacteria are termed prokaryotes. 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:** The cell has ribosomes but no membrane bound organelles.

> **Note:**
>
> Prokaryotes have no nuclear membrane around genetic material and no cell organelles. They have only the ribosomes.

Gram staining

- A Danish physician **Christian Gram,** in 1884 devised a technique of differential staining called gram staining for bacterial cells.
- **Gram staining** is one method used to classify bacteria. Bacteria are differentiated into **Gram-positive** and **Gram-negative** based on the ability to retain a purple dye. The ability to retain the dye depends on the type of cell wall and outer membrane the bacterium has.
- Gram-positive bacteria stains purple with Gram stain. This is because they have a thick cell wall (made of peptidoglycan) without an outer membrane.
  Examples: Cyanobacteria, *Treponema pallidum*, *Escherichia coli*, *Shigella sp.*, *Yersinia pestis*, *Vibrio cholerae.*
- Gram-negative bacteria stains red with Gram stain. This is because they have a thin cell wall (peptidoglycan layer) with an outer membrane composed of Lipopolisakarisa (LPS) and protein.

Examples: *Salmonella*, *Corynebacterium diptheriae*, *Mycobacterium tuberculosis*.

Nutrition

The four nutritional categories found in bacteria are:

(i) Autotrophs: Some bacteria are autotrophic and are photosynthetic *i.e.* they can synthesize their organic food in the presence of sunlight *e.g*. *Spirillum*.

(ii) Chemotrophs: Some bacteria are chemosynthetic *i.e*. they can synthesize their organic food by deriving energy from some chemical reactions. *e.g*. *Nitrosomonas* and *Nitrobacter*. Many other bacteria like *Rhizobium*, *Azotobacter* and *Clostridium* can fix atmospheric nitrogen into ammonia. This phenomenon is called biological nitrogen fixation.

(iii) Saprotrophs: Some bacteria feed on dead and decaying matter.

(iv) Symbionts (Mutualism): Some use food from other living organisms with which they are associated for mutual benefit. For example, some bacteria live in the roots of legumes, such as pea plants. The bacteria turn nitrogen-containing molecules into nitrogen that the plant can use. Meanwhile, the root provides nutrients to the bacteria. In this relationship, both the bacteria and the plant benefit, so it is known as a mutualism.

(v) Parasites: Some are parasitic. They absorb food from living organisms and cause harm to them.

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.
  Example: Some monerans like Archaebacteria.
- Cellular respiration or breakdown of food to release energy occurs in **mesosomes** which are the inner extensions of the cell membrane.

Reproduction

(i) Asexual Reproduction: Bacteria reproduce asexually by **binary fission** under favourable conditions. During binary fission, the chromosome copies itself, forming two genetically identical copies. Then, the cell enlarges and divides into two new daughter cells. The two daughter cells are identical to the parent cell. Binary fission can happen very rapidly. It takes about 20 minutes for one bacterium to divide into two by binary fission.

(ii) Sexual Reproduction: Sexual reproduction does not occur in bacteria. But not all new bacteria are clones. This is because bacteria can still combine and exchange DNA. This exchange occurs in three different ways:

(a) Conjugation: Conjugation involves transfer of DNA from one bacterium to another through an extension on the surface.

(b) Transformation: In transformation, bacteria pick up pieces of DNA from their environment.

(c) Transduction: In transduction, viruses that infect bacteria carry DNA from one bacterium to another.

Beneficial and harmful bacteria

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

Beneficial Activities of Bacteria

Bacterium	Function
Rhizobium	It is found in roots of legumes (peas, grams, pulses etc). It fixes atmospheric nitrogen as ammonia, which is then converted into useful amino acid.
Azotobacter	It makes the soil fertile. It fixes atmospheric nitrogen in the soil.
Streptomycetes	It is used to produce the antibiotic called Streptomycin.
Lactobacillus	It ferments lactose (milk sugar) to lactic acid. This helps in setting of milk into curd.
Methanogenic	It helps in sewage treatment.

Diseases Caused by Bacteria

Bacterium	Disease caused
Vibrio cholerae	Cholera
Salmonella typhi	Typhoid
Clostridium tetani	Tetanus
Corynebacterium diptheriae	Diphtheria
Mycobacterium tuberculosis	Tuberculosis

Cyanobacteria

These were earlier called the blue green algae. It is a very successful group on primitive earth. They carried out the process of photosynthesis and released oxygen on the earth's atmosphere, which in turn gradually increased the level of oxygen in the atmosphere.

How Bacteria is Different from Cyanobacteria

Bacteria	Cyanobacteria
They are smaller in size.	They are comparatively larger cells.
They may have flagella.	They do not have flagella.
Some bacteria (green) carry out photosynthesis in a different way and do not release oxygen.	They all carry out photosynthesis in the usual manner as in green plants and release oxygen.

Kingdom **Monera** includes two groups: **Archaebacteria** and **Eubacteria**

(i) Archaebacteria: It includes bacteria that live in unusual environments particularly at low levels of oxygen.
Types of Archaebacteria are:
- **(a) Halophiles:** They are salt-loving bacteria.
- **(b) Thermoacidophiles:** They are the bacteria that live in hot springs.
- **(c) Methanogens:** They are the bacteria that are found in marshy areas (sewage) and intestinal tracts of ruminants. Methanogens are responsible for production of methane gas from the dung of ruminants.

(ii) Eubacteria: They are known as true bacteria. It includes:
- **(a) Photosynthetic autotrophs** like Cyanobacteria. Cyanobacteria often forms bloom in polluted areas. Some of these like *Anabaena* and *Nostoc* have specialised cells called **heterocysts** for nitrogen fixation.
- **(b) Chemosynthetic autotrophs** bacteria oxidise various inorganic substances like nitrates/nitrites, ammonia and use released energy for their ATP production. They play an important role in recycling of nutrients.
- **(c) Heterotrophic bacteria:** They help in making curd, production of antibiotics, Nitrogen fixation etc. Some are pathogens and cause diseases like cholera, typhoid, tetanus etc.

Mycoplasma

- It completely lacks cell wall.
- It is the smallest known living cells and is about 0.1 µm.
- It can survive without oxygen.
- Some are pathogenic in animals and plants.
- An older name for *Mycoplasma* was **Pleuro Pneumonia-Like Organisms** (PPLO).

KINGDOM PROTISTA (Kingdom of unicellular eukaryotes)

- It forms a link between plants, animals and fungi.
- This kingdom includes eukaryotic unicellular mostly aquatic cells. Protozoan, diatoms and algae are included in it.

Structure of protists

1. They have a typical Eukaryotic cell organization.
2. They have membrane bound organelles such as nucleus with chromosomes enclosed in nuclear membrane, mitochondria, chloroplast (in photosynthetic protists only), Golgi bodies and endoplasmic reticulum.
3. They have mitochondria as respiratory organelles.

Locomotion in protists

4. They often bear cilia or flagella for locomotion, having 9+2 microtubules unlike those of bacteria which have 9+1 arrangement of microtubules.
5. **Types of locomotion found in protista:**
   - **(i) Pseudopodial locomotion:** It is performed with the help of protoplasmic outgrowths called pseudopodia. E.g. sarcodines and slime moulds.
   - **(ii) Flagellar locomotion:** In this flagella show whip like movement. E.g. dinoflagellates, euglenoids and zooflagellates.
   - **(iii) Ciliary locomotion**: In this, cilia show oar-like movement. E.g. *Paramecium.*
   - **(iv) Wriggling locomotion:** It is a slow worm like movement with the help of a wave of contraction and expansion in the body. E.g. sporozoans, non flagellates, euglenoids.
   - **(v) Locomotion by mucilage propulsion**: In this, movement occurs through secretion of mucilage. E.g. diatoms.

Nutrition in Protists

6. **Autotrophic or holophytic:** Most of them are photosynthetic autotrophs. They form the chief producers of food in oceans and in fresh water. E.g. dinoflagellates, diatoms, euglenoids.
7. **Holozoic:** Zooplanktons are mostly predatory. They show holozoic mode of nutrition as in *Amoeba*. In this mode, individual captures and ingests the food like animals. E.g. many protozoans like *Amoeba* and *Paramecium.*
8. **Saprophytic:** In this mode, organisms absorb food from organic matter. E.g. Slime moulds.
9. **Parasitic:** Some protists are parasitic. They obtain food from the body of other organisms. E.g. *Trypanosoma, Plasmodium, Entamoeba* etc.
10. **Symbiotic:** Some protists are symbionts. E.g. zooflagellates like *Trichonympha* live as symbionts in the intestine of termites.
11. **Mixotrophic (Halophytic + Holozoic or saprobes):** *Euglena*, a protozoan has two modes of nutrition. In the presence of sunlight it is autotrophic and in the absence of sunlight it is heterotrophic. This mode of nutrition is known

as Mixotrophic and hence they form a border line between plants and animals and can be classified in both.

Reproduction in Protists

12. They reproduce both asexually and sexually.

(a) Asexually reproduction:

(i) Binary fission: It is the division of parent body into two equal daughter individuals by mitosis. E.g. *Amoeba, Paramecium, Euglena.*

(ii) Multiple fission: It is the division of parent body into several daughter individuals. E.g. *Amoeba, Plasmodium.*

(iii) Plasmotomy: It is the division of multinucleate protist into two or more multinucleate offspring by the division of cytoplasm without nuclear division. E.g. *Opalina.*

(iv) Spore formation: Some protists reproduce asexually by forming spores. E.g. Slime moulds.

(v) Budding: E.g. *Arcella* (a sarcodine).

(b) Sexual reproduction:

Syngamy: It involves fusion of two gametes to produce a diplod zygote. Syngmay is of three types:

- **Isogamy:** In this, the two fusing gametes are similar. E.g. *Monocystis.*
- **Anisogamy:** In this, the two fusing gametes are dissimilar. E.g. *Ceratium.*
- **Oogamy:** In this, large non-motile gametes are fertilized by smaller motile gametes. E.g. *Plasmodium*.

Classification of Protista

(i) Chrysophytes (Has diatoms and golden algae-desmids)

- Cell walls are embedded with silica and form two thin overlapping shells, which fit together like a soap box. Thus their walls are indestructible.
- The siliceous frustules of diatoms do not decay easily. They pile up at the bottom of water reservoirs and form big heaps called 'Diatomaceous Earth'.
- Being gritty, this soil is used in polishing, filtration of oils and syrups.
- Diatoms are chief producers in the oceans. They are very good pollution indicators. Examples: *Triceratium, Navicula, Amphipleura etc.*

(ii) Dinoflagellates

- They are mostly marine, and photosynthetic.
- They are variously coloured depending on the main pigments present in their cell.
- Their cell wall has cellulose.
- Most of them have two flagella-one longitudinal and other transversely in a furrow between wall plates.
- Example: *Gonyaulax, Ceratium, Noctiluca*.

Note:

- *Gonyaulax* is often known as red dinoflagellates. They undergo such rapid multiplication that they make the sea appear red. This is often referred as red tide. Red tide refers to the red colour imparted to the sea water by the rapid multiplication of dinoflagellates like *Gonyaulax.* The toxins released by such large number of *Gonyaulax* may sometimes kill other marine animals such as fishes.
- *Noctiluca* is a colourless dinoflagellate. This alga is famous for its bioluminescence.

(iii) Euglenoids

- Most of them are freshwater organisms found in stagnant water.
- Instead of cell wall. They have protein rich layer 'pellicle' which makes body flexible.
- They are photosynthetic in presence of sunlight but become heterotrophs if they do not get sunlight.
- They have two flagella- one short and one long.
- Example: *Euglena, Paranema, Phacus.*

(iv) Slime Moulds

- They are saprophytic protists.
- Slime moulds possess the characters of both animals and fungi. Therefore they are commonly called fungus-animals.
- They are found in decaying twigs and leaves, feeding on organic matter.
- Under suitable condition, they form an aggregation called plasmodium, which may grow and spread several feet.
- Under unfavourable conditions, plasmodium forms fruiting bodies bearing spores on their tips. Spores have true walls which are extremely resistant and survive for many years.
- Example: Plasmodium.

(v) Protozoans (Unicellular animal-like protist.)

- **Habit and Habitat:** They occupy a vast array of habitats and niches and have organelles similar to those found in other eukaryotic cells as well as specialized organelles. Protozoans are found in moist environments. If you were to pick up wet decaying leaves from the edge of a pond and place them under a microscope, you would discover the small world inhabited by protozoans. They can be both free-living (can live outside of a host) or parasitic (colonize host cell tissues). Many are able to exist in extreme environments, from Polar Regions to hot springs and desert soils.
- **Body form:** They are small, microscopic organisms with varied forms. The body is unicellular, however they are preferably be referred to as **a cellular** because the single cell performs all the life activities and is functionally equivalent to the whole metazoan animal.

- Animals are microscopic so known as animalcules.
- **Symmetry:** All symmetries are represented in the group.
- **Germ layer:** No germ layer present.
- **Level of organization**: They have no organs or tissues, but specialized organelles found.
- **Nutrition:** Nutrition is holozoic or holophytic or osmotrophic. *Euglena* shows mixotrophic nutrition.
- **Digestion:** Digestion is intracellular. Protozoa may absorb food *via* their cell membranes, some, *e.g.*, Amoebas, surround food and engulf it, and yet others have openings or "mouth pores" into which they sweep food, and that engulfing of food is said to be phagocytosis. All protozoa digest their food in stomach-like compartments called vacuoles.
- **Respiration and excretion:** Respiration and excretion occurs by plasmalemma.
- **Osmoregulation:** Contractile vacuole is present for osmoregulation (It is absent in parasitic protozoa and marine protozoa).
- **Motility:** They move around with whip-like tails called flagella, hair-like structures called cilia, or foot-like structures called pseudopodia. Others do not move at all.

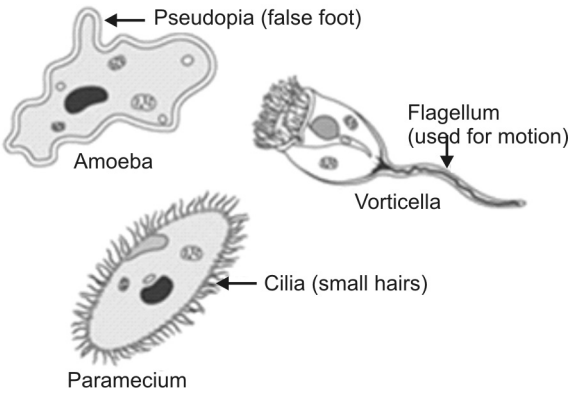


Fig. Protozoans

- **Reproduction:** A sexual reproduction by binary or multiple fissions or plasmotomy or budding. Sexual reproduction occurs by syngamy or conjugation.
- *Giardia*, *Cryptosporidium* and *Microsporidium* have become major concerns in the drinking water Industry.
- **The protozoa are subdivided into four phyla depending on their method of locomotion: Mastigophora (flagellates), Sarcodina (*Amoebas*), Ciliophora (Ciliates), and Sporozoa.** Three of the groups—amoebas, flagellates, and ciliates—are grouped according to the way they move. The fourth group, sporozoans, are grouped together because they are parasites.

(a) Mastigophora

- Members of the phylum Mastigophora move about by using one or more whip like flagella.
- The genus *Euglena* contains flagellated species.
- Members are freshwater protists with typical eukaryotic properties, including two flagella, reproduction by mitosis, and flexible nutritional requirements.
- *Euglena* species also possess chlorophyll within chloroplasts. This pigment allows the organisms to synthesize organic compounds in the presence of sunlight. When no sunlight is available, the organism feeds on dead organic matter in the surrounding environment. Thus, the organism is autotrophic and heterotrophic. Some biologists consider *Euglena* to be the basic stock of evolution for both animals and plants.
- Certain species of Mastigophora are zooflagellates, while some are phytoflagellates.
- The *zooflagellates* live within the bodies of animals and are typified by the wood-digesting flagellates in the intestines of termites. Among the pathogenic zooflagellates are those that cause sleeping sickness, trichomoniasis, and giardiasis.
- The *phytoflagellates* have photosynthetic abilities.
- Some species of Mastigophora organize themselves into colonies. Members of the genus *Volvox* are typical colonial forms. The cell colonies are not differentiated into tissues or organs, but the colonies show how a preliminary step in evolutionary development might have occurred.
- **Examples:**
  - ➢ *Euglena gracilis:* It is the simplest protozoan and most primitive animal. It forms the connecting link between plants and animals.
  - ➢ *Noctiluca:* It is bioluminescent in nature and has luciferin.
  - ➢ *Ceratium:* It is bioluminescent in nature. Binary fission is oblique.
  - ➢ *Mastigamoeba:* It is the connecting link between sarcodina and mastigophora.
  - ➢ *Leshmania donovani:* It causes kala-azar or leishmaniasis or dum–dum fever. Vector of this disease is sand fly (Phlebotomus)
  - ➢ *Trypansoma gambiense:* It is the parasite of sleeping sickness.

Euglena

- It is a freshwater flagellate. It is abundantly found in stagnant waters such as pools, ponds, and ditches etc. containing decaying organic matter.

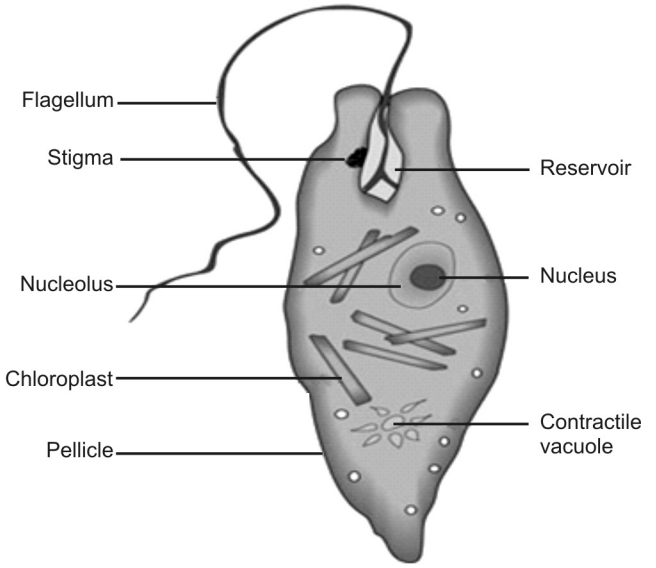


Fig. Structure of *a Euglena*

Structure of *Euglena*

- **Pellicle:** *Euglena* has elastic body which is covered by a covering called pellicle. Pellicle is made up of protein.
- **Cytostome and Reservoir:** Cytostome is the cell mouth leading into a tubular cytopharynx which opens into a vesicle called reservoir.
- **Stigma:** Stigma is a prominent red pigment spot. It is sensitive to light.
- **Contractile vacuole:** *Euglena* has contractile vacuole for osmoregulation.
- **Flagellum:** It has flagellum for propulsion in water.
- **Chloroplast:** It has chloroplast containing green coloured chlorophyll for photosynthesis.
- ***Euglena*** reproduces asexually by binary fission.

(b) Sarcodina (Rhizopoda)

- Members of the phylum Sarcodina are the *Amoebas* and their relatives.
- *Amoebas* consist of a single cell without a definite shape. They feed on small organisms and particles of organic matter, and they engulf the particles by phagocytosis. Extensions of the cytoplasm called *pseudopodia* (the singular is *pseudopodium*) assist phagocytosis and motion in the organisms.
- Pseudopodia are of four types:
  - ➢ **Lobopodia** (broad and blunt)- E.g. *Amoeba*
  - ➢ **Filopodia** (slender without any support and independent)- E.g. *Euglypha*
  - ➢ **Axopodia** (Slender with axial support)- E.g. **Actinophyrs**
  - ➢ **Reticulopodia** (Slender and reticulate)- E.g. *Globigerina*
- *Amoebas* are found in most lakes, ponds, and other bodies of fresh water. They move by a creeping form of locomotion called amoeboid motion. One amoeba called *Entamoeba histolytica* causes a type of dysentery in humans.
- Two interesting *Amoebas* are the foraminiferans and the radiolarians. Both are marine *Amoebas* that secrete shells. Their shells have been identified as markers for oil deposits because both were present in the ocean communities that became the organic deposits that, under pressure, became oil fields.

Amoeba

- *Amoeba* is commonly found in the mud in fresh water ponds and ditches containing decaying leaves.
- They have pseudopodia for locomotion.
- It captures food by pseudopodia to form a food vacuole.
- *Amoeba* has a contractile vacuole for osmoregulation.
- *Amoeba* reproduces asexually by binary fission. Sexual reproduction is absent.

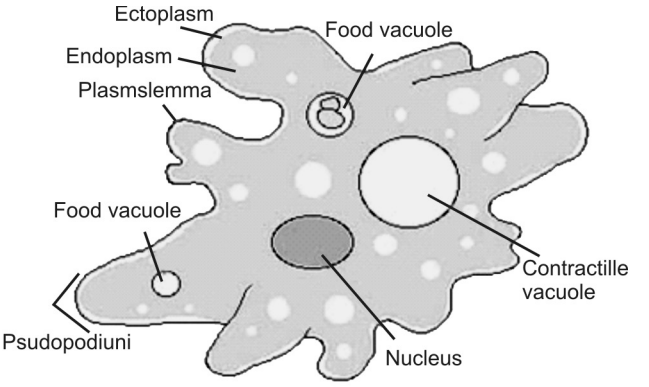


Fig. *Amoeba*

Entamoeba

- *Entamoeba histolytica* cause amoebic dysentery in humans. It is amoeboid in form. The symptoms of amoebic dysentery are abdominal pain, nausea, blood and mucus with stool.

(c) Ciliophora (Ciliata)

- Members of the phylum Ciliophora move by means of cilia.
- The organisms are all heterotrophic and have specialized organelles in their cytoplasm.
- Ciliates show nuclear dimorphism or two types of nuclei-
  - ➢ A large **macronucleus:** Macronucleus controls metabolic activities and growth. It is also called vegetative nucleus.
  - ➢ A number of smaller **micronuclei:** The micronuclei carry the genetic information of the cell. Hence, it is termed as reproductive nucleus.
- **Examples:** *Paramecium, Opalina* (multinucleated, endoparasite in rectum of frog), *Nyctotherus* (endoparasite in rectum of frog), *Balantidium, Vorticella* (Commonly known as bell animalcule).

***Paramecium* (The slipper animalcule)**

- The ciliate *Paramecium* typifies the phylum Ciliophora.
- This organism has a slipper-shaped body with a covering called a *pellicle*.

- Defensive organelles called *trichocysts* are present in the pellicle.
- Mouth is known as cytostome and anus is known as cytopyge.
- The organism reproduces by mitosis and by an elaborate form of sexual behaviour called *conjugation*, which occurs when two *Paramecium* join to one another in the oral region and exchange nuclear material.
- The cilia of *Paramecium* provide a precise form of motion not provided by flagella or pseudopodia. The cilia can propel the *Paramecium* either forward or backward and move it in a spiral manner.

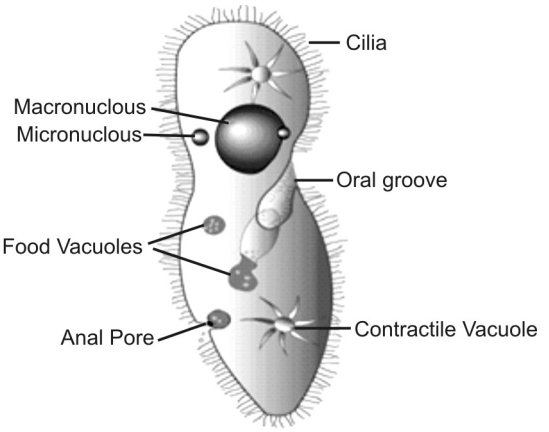


Fig.: *Paramecium*

Difference between Cilia and Flagella

Flagella	Cilia
They are larger and longer.	They are smaller and shorter.
They are rarely more than a dozen found on a cell.	They are always found in large numbers on a cell.
They may carry various additional structures.	They do not carry additional structures (but may be fused together into structures).
When more than one is present, they rarely act in a coordinated fashion.	They almost always act with a high degree of coordination.
The most common activity is a spinning/whipping motion.	The most common activity is an oarlike stroke somewhat like a swimming human's arm.

(d) Sporozoa

- Members of the phylum Sporozoa are exclusively parasites. They are so named because some members produce spore like bodies.
- Often they have an amoeboid body form, but they are not related to the Sarcodina.
- Sporozoans are generally parasitic organisms with complex life cycles involving several stages.
- Examples:
  - ➢ *Plasmodium:* It is the smallest animalcule and commonly known as malaria parasite.
  - ➢ *Babesia:* It causes Texas fever or red water fever in cattles.
  - ➢ *Monocystis:* It is the parasite in seminal vesicle of earthworm.
  - ➢ *Gregerina:* It is present in intestine of cockroach.
  - ➢ *Nosema:* It is the parasite of silk moth.
  - ➢ *Eimeria:* It is found in epithelium of liver of rabbit.

Plasmodium

- One of the best-known members of the group is the *Plasmodium* species, which are the agents of malaria.
- The organisms spend portions of their life cycle within mosquitoes. After being injected into the human bloodstream by the mosquito, the parasites invade the red blood cells, undergo numerous changes, and emerge from the red blood cells, destroying them. The infected human experiences a malaria attack soon after.
- *Plasmodium* has two hosts:
  - ➢ Female *Anopheles* mosquito: In this, sexual phase of the malarial parasite occurs. Hence, it is considered as primary host of malarial parasite.
  - ➢ Human beings: In man, asexual phase of the malarial parasite occurs. Hence, it is considered as secondary host.
- Two phases found in life cycle of *Plasmodium*:
  - ➢ Sexual cycle produces sporozoites in body of mosquito. Meiosis occurs just after zygote formation (zygotic meiosis).
  - ➢ Sporozoites infect a human and reproduce asexually, first in liver cells and then in red blood cells. Malaria is spread by Anopheles mosquito, which ingests gametocytes along with human blood, then, when biting another victim, leaves sporozoites in new wound.

KINGDOM FUNGI (Kingdom of multicellular decomposers)

This kingdom includes moulds, mushrooms, toad stools, puffballs and bracket fungi.

Characteristic Features

- They have eukaryotic cell organization.
- Their body is made up of numerous filamentous structures called hyphae. A hypha may be divided into cells by partitions called septa. Hypha has many nuclei. Yeast, however, is single celled.
- A group of hyphae forming a network is called mycelium, mycetos meaning fungus.
- Cell wall is made of chitin and polysaccharides
- Their mode of nutrition is heterotrophic since they lack the green pigmentchlorophyll. Some fungi like *Puccinia* are parasites while others like *Rhizopus* are saprotrophic

and feed on dead organic matter. They can also live as symbionts – in association with algae as lichens and with roots of higher plants as mycorrhiza.

- Reproduction in fungi is both asexual and sexual
  - ➢ **Asexual reproduction in fungi:**
    - **(i)** Vegetative means by fragmentation, fission and budding.
    - **(ii)** Asexually by spores called conidia, sporangiospores, or zoospores.
    - **(iii)** Sexually by oospores, ascospores, and basidiospores.
  - ➢ **Sexual reproduction in fungi:** It involves three steps:
    - **(i) Plasmogamy:** It involves fusion between two motile or non-motile gametes. Sometimes two haploid hyphae come together and fuse.
    - **(ii) Karyogamy:**It involves fusion of two nuclei. In some fungi two haploid cells immediately fuse and form diploid cells while in some (e.g. ascomycetes and basidiomycetes) a dikaryotic (n+n)occurs which later become diploid. Such phase is called **dikaryophase**.
    - **(iii) Meiosis in zygote:** Fungi from fruiting bodies in which reduction division occurforming haploid spores.
- E.g., *Puccinia* (rust causing), *Penicillium.*
- The branch of biology that deals with the study of fungi is known as **Mycology**.

Classes of Fungi

(i) Phycomycetes (Lower or Algal fungi)

- They are found in aquatic habitats and grow on decaying wood in moist and damp places.
- Mycelium is aseptate and coenocytic.
- Asexual reproduction occurs by zoospores (motile) or a planospores (non-motile).
- Spores are produced endogenously.
- e.g., *Rhizopus* (bread mould), *Albugo*.

Phycomycetes is divisible into two groups: Oomycetes and Zygomycetes.

(a) Oomycetes (The oogamous fungi)

- Mycelium is coenocytic (multinucleate and aseptate).
- A sexual reproduction involves formation of spore contain sac or sporangia.
- Zoospores are biflagellate.
- Sexual reproduction is by gametangial contain where male sex organs or antheridium passes its products into female sex organ or oogonium.
- The product of sexual reproduction is oospore.
- E.g.
  - ➢ *Phytophthora infestans*: It causes late blight of potato and tomato.
  - ➢ *Albuga candida*: It causes white rust.
  - ➢ *Peronospora parasitica* causes downy mildew in number of plants like pea, mustard, onion etc.

(b) Zygomyctes (The conjugation fungi)

- The mycelium is coenocytic (multinucleate and aseptate).
- Hyphal wall contains chitin or fungus cellulose.
- Motile cells are absent.
- Mitospores are non-motile and called sporangiospores as the sproes are formed inside sporangia born at the tips of sproangiophores.
- Sexual reproduction occurs through conjugation.
- The product of sexual reproduction is diploid spore called zygospores.
- E.g.
  - ➢ *Rhizopus stolonifer*: It is popularly known as black bread mould.
  - ➢ *Mucorcaninus coprophilus*. It is also known as dung mould.
  - ➢ *Rhizopus* and *Mucor* are the common saprotrophic fungi that attack a variety of food stuffs. Both of them are commonly used in alcoholic fermentation.

(ii) Ascomycetes (The sac fungi)

- It is also known as 'sac fungi'.
- They are mostly multicellular (e.g. *Penicillium)* or rarely unicellular (e.g. *Saccharomyces*- yeast)
- Mycelium is branched and septate. Yeast is an exception in that they are basically unicellular. They may however, form short temporary filamentous structure called pseudomycelium.
- Asexual spores are called conidia produced exogenously on the conidiophores.
- Sexual spores are called ascospores produced endogenously in sac like ascus. Asci are produced inside fruiting body called Ascocarp.
- *E.g., Aspergillus, Neurospora, Claviceps.*
- *Neurospora crassa* is known as the *Drosophila* of plant kingdom. It is used extensively in biochemical and genetic work.
- *Aspergillus flavus,* growing on stored grains, groundnut and bread produces toxin called aflatoxin, which is carcinogenic to humans.
- *Claviceps purpurea* produces ergot of rye and other cereals in which ears come to have sclerotia of fungus. Eating of infected cereals produces ergotism.
- *Morels and Truffles* are edible ascomycetes.

(iii) Basidiomycetes (The club fungi)

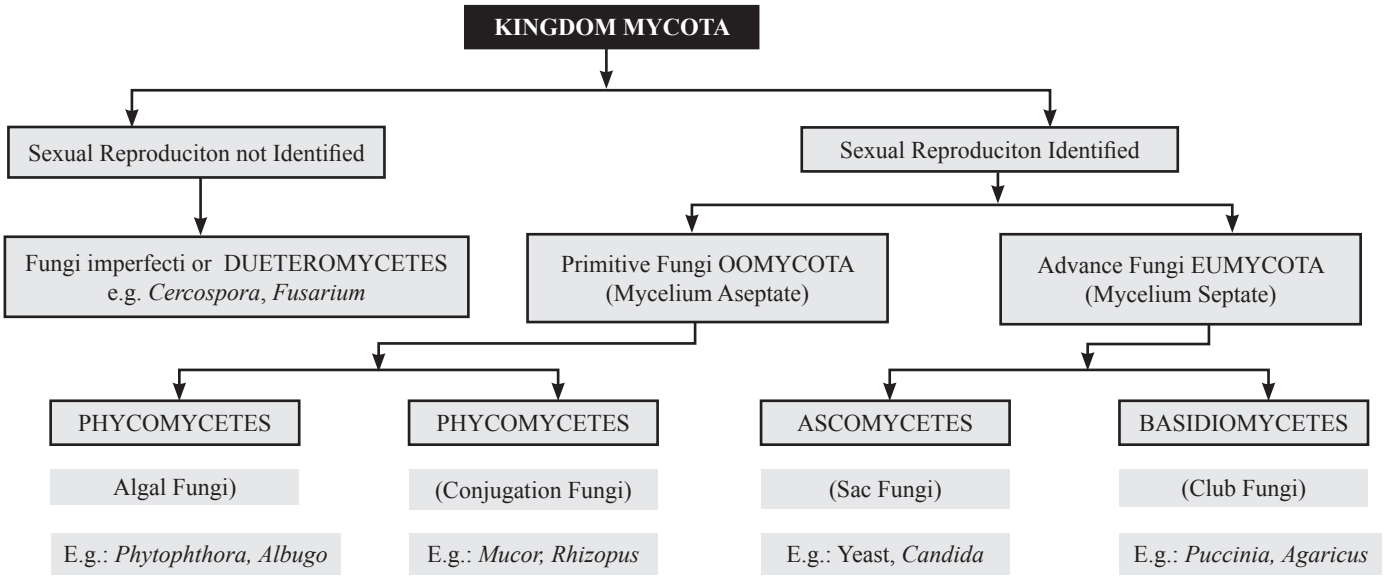
- The commonly known forms of basidiomycetes are mushroom, bracket fungi.
- Mycelium is branched and septate.
- Asexual spores generally are not found.
- Vegetative reproduction is by fragmentation.
- Sexual reproduction is by plasmogamy. It involves fusion of vegetative or somatic cells of different strains to form

basidium. Basidia are arranged in fruiting bodies called basidiocarp.

- Karyogamy and meiosis take place in the basidium producing four basidiospores. The basidiospores are exogenously produced on the basidium.
- *E.g., Agaricus (*mushroom*), Ustilago (*smut*), Puccinia (*rust fungus).

(iv) Deuteromycetes

- It is commonly called as 'Fungi Imperfecti' as only asexual or vegetative form of this fungus is known.
- Mycelium is septate and branched.
- The deuteromycetes reproduce only by asexual spores known as conidia.
- They are saprophytic, parasitic or decomposers.
- *E.g.,*
  - ➢ *Colletotrichum falcatum* produces red rot of sugarcane.
  - ➢ *Helminthosporiumoryzae* produces sesame or brown leaf spot of rice.
  - ➢ *Alternaria* causes early blight of potato and tomato.
  - ➢ *Trichoderma* is a soil fungus used in biological control of other fungi.



Importance of Fungi

Harmful 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. 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 on bread 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 bywind and germinate after falling out a suitable place. This is asexual reproduction.

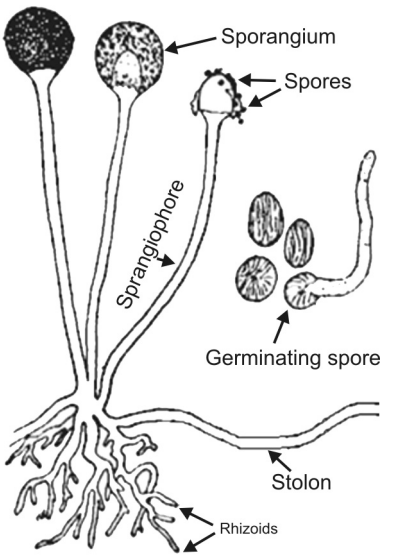


Fig.: Structure of fungi

- Sexual reproduction 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.

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

Beneficial Fungi

- Certain Mushrooms (*Agaricus campestris*) are edible.
- Yeasts are 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*. Its antibiotic effect was discovered by chance by Alexander Flemming in 1927.

KINGDOM PLANTAE (Kingdom of multicellular producers/metaphyta)

- It includes multi-cellular plants of land and water.
- The major groups of Algae, Bryophytes, Pteridophytes, Gymnosperms and Angiosperms belong to this kingdom.

Characteristic features

- They are chlorophyll containing multicellular eukaryotes.
- The cells have a rigid cell wall made up of cellulose.
- They show various modes of nutrition. Most of them are autotrophs since they have chlorophyll. Some plants are heterotrophs. For e.g. *Cuscuta* is a parasite. *Nepenthes* and *Drosera* are insectivorous plants.
- Life cycle shows alternation of generation having gametophytic (n) and sporophytic (2n) phase.

How Fungi and Plants Differ from each other

1. Fungi cannot make their own food like plants can, since they do not have chloroplasts and cannot carry out photosynthesis. Fungi are more like animals because they are heterotrophs. They have to obtain their food from outside sources.
2. The cell walls in many species of fungi contain chitin. Chitin is tough carbohydrate found in the shells of animals such as beetles and lobsters. The cell wall of a plant is made of cellulose, not chitin.
3. Unlike many plants, most fungi do not have structures that transfer water and nutrients.

KINGDOM ANIMALIA (Kingdom of multicellular consumers/metazoa)

This kingdom includes all multi-cellular eukaryotic organisms. They are also referred to as metazoans.

Characteristic features

- They are motile or mobile as they have to search for their food. However sponges and corals are exception.
- All animals show heterotrophic mode of nutrition. They form the consumers of an ecosystem.
- They have contractibility of the muscle cells.
- They can transmit impulses due to the presence of nerve cells.
- Some groups of animals are parasites e.g. Tapeworms and roundworms.
- They lack cell wall.
- They stores food reserves as fat or glycogen.
- Reproduction is mostly sexual.

VIRUSES

They did not find a place in classification. They show both living and non-living characters. Hence viruses are regarded as a separate entity. It is not taken into account in Whittaker's five kingdom classification.

Living characteristics of virus

- It has the ability to multiply inside a host plant or animal cell.
- It has the ability to cause diseases.
- It possesses nucleic acid, protein, enzyme etc.
- It has the ability to undergo mutation.

Non-living characteristics of virus

- Virus is unable to multiply extra cellular.
- It does not have any metabolic activity.
- It lacks protoplasm.
- It can be crystallized.

Viruses are defined as ultramicroscopic, disease causing intra cellular **obligate parasites.** They have no cellular organization and have no machinery for any metabolic activity. They are obligate intracellular parasites and they multiply within their host cells. Once outside the host cell they are completely inactive.

History of discovery of virus

- Pasteur coined the term 'Virus' *i.e.,* poisonous fluid.
- It attracted the attention of investigators only in the 19th century when a virus called **Tobacco Mosaic Virus (TMV)** caused severe damage to commercially important tobacco crop.
- **D.J. Ivanowsky** found out that certain microbes caused Tobacco Mosaic Disease in tobacco plant.
- Dutch microbiologist **Beijerinek** (1898) confirmed the findings of **Iwanowsky** and called the fluid *"contagium vivum fluidum"* which means contagious living fluid. This

was later on called virion (poison) and the disease causing agent as virus.

- **W. M. Stanley** in 1935 showed viruses could be crystallised to form crystals of protein which are inert outside their specific host.
- Viruses are ultramicroscopic. They can be seen only under electron microscope. They are measured in millimicrons (1 millimicron = 1/1000 micron). (1 micron = 1/1000 millimeter). Generally they vary from 2.0 mm to 300 mm in size.
- The branch of science that deals with study of virus is known as **virology**.

Structure of Virus

A virus is composed of two major parts: **Capsid** (the protein coat) and **Nucleic acid**.

(i) Capsid: The capsid is the outer protein coat. It is protective in function. It is often composed of many identical subunits called **capsomeres** arranged in helical or polygeometric forms. Some of the viruses have an outer covering called **envelope.** E.g. HIV. They are called enveloped viruses. Others are called naked viruses or non- enveloped viruses. The capsid is in close contact with the nucleic acid and hence known as **nucleocapsid**.

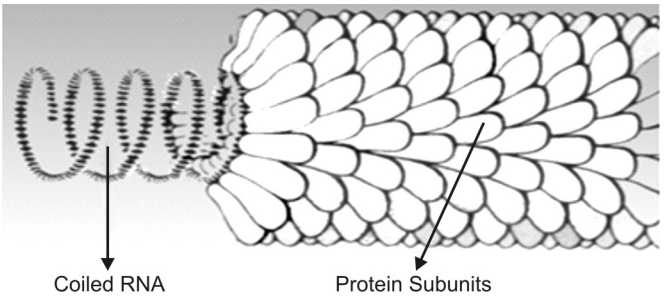


Fig. Structure of tobacco mosaic virus

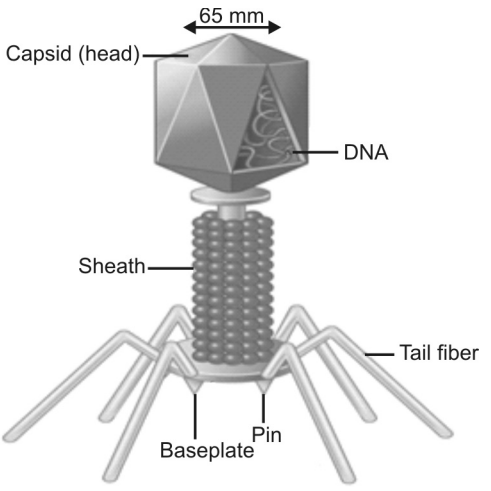


Fig. Bacteriophage

(ii) Nucleic acid: The nucleic acid forms the central core. Unlike any living cell a virus contains either DNA or RNA as genetic material which may be single or double stranded. Usually plant viruses have single stranded RNA; bacteriophages have double stranded DNA and animal viruses have single or double stranded RNA or double stranded DNA. The infective nature of the virus is attributed to the nucleic acid while host specificity is attributed to the protein coat.

According to the type of the host they infect, viruses are classified mainly into the following types.

(i) Plant Viruses

They infect plants and cause diseases. Some common plant viral diseases are:

- Mosaic diseases of tobacco (TMV), cucumber (CMV), cauliflower.
- Bunchy top of banana
- Leaf-roll of potato
- Spotted wilt of tomato
- Generally, plant viruses have RNA with the exception of some viruses such as cauliflower mosaic virus which has DNA.

(ii) Animal Viruses

- They infect animals and cause diseases. The nucleic acid is either DNA or RNA. some of the diseases caused by viruses in human beings are: common cold, measles, small pox (now extinct), chicken pox, Jaundice, herpes, hepatitis A, B, C, D, E, G, influenza, polio, mumps, rabies, AIDS and SARS.
- Viruses also cause diseases in cattle. E.g. Foot and mouth disease (FMD) in cattle, encephalomyelitis of horse, rabies etc.
- Viruses that cause diseases in fungi are called **mycophages** and viruses that attack blue green algae/cyanobacteria and cause diseases are called **cyanophages.**

(iii) Bacteriophages

Virus that infects bacteria is called **bacteriophage** or simply **phage**. It is tadpole like and the nucleic acid is DNA e.g. T2, T4, T6 bacteriophages.

DNA containing viruses are called deoxy viruses while RNA containing viruses are called ribo viruses. Each of them has two subtypes, double stranded and single stranded.

Genetic material	Examples
dsDNA	T2, T4 bacteriophges, coliphage lambda, adenovirus, herpes virus, cauliflower mosaic, pox virus.
ssDNA	Coliphge MS 2, coliphage fd, coliphage ϕ 174
dsRNA	Reovirus, tumor virus.
ssRNA	Polio virus, food and mouth disease virus, influenza virus, Tobacco mosaic virus, HIV, Rous sarcoma virus etc.

Note:

Retrovirus is a virus whose genes are encoded in RNA instead of DNA. They synthesize complementary DNA through reverse transcriptase. Others have RNA → RNA replication.

The most well-known retrovirus that infects humans is HIV.

VIRION

An intact, infective virus particle which is non-replicating outside a host cell is called virion.

VIROIDS

- Viroids were discovered by **T.O. Diener**.
- It is the smallest self-replicating particles.
- A viroid is a circular molecule of ss RNA without a capsid.
- It lacks protein coat.
- It has a free RNA of low molecular weight.
- Viroids are known to cause diseases in plants only. E.g. Potato spindle tuber disease, Citrus exocortis.

PRIONS

- **Stanley Prusiner** did most of the work on prions and was awarded Nobel Prize in 1998.
- They are very unique among infectious agents because they contain no genetic material *i.e.* DNA/RNA.
- They are proteinaceous infectious particles.
- They are the causative agents for about a dozen fatal degenerative disorders of the central nervous systems of humans and other animals.
- *Eg. Creutzfeldt-Jacob Disease (CJD), Bovine Spongiform Encephalopathy (BSE)-Commonly known as mad cow disease, etc.*

INTERFERONS (IFNS)

- They are the host coded proteins of cytokine family that inhibit viral replication.
- They are produced by intact animal or cultured cells in response to viral infection or other inducers.
- They are believed to be the part of body's first line of defense against viral infection.

LICHENS

- It is the symbiotic association of algae and fungi.
- Algal part is called *phycobiont* and fungal part is called *mycobiont*.
- Phycobiont is autotrophic. Its main function is photosynthesis. It prepares food for fungi (Mycobiont).
- Mycobiont is heterotrophic. It provides shelter and absorbs mineral and water for alga.
- It acts as pollution indicator *i.e*. it does not grow in polluted area. Lichen cannot tolerate air pollution expecially due to sulphur dioxide.
- Lichens are of three types:

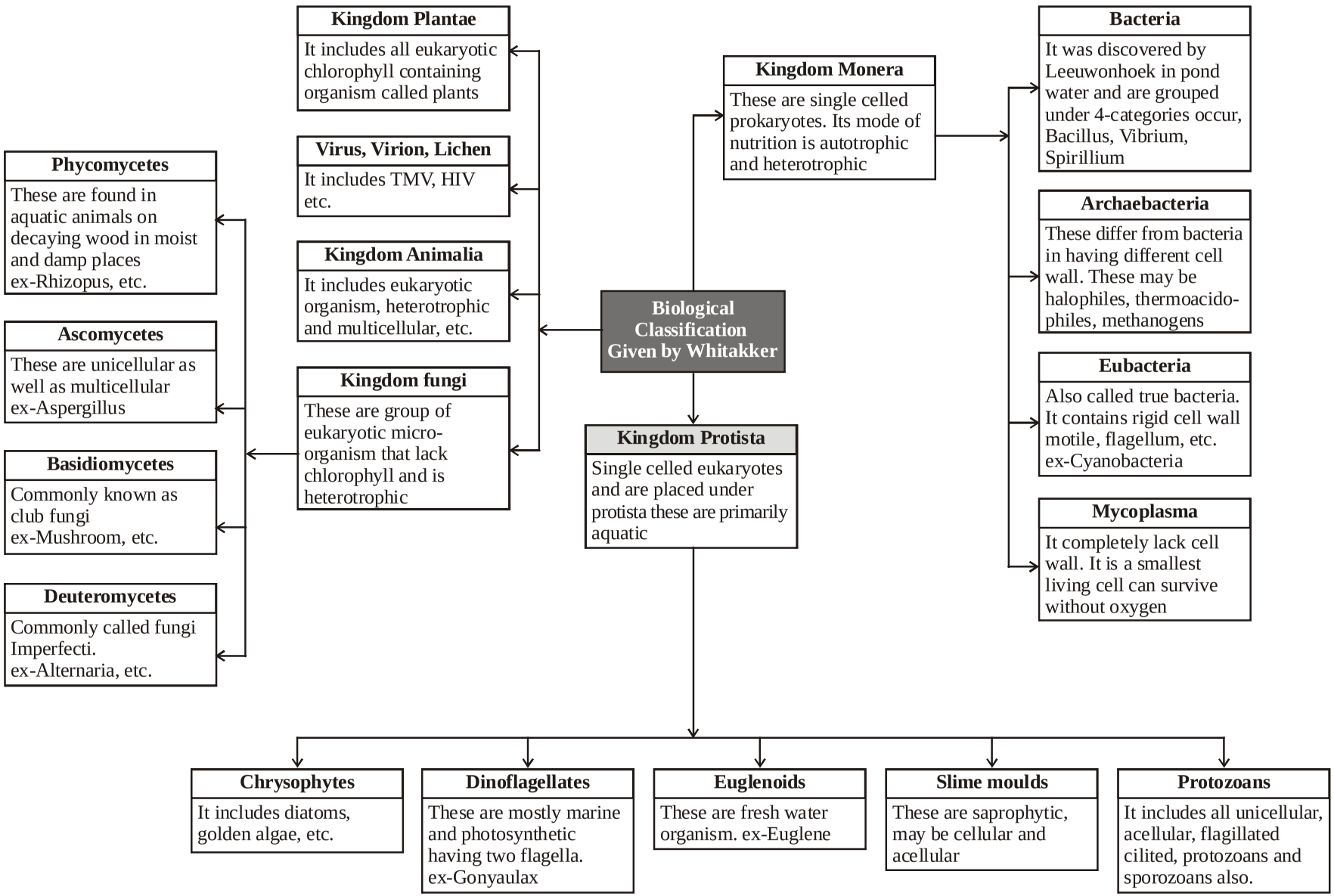
(i) **Crustose:** It is the curst like and closely appressed to the substratusm and attached to it at several places. E.g. *Graphis, lecanora, Rhizocarponetc*

(ii) **Foliose:** The body of foliose lichen is flat, broad, and lobed and leaf like which is attached to the substratum at one or a few places. E.g. *Parmelia, Dictyonema, etc.*

(iii) **Fructicose:** This type of lichen is branched like a bush and attached to the substratum by means of disc. E.g. *Cladonia, Evernia, Usnea.*

MYCORRHIZAE

- It is the mutual beneficial or symbiotic association of a fungus with the root of a higher plant.
- Here, the fungus is dependent upon the higher plant for shelter and food while fungus absorbs mineral and water for the plant. The fungus also seems to be essential for proper growth of the plant having mycorrhiza.


Biological Classification Given by Whitakker
Kingdom Plantae
It includes all eukaryotic chlorophyll containing organism called plants
Virus, Virion, Lichen
It includes TMV, HIV etc.
Kingdom Animalia
It includes eukaryotic organism, heterotrophic and multicellular, etc.
Kingdom fungi
These are group of eukaryotic micro-organism that lack chlorophyll and is heterotrophic
Phycomycetes
These are found in aquatic animals on decaying wood in moist and damp places ex-Rhizopus, etc.
Ascomycetes
These are unicellular as well as multicellular ex-Aspergillus
Basidiomycetes
Commonly known as club fungi ex-Mushroom, etc.
Deuteromycetes
Commonly called fungi Imperfecti. ex-Alternaria, etc.
Kingdom Monera
These are single celled prokaryotes. Its mode of nutrition is autotrophic and heterotrophic
Bacteria
It was discovered by Leeuwonhoek in pond water and are grouped under 4-categories occur, Bacillus, Vibrium, Spirillium
Archaebacteria
These differ from bacteria in having different cell wall. These may be halophiles, thermoacido-philes, methanogens
Eubacteria
Also called true bacteria. It contains rigid cell wall motile, flagellum, etc. ex-Cyanobacteria
Mycoplasma
It completely lack cell wall. It is a smallest living cell can survive without oxygen
Kingdom Protista
Single celled eukaryotes and are placed under protista these are primarily aquatic
Chrysophytes
It includes diatoms, golden algae, etc.
Dinoflagellates
These are mostly marine and photosynthetic having two flagella. ex-Gonyaulax
Euglenoids
These are fresh water organism. ex-Euglene
Slime moulds
These are saprophytic, may be cellular and acellular
Protozoans
It includes all unicellular, acellular, flagillated cilited, protozoans and sporozoans also.

EXERCISE - 1
Conceptual Questions

1. In Whittaker's system of classification, prokaryotes are placed in the kingdom
(a) Protista (b) Monera
(c) Plantae (d) Animalia

2. In the five kingdom system of classification, which single kingdom out of the following can include blue-green algae, nitrogen fixing bacteria and methanogenic archaebacteria ?
(a) Monera (b) Fungi
(c) Plantae (d) Protista

3. Which of the following kingdom does not have nuclear membrane?
(a) Protista (b) Fungi
(c) Monera (d) Plantae

4. What type of mode of nutrition is found in the kingdom Animalia?
(a) Autotrophic and heterotrophic
(b) Chemosynthetic and photosynthetic
(c) Saprophytic and parasitic
(d) Holozoic and saprophytic

5. The separation of living beings into five kingdoms is based on –
(a) Complexity of cell structure
(b) Complexity of organism's body
(c) Mode of obtaining nutrition
(d) All of the above

6. The chief component of bacterial cell wall is
(a) Cellulose and chitin
(b) Cellulose and pectin
(c) Amino acids and polysaccharides
(d) Cellulose and carbohydrates

7. Bacteria whose cell has only a curve/comma is
(a) Vibrio (b) Cocci
(c) Spirilli (d) Bacilli

8. The main difference between Gram positive and Gram negative bacteria lies in the composition of
(a) Cilia (b) Cell wall
(c) Nucleolus (d) Cytoplasm

9. Helically coiled shaped bacteria are called
(a) Spirilla (b) Coed
(c) Bacilli (d) Vibrio

10. Cell wall is absent in
(a) bacteria (b) fungi
(c) plants (d) animals

11. Which one of the following organisms may respire in the absence of oxygen ?
(a) *Azotobacter* (b) *Clostridium*
(c) *Rhizobium* (d) *Lactobacillus*

12. An organism having cytoplasm i.e. DNA and RNA but no cell wall is
(a) Cyanobacterium (b) Mycoplasma
(c) Bacterium (d) Virus

13. Kingdom monera comprises the –
(a) Plants of economic importance
(b) All the plants studied in botany
(c) Prokaryotic organisms
(d) Plants of Thallophyta group

14. The cell wall of green plants is made up of
(a) Pectin (b) Suberin
(c) Cellulose (d) Chitin

15. Which of the following is not a blue-green algae ?
(a) *Nostoc* (b) *Anabaena*
(c) Lichen (d) *Aulosiras*

16. During rainy seasons, the ground becomes slippery due to dense growth of
(a) Lichens (b) Bacteria
(c) Green algae (d) Cyanobacteria

17. *Paramecium* is a
(a) Protozoan (b) Bacterium
(c) Virus (d) Annelid

18. Protists are
(a) single-celled eukaryotes (b) multicellular eukaryotes
(c) single-celled prokaryotes (d) single-celled akaryote

19. Total parasites belong to protozoan group
(a) Sporozoa (b) Ciliata
(c) Sarcodina (d) Zooflagellata

20. The cilia in *Paramecium* are
(a) All equal (b) All unequal
(c) Longer at posterior end (d) Longer at anterior end

21. *Plasmodium*, the parasite, belongs to class
(a) Sarocodina (b) Ciliata
(c) Sporozoa (d) Dinophyceae

22. Which of the following organisms were never included in protista ?
(a) Bacteria (b) Red algae
(c) Slime moulds (d) Mosses

23. Which of the following does not contain chlorophyll ?
(a) Fungi (b) Algae
(c) Bryophyta (d) Pteridophyta

24. Which of the following statements are true about bacteria?
(a) They are the sole members of the kingdom Monera.
(b) They live in extreme habitats such as hot springs, deserts, snow and deep oceans
(c) They show the most extensive metabolic diversity
(d) All of these

25. The cell wall of fungi is made up of
(a) Chitin (b) Cellulose
(c) Pectin (d) Suberin

26. The disease of potato responsible for famous famine of Europe was caused by or late blight of potato is caused by
(a) *Colletotrichum falcatum*
(b) *Phytophthora infestans*
(c) Potato mosaic virus
(d) *Alternaria solani*

27. Ergot is caused by
(a) *Claviceps* (b) *Penicillium*
(c) *Aspergillus* (d) *Rhizobium*

28. When fungi feed on dead organic matter, they are known as
(a) Dimorphic (b) Parasites
(c) Saprophytes (d) None of these

29. Which of the following divisions of fungi includes Club fungi ?
(a) Zygomycota (b) Ascomycota
(c) Deuteromycota (d) Basidiomycota

30. Which of the following fungi are edible ?
(a) *Agaricus campestris* (b) *Morchella esculenta*
(c) *Podaxon prodaxis* (d) All of these

31. Gametangial copulation (conjugation) is common in
(a) Zygomycetes (b) Ascomycetes
(c) Phycomycetes (d) Deuteromycetes

32. Dikaryon formation is characteristic of
(a) Ascomycetes and basidiomycetes
(b) Phycomycetes and basidiomycetes
(c) Ascomycetes and phycomycetes
(d) Phycomycetes and zygomycetes

33. Plasmogamy is fusion of
(a) Two haploid cells including their nuclei
(b) Two haploid cells without nuclear fusion
(c) Sperm and egg
(d) Sperm and two polar nuclei

34. Clamp connection is found in
(a) Basidiomycetes (b) Ascomycetes
(c) Saccharomycetes (d) Haplomycetes

35. Difference between virus and viroid is
(a) absence of protein coat in viroid but present in virus
(b) presence of low molecular weight RNA in virus but absent in viroid
(c) both (a) and (b)
(d) None of these

36. Common bread mould is
(a) Yeast (b) *Rhizopus*
(c) Bacteria (d) Virus

37. Branched, aseptate, coenocytic mycelium is present in
(a) *Aspergillus* (b) *Albugo*
(c) *Penicillium* (d) *Erysiphae*

38. In manufacture of bread, it becomes porous due to release of CO_2 by the action of
(a) Virus (b) Yeast
(c) Bacteria (d) Protozoans

39. Members of phycomycetes are found in
(a) aquatic habitats (b) on decaying wood
(c) moist and damp places (d) all of these

40. 'Mycorrhizae' are useful for plants mainly due to their following attribute
(a) Fixing atmospheric nitrogen
(b) Enhanced absorption of nutrients from soil
(c) Killing insects and pathogens
(d) Providing resistance against abiotic stresses

41. Red rot of sugarcane is caused by –
(a) *Puccinia* (b) *Albugo*
(c) *Ustilago* (d) *Colletotrichum*

42. Fungi are always –
(a) Autotrophs (b) Heterotrophs
(c) Saprophytes (d) Parasites

43. Which of the following option is true for methanogens?
(i) They are eukaryotes.
(ii) They live in marshy areas.
(iii) They are also present in the guts of several ruminant animals such as cows and buffaloes.
(iv) They are responsible for the production of methane (biogas)
(a) (i) and (ii) (b) (ii) and (iii)
(c) (i), (ii), (iii) and (iv) (d) None of these

44. Pseudomycelium is characteristic feature of –
(a) Mushroom (b) Mucor
(c) Bread mould (d) Yeast

45. Common form of food stored in a fungal cell is –
(a) Glycogen (b) Starch
(c) Glucose (d) Sucrose

46. Which of the following pigment present in cyanobacteria?
(a) Chlorophyll '*a*' (b) Chlorophyll '*b*'
(c) Chlorphyll '*c*' (d) Chlorophyll '*d*'

47. *Rhizopus* belongs to the class –
(a) Ascomycetes (b) Phycomycetes
(c) Basidiomycetes (d) Deuteromycetes

48. Which one of the following is smallest living cell and live without oxygen?
(a) Mycoplasma (b) Mycorrhiza
(c) *Euglena* (d) *Trypanosoma*

49. The Tobacco mosaic virus was crystallized for first time by
(a) W. M. Stanley (b) E . C. Stackman
(c) A. K. Smith (d) Ivanowski

50. The genetic material in viruses is
(a) Only RNA
(b) Only DNA
(c) RNA and DNA both
(d) RNA or DNA *i.e.* one nucleic acid in a virus

51. Which of the following pair comes under the group chrysophytes?
(a) Diatoms and *Euglena*
(b) *Euglena* and *Trypanosoma*
(c) Diatoms and desmids
(d) *Gonyaulax* and desmids

52. Which one is absent in viruses ?
(a) Replication (b) Protein synthesis
(c) Energy liberation (d) Mutation

53. Protists obtain food as
(a) photosynthesisers, symbionts and holotrophs
(b) photosynthesisers
(c) chemosynthesisers
(d) holotrophs

54. The part of the virus which gives to it the hereditary feature, is
(a) Capsid (b) Capsomere
(c) Nucleic acid (d) Nucleotide

55. A bacteriophage is
(a) A virus attacking a bacterium
(b) A bacterium attacking a virus
(c) A stage in the life-cycle of bacterium
(d) A virus attacking another virus

56. A few organisms are known to grow and multiply at temperatures of 100–105ºC. They belong to
(a) marine archaebacteria
(b) thermophilic sulphur bacteria
(c) hot-spring blue-green algae (cyanobacteria)
(d) thermophilic, subaerial fungi

57. The most abundant prokaryotes helpful to humans in making curd from milk and in production of antibiotics are the ones categorised as :
(a) Cyanobacteria
(b) Archaebacteria
(c) Chemosynthetic autotrophs
(d) Heterotrophic bacteria

58. The cyanobacteria are also referred to as
(a) protists (b) golden algae
(c) slime moulds (d) blue green algae

59. Lichens are important in studies on atmospheric pollution because they –
(a) can also grow in greatly polluted atmosphere
(b) can readily multiply in polluted atmosphere
(c) efficiently purify the atmosphere
(d) are very sensitive to pollutants

60. The symbiotic association of fungi and algae is called –
(a) Lichen (b) Mycorrhiza
(c) Rhizome (d) Endomycorrhiza

61. Which one of the following is not true about lichens?
(a) Their body is composed of both algae and fungal cells.
(b) These grow very fast at the rate of about 2cm per year.
(c) Some form food for reindeer in arctic regions.
(d) Some species can be used as pollution indicators.

62. There exists a close association between the alga and the fungus within a lichen. The fungus
(a) provides protection, anchorage and absorption for the alga
(b) provides food for the alga
(c) fixes the atmospheric nitrogen for the alga
(d) releases oxygen for the alga

63. The thalloid body of a slime mould (Myxomycetes) is known as
(a) plasmodium (b) fruiting body
(c) mycelium (d) protonema

64. Which pair of the following belongs to Basidiomycetes ?
(a) Puffballs and *Claviceps*
(b) *Peziza* and stink borns
(c) *Morchella* and mushrooms
(d) Birds nest fungi and puffballs.

65. Which one of the following is a slime mould?
(a) *Physarum* (b) *Thiobacillus*
(c) *Anabaena* (d) *Rhizopus*

66. *Thermococcus*, *Methanococcus* and *Methanobacterium* exemplify:
(a) Archaebacteria that contain protein homologous to eukaryotic core histones
(b) Archaebacteria that lack any histones resembling those found in eukaryotes but whose DNA is negatively supercoiled
(c) Bacteria whose DNA is relaxed or positively supercoiled but which have a cytoskeleton as well as mitochondria
(d) Bacteria that contain a cytoskeleton and ribosomes

67. Mannitol is the stored food in:
(a) *Porphyra* (b) *Fucus*
(c) *Gracillaria* (d) *Chara*

68. Single-celled eukaryotes are included in:
(a) Protista (b) Fungi
(c) Archaea (d) Monera

69. Ringworm in humans is caused by :
(a) Bacteria (b) Fungi
(c) Nematodes (d) Viruses

70. Which one of the following organisms is not an example of eukaryotic cells ?
(a) *Paramecium caudatum* (b) *Escherichia coli*
(c) *Euglena viridis* (d) *Amoeba proteus*

71. In eubacteria, a cellular component that resembles eukaryotic cells is :
(a) plasma membrane (b) nucleus
(c) ribosomes (d) cell wall

72. Organisms called methanogens are most abundant in a :
(a) sulphur rock (b) cattle yard
(c) polluted stream (d) hot spring

73. The highest number of species in the world is represented by
(a) Fungi (b) Mosses
(c) Algae (d) Lichens

74. In the five-kingdom classification, *Chlamydomonas* and *Chlorella* have been included in
(a) protista (b) algae
(c) plantae (d) monera

75. Which one of the following pathogens causes canker disease ?
(a) *Meloidogyne incognita*
(b) *Anguina tritici*
(c) *Xanthomonas citri*
(d) *Pseudomonas rubilineans*

EXERCISE - 2
Applied Questions

1. Which statement is true for dinoflagellates flagella ?
(a) A single flagellum in the transverse groove between the cell plates.
(b) A single flagellum in the longitudinal groove between the cell plates.
(c) Two flagella, one lies longitudinally and one transversely in a furrow between the wall plates.
(d) No flagella.

2. Which is the correct option for the all given characteristics of fungi ?
I. It includes unicellular as well as multicellular fungi.
II. In multicellular forms hyphae are branched and septate.
III. Conidiophore produces conidia (spores) exogenously in chain.
IV. Sexual spores are ascopores produced endogenously in chain.
V. Fruiting body is called ascocarp.
(a) Phycomycetes (b) Sac fungi
(c) Club fungi (d) Fungi imperfecti

3. Which one of the following option does not belong to Ascomycetes ?
(a) They are saprophytic, decomposer, coprophilous (growing on dung) and parasitic.
(b) They include unicellular (*e.g.* yeast) and multicellular forms.
(c) Their mycelium is coenocytic.
(d) *Aspergillus, Claviceps, Neurospora* are important members of Ascomycetes.

4. In Whittaker's five kingdom classification, eukaryotes were assigned to
(a) all the five kingdom
(b) only four of the five kingdoms
(c) only three kingdom
(d) only one kingdom

5. Mycorrhiza is
(a) a symbiotic association of plant roots and certain fungi.
(b) an association of algae with fungi.
(c) a fungus parasitie on root system of higher plants.
(d) an association of *Rhizobium* with the roots of leguminous plants.

6. Which one of the following statements is true about Archaea?
(a) Archaea resemble eukaryotes in all respects.
(b) Archaea have some novel features that are absent in other prokaryotes and eukaryotes.
(c) Archaea completely differ from both prokaryotes and eukaryotes.
(d) Archaea completely differ from prokaryotes.

7. Two species of *Amoeba* X and Y were kept in fresh water and got adapted. Species X developed contractile vacuole. When both were transferred to sea water and got adapted, both X and Y lost their contractile vacuole. From these observation we conclude that
(a) Both X and Y are marine species
(b) Species Y is marine species and X is fresh water species
(c) Species X is marine species and Y is fresh water species
(d) Both X and Y are fresh water species

8. Yeast is not included in protozoans but in fungi because
(a) it has no chlorophyll
(b) some fungal hyphae grow in such a way that they give the appearance of pseudomycelium
(c) it has eukaryotic organisation
(d) cell wall is made up of cellulose and reserve food material is starch

9. All of the following statements concerning the Actinomycetes filamentous soil bacterium *Frankia* are correct except that *Frankia* :
(a) Can induce root nodules on many plant species.
(b) Cannot fix nitrogen in the free-living state.
(c) Forms specialized vesicles in which the nitrogenase is protected from oxygen by a chemical barrier involving triterpene hopanoids.
(d) Like *Rhizobium*, it usually infects its host plant through root hair deformation and stimulates cell proliferation in the host's cortex.

10. Which one of the following statements about mycoplasma is wrong ?
(a) They are pleomorphic.
(b) They are sensitive to penicillin.
(c) They cause diseases in plants.
(d) They are also called PPLO.

11. In the light of recent classification of living organisms into three domains of life (bacteria, archaea and eukarya), which one of the following statements is true about archaea?
(a) Archaea resemble eukarya in all respects.
(b) Archaea have some novel features that are absent in other prokaryotes and eukaryotes.
(c) Archaea completely differ from both prokaryotes and eukaryotes.
(d) Archaea completely differ from prokaryotes.

12. Which one is the wrong pairing for the disease and its causal organism?
(a) Black rust of wheat - *Puccinia graminis*
(b) Loose smut of wheat - *Ustilago nuda*
(c) Root-knot of vegetables - *Meloidogyne sp*
(d) Late blight of potato - *Alternaria solani*

13. Virus envelope is known as:
(a) Capsid (b) Virion
(c) Nucleoprotein (d) Core

14. Which one single organism or the pair of organisms is **correctly** assigned to its taxonomic group?
(a) *Paramoecium* and *Plasmodium* belong to the same kingdom as that of *Penicillium*
(b) Lichen is a composite organism formed from the symbiotic association of an algae and a protozoan
(c) Yeast used in making bread and beer is a fungus
(d) *Nostoc* and *Anabaena* are examples of protista

15. Malignant tertian malaria is due to
(a) *Plasmodium falciparum*
(b) *P. vivax*
(c) *P. ovale*
(d) *P. malariae*

16. What is common about *Trypanosoma*, *Noctiluca*, *Monocystis* and *Giardia* ?
(a) They produced spores
(b) These are all parasites
(c) These are all unicellular protists
(d) They have flagella

17. Tobacco Mosaic Virus (TMV) has
(a) A single stranded RNA molecule
(b) A double stranded RNA molecule
(c) A single stranded DNA molecule
(d) A double stranded DNA molecule

18. Which one of the following pairs is correctly matched ?
(a) *Rhizobium* - Parasite in the roots of leguminous plants
(b) Mycorrhizae - Mineral uptake from soil
(c) Yeast - Production of biogas
(d) Myxomycetes - The disease ring worm

19. Which of the following are likely to be present in deep sea water ?
(a) Eubacteria (b) Blue-green algae
(c) Saprophytic fungi (d) Archaebacteria

20. Which one of the following is true for fungi?
(a) They are phagotrophs
(b) They lack a rigid cell wall
(c) They are heterotrophs
(d) They lack nuclear membrane

21. Specialized cells for fixing atmospheric nitrogen in *Nostoc* are
(a) Akinetes (b) Heterocysts
(c) Hormogonia (d) Nodules

22. Satellite RNAs are present in some
(a) Plant viruses (b) Viroids
(c) Prions (d) Bacteriophages

23. Aristotle used simple_____characters to classify plants into trees, shrubs and herbs.
(a) anatomical (b) biochemical
(c) morphological (d) physiological

24. Which of the following characteristic is not used by Whittaker for the classification organisms?
(a) Mode of nutrition
(b) Thallus organisation
(c) Phylogenetic relationships
(d) None of these

25. Which of the following processes are involved in the reproduction of protista?
(a) Binary fission and fragmentation
(b) Cell fusion and zygote formation
(c) Spore formation and fragmentation
(d) Budding and spore formation

26. Auxopores and hormocysts are formed, respectively, by:
(a) Some diatoms and several cyanobacteria
(b) Some cyanobacteria and diatoms
(c) Several cyanobacteria and several diatoms
(d) Several diatoms and a few cyanobacteria.

27. Which of the following statements is not true for retroviruses?
(a) DNA is not present at any stage in the life cycle of retroviruses
(b) Retroviruses carry gene for RNA-dependent DNA polymerase
(c) The genetic material in mature retroviruses is RNA
(d) Retroviruses are causative agents for certain kinds of cancer in man

28. The most thoroughly studied fact of the known bacteria-plant interactions is the
(a) cyanobacterial symbiosis with some aquatic ferns
(b) gall formation on certain angiosperms by *Agrobacterium*
(c) nodulation of *Sesbania* stems by nitrogen fixing bacteria
(d) plant growth stimulation by phosphate-solubilising bacteria

29. Viruses are no more "alive" than isolated chromosomes because
(a) both require the environment of a cell to replicate
(b) they require both RNA and DNA
(c) they both need food molecules
(d) they both require oxygen for respiration

30. The main role of bacteria in the carbon cycle involves
(a) photosynthesis
(b) chemosynthesis
(c) digestion or breakdown of organic compounds
(d) assimilation of nitrogenous compounds

31. Which of the following is not correctly matched?
(a) Root knot disease - *Meloidogyne javanica*
(b) Smut of bajra - *Tolysporium penicillariae*
(c) Covered smut of barley - *Ustilago nuda*
(d) Late blight of potato - *Phytophthora infestans*

32. Reverse transcriptase is
(a) RNA dependent RNA polymerase
(b) DNA dependent RNA polymerase
(c) DNA dependent DNA polymerase
(d) RNA dependent DNA polymerase

33. Organisms which are indicator of SO_2 pollution of air
(a) Mosses (b) Lichens
(c) Mushrooms (d) Puffballs

34. Which of the following is an example of amoeboid protozoan?
(a) *Trypanosoma* (b) *Paramoecium*
(c) *Gonyaulax* (d) *Entamoeba*

35. Which of the following is a parasitic fungi on the mustard plant?

(a) *Albugo* (b) *Puccinia*

(c) Yeast (d) *Ustilago*

36. Which of the following is used extensively in biochemical and genetic work?

(a) *Agaricus* (b) *Alternaria*

(c) *Neurospora* (d) *Mucor*

37. Which of the following is/are example(s) of Deuteromycetes?

(a) *Alternaria* (b) *Colletotrichum*

(c) *Trichoderma* (d) All of these

38. Which of the following group of fungi is commonly known as imperfect fungi?

(a) Phycomycetes (b) Ascomycetes

(c) Basidiomycetes (d) Deuteromycetes

39. Bladderwort and Venus fly trap are examples of

(a) insectivorous plants (b) parasitic plants

(c) N_2– rich plants (d) aquatic plants

40. The subunit of capsid is called

(a) Core (b) Nucleotide

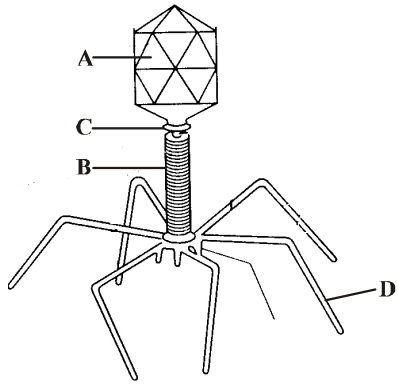
(c) Amino acid (d) Capsomere

41. All are viral diseases except

(a) AIDS and mumps (b) Small pox and herpes

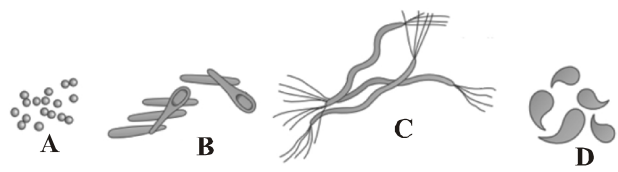
(c) Influenza (d) Cholera

42. Which option is true for A, B, C and D?



	A	B	C	D
(a)	Tail fibres	Head	Sheath	Collar
(b)	Sheath	Collar	Head	Tail fibres
(c)	Head	Sheath	Collar	Tail fibres
(d)	Collar	Tail fibres	Head	Sheath

43. Choose the correct names of the different bacteria according to their shapes.



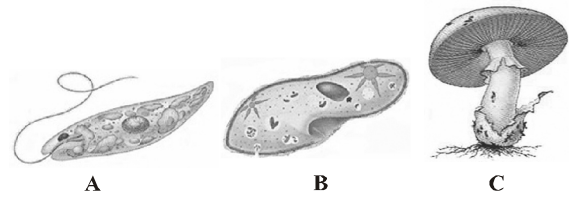
(a) A – Cocci, B – Bacilli, C – Spirilla, D – Vibrio

(b) A – Bacilli, B – Cocci, C – Spirilla, D – Vibrio

(c) A – Spirilla, B – Bacilli, C – Cocci, D – Vibrio

(d) A – Spirilla, B – Vibrio, C – Cocci, D – Bacilli

44. Identify the following figures.



(a) A – *Euglena*, B – *Paramecium*, C – *Agaricus*

(b) A – *Euglena*, B – *Planaria*, C – *Agaricus*

(c) A – *Planaria*, B – *Paramecium*, C – *Agaricus*

(d) A – *Euglen*a, B – *Paramecium*, C – A*spergillus*

45. Match Column - I with Column - II

	Column-I		**Column-II**
A.	Aerobic	1.	*Frankia*
B.	Cyanobacteria	2.	*Azospirillum*
C.	*Casuarina*	3.	*Clostridium*
D.	Tropical grasses	4.	*Aulosira*
		5.	*Azotobacter*

(a) A → 4; B → 3; C → 2; D → 1

(b) A → 3; B → 5; C → 4; D → 2

(c) A → 2; B → 1; C → 3; D → 5

(d) A → 5; B → 4; C → 1; D → 2

46. Match Column - I with Column - II

	Column-I (Group Protista)		**Column-II (Example)**
A.	Chrysophytes	1.	*Paramecium*
B.	Dinoflagellates	2.	*Euglena*
C.	Euglenoids	3.	*Gonyaulax*
D.	Protozoans	4.	Diatoms

(a) A → 1; B → 3; C → 2; D → 4

(b) A → 2; B → 4; C → 3; D → 1

(c) A → 4; B → 2; C → 3; D → 1

(d) A → 4; B → 3; C → 2; D → 1

47. Which of the following statement(s) is/are correct about mycoplasma ?

(1) Mycoplasma has no cell wall.

(2) Mycoplasma is the smallest living organism.

(3) Mycoplasma cannot survive without O_2.

(4) Mycoplasma are pathogenic in animals and plants.

(5) True sexuality is not found in bacteria.

(6) A short of sexual reproduction by adopting a primitive DNA transfer from one bacterium to the other occurs.

Choose the answer from the following options

(a) All of these

(b) Only (3)

(c) (1), (2), (4), (5) and (6)

(d) (1), (3) and (6)

48. Which of the following is correct about the slime mould ?
(1) Its thalloid body, *Plasmodium* has pseudopodia for locomotion and engulfing organic matter.
(2) During unfavourable conditions *Plasmodium* differentiates and produces fruiting bodies, sporangium.
(3) Spores posses no true cell wall.
(4) They are dispersed by air current.
(5) Being extremely resistant, spores survive for many years.
(6) *Plasmodium* can grow upto several feet.
Choose the answer from the following options
(a) (1),(2), (4), (5) and (6)
(b) (1),(2) and (3)
(c) (1),(2), (3) and (6)
(d) (2),(3) and (6)

49. Fungi can be parasites on –
(1) Animals (2) Human being
(3) Plants
Choose the answer from the following options
(a) Only (1) (b) (2) and (3)
(c) (1) and (2) (d) All of these

50. Which of the following statments are true about virues ?
(1) Viruses are obligate parasites
(2) Viruses can multiply only when they are inside the living cells
(3) Viruses cannot pass through bacterial proof filters
(4) Viruses are made up of protein + DNA or RNA (never both DNA and RNA)
Choose the answer from the following options
(a) (1) and (2) (b) (1), (2) and (3)
(c) (1), (2) and (4) (d) All of these

EXERCISE - 3
Exemplar & Past Years NEET/AIPMT Questions

Exemplar Questions

1. All eukaryotic unicellular organisms belong to
(a) Monera (b) Protista
(c) Fungi (d) Bacteria

2. The five kingdom classification was proposed by
(a) R.H. Whittaker (b) C. Linnaeus
(c) A Roxberg (d) Virchow

3. Organisms living in salty areas are called as
(a) methanogens (b) halophiles
(c) heliophytes (d) thermoacidophiles

4. Naked cytoplasm, multinucleated and saprophytic are the characteristics of
(a) Monera (b) Protista
(c) Fungi (d) Slime molds

5. An association between roots of higher plants and fungi is called
(a) lichen (b) fern
(c) mycorrhiza (d) BGA

6. A dikaryon is formed when
(a) meiosis is arrested
(b) the two haploid cells do not fuse immediately
(c) cytoplasm does not fuse
(d) None of the above

7. Contagium vivum fluidum was proposed by
(a) D.J. Ivanowsky (b) M.W. Beijernek
(c) Stanley (d) Robert Hook

8. Association between mycobiont and phycobiont are found in
(a) mycorrhiza (b) root
(c) lichens (d) BGA

9. Difference between virus and viroid is
(a) absence of protein coat in viroid, but present in virus.
(b) presence of low molecular weight RNA in virus, but absent in viroid
(c) Both (a) and (b) (d)None of the above

10. With respect to fungal sexual cycle, choose the correct sequence of events.
(a) Karyogamy, Plasmogamy and Meiosis
(b) Meiosis, Plasmogamy and Karyogamy
(c) Plasmogamy, Karyogamy and Meiosis
(d) Meiosis, Karyogamy and Plasmogamy

11. Viruses are non-cellular organisms, but replicate themselves once they infect the host cell. To which of the following kingdom do viruses belong to?
(a) Monera (b) Protista
(c) Fungi (d) None of these

12. Members of phycomycetes are found in
(i) Aquatic habitats
(ii) On decaying wood
(iii) Moist and damp places
(iv) As obligate parasites on plants
Choose from the following options.
(a) (i) and (iv) (b) (ii) and (iii)
(c) None of these (d) All of these

NEET/AIPMT (2013-2017) Questions

13. Which of the following are likely to be present in deep sea water ? ***[2013]***
(a) Eubacteria (b) Blue-green algae
(c) Saprophytic fungi (d) Archaebacteria

14. Which one of the following is true for fungi?
(a) They are phagotrophs ***[NEET Kar. 2013]***
(b) They lack a rigid cell wall
(c) They are heterotrophs
(d) They lack nuclear membrane

15. Specialized cells for fixing atmospheric nitrogen in *Nostoc* are ***[NEET Kar. 2013]***
(a) Akinetes (b) Heterocysts
(c) Hormogonia (d) Nodules

16. Satellite RNAs are present in some ***[NEET Kar. 2013]***
(a) Plant viruses (b) Viroids
(c) Prions (d) Bacteriophages

17. Five kingdom system of classification suggested by R.H. Whittaker is **not** based on: ***[2014]***
(a) Presence or absence of a well defined nucleus.
(b) Mode of reproduction.
(c) Mode of nutrition.
(d) Complexity of body organisation.

18. Which one of the following fungi contains hallucinogens?
(a) *Morchella esculenta* ***[2014]***
(b) *Amanita muscaria*
(c) *Neurospora sp.*
(d) *Ustilago sp.*

19. Archaebacteria differ from eubacteria in: ***[2014]***
(a) Cell membrane
(b) Mode of nutrition
(c) Cell shape
(d) Mode of reproduction

20. Which of the following shows coiled RNA strand and capsomeres? ***[2014]***
(a) Polio virus
(b) Tobacco mosaic virus
(c) Measles virus
(d) Retrovirus

21. Viruses have: ***[2014]***
(a) DNA enclosed in a protein coat
(b) Prokaryotic nucleus
(c) Single chromosome
(d) Both DNA and RNA

22. The motile bacteria are able to move by: ***[2014]***
(a) Fimbriae (b) Flagella
(c) Cilia (d) Pili

23. Which one one of the following matches is correct ? ***[2015 RS]***

1.	*Alternaria*	Sexual reproduction absent	Deuteromycetes
2.	*Mucor*	Reproduction by Conjugation	Ascomycetes
3.	Agaricus	Parasitic fungus	Basidiomycetes
4.	Phytophthora	Aseptate mycelium	Basidiomycetes

24. True nucleus is absent in : ***[2015 RS]***
(a) *Mucor* (b) *Vaucheria*
(c) *Volvox* (d) *Anabaena*

25. Which of the following structures is not found in a prokaryotic cell? ***[2015 RS]***
(a) Ribosome
(b) Mesosome
(c) Plasma membrane
(d) Nuclear envelope

26. The imperfect fungi which are decomposers of litter and help in mineral cycling belong to: ***[2015 RS]***
(a) Basidiomycetes (b) Phycomycetes
(c) Ascomycetes (d) Deuteromycetes

27. The structures that help some bacteria to attach to rocks and / or host tissues are: ***[2015 RS]***
(a) Fimbriae (b) Mesosomes
(c) Holdfast (d) Rhizoids

28. Pick up the wrong statement ***[2015 RS]***
(a) Prostista have photosynthetic and heterotrophic modes of nutrition
(b) Some fungi are edible
(c) Nuclear membrane is present Monera
(d) Cell wall is absent in Animalia

29. In which group of organisms the cell walls form two thin overlapping shells which fit together? ***[2015 RS]***
(a) Euglenoids (b) Dinoflagellates
(c) Slime moulds (d) Chrysophytes

30. Choose the wrong statement: ***[2015 RS]***
(a) *Neurospora* is used in the study of biochemical genetics
(b) Morels and truffles are poisonous mushrooms
(c) Yeast is unicellular and useful in fermentation
(d) *Penicillium* is multicellular and produces antibiotics

31. Which of the following are most suitable indicators of SO_2 pollution in the environment? ***[2015 RS]***
(a) Conifers (b) Algae
(c) Fungi (d) Lichens

33. Which of the following statements is wrong for viroids?
(a) They lack a protein coat ***[2016]***
(b) They are smaller than viruses
(c) They cause infections
(d) Their RNA is of high molecular weight

33. One of the major components of cell wall of most fungi is
(a) Chitin (b) Peptidoglycan ***[2016]***
(c) Cellulose (d) Hemicellulose

34. Which one of the following statements is wrong? ***[2016]***
(a) Cyanobacteria are also called blue-green algae
(b) Golden algae are also called desmids
(c) Eubacteria are also called false bacteria
(d) Phycomycetes are also called algal fungi

35. Chrysophytes, Euglenoids, Dinoflagellates and Slime moulds are included in the kingdom ***[2016]***
(a) Monera (b) Protista
(c) Fungi (d) Animalia

36. Which of the following are found in extreme saline conditions ?
(a) Eubacteria (b) Cyanobacteria ***[2017]***
(c) Mycobacteria (d) Archaebacteria

37. Which of the following components provides sticky character to the bacterial cell? ***[2017]***
(a) Nuclear membrane
(b) Plasma membrane
(c) Glycocalyx
(d) Cell wall

38. Viroids differ from viruses in having; ***[2017]***
(a) DNA molecules without protein coat
(b) RNA molecules with protein coat
(c) RNA molecules without protein coat
(d) DNA molecules with protein coat

39. Which among the following are the smallest living cells, known without a definite cell wall, pathogenic to plants as well as animals and can survive without oxygen? ***[2017]***
(a) *Pseudomonas* (b) *Mycoplasma*
(c) *Nostoc* (d) *Bacillus*

Hints & Solutions

EXERCISE - 1

1. (b) 2. (a) 3. (c) 4. (d) 5. (d)
6. (c) 7. (a)
8. (b) In G^+ (Gram-positive bacteria) cell wall is 200-300 Å thick, having mucopeptides 85% and lipids 1-2% while in G^- (Gram-negative bacteria) cell wall is 100-200 Å thick and mucopeptides are 10-12% and lipids are 80-90%.
9. (a) 10. (d) 11. (b)
12. (b) Mycoplasma are cell wall less cells but show multiplication like bacteria, so that they are termed as cell wall less bacteria.
13. (c) 14. (c) 15. (c) 16. (d) 17. (a)
18. (a) 19. (a)
20. (c) The cilia of extreme posterior end are longer and form a bunch called caudal tuft.
21. (c) 22. (d) 23. (a) 24. (d) 25. (a)
26. (b) Late blight of potato is a seed born disease which is caused by *Phytophthora infestans*. The disease is characterised by brownish to blackish dead areas on the tip and margin of the leaflet leading to blighting of the whole leaf. So the tuber formation is reduced.
27. (a) *Claviceps puerpurea* is a fungus which causes ergotism in rye (*Secale cereale*) and other plants. It also yields a hallucinogenic drug called LSD.
28. (c) All fungi are heterotrophs in their nutrition. Some depend upon organic matter known as saprophytes.
29. (d) The members of division basidiomycota (class basidiomycetes) are commonly called club fungi because the basidia are club shaped.
30. (d) *Agaricus campestris* is a common field mushroom, *Morchella esculenta* have apothecia type of edible ascocarp and *Podaxon prodaxis* is also edible.
31. (a) In gametangial copulation two gametangia come in contact and fuse completely to form a zygote or zygospore. It is found in members of *zygomycetes, e.g.*, *Rhizopus* and *Mucor*.
32. (a)
33. (b) It is the first stage of sexual reproduction in which the cytoplasm of two sex cells fuse with each other. The nuclei of sex cells come close to each other but do not fuse. Thus the resulting cell becomes binucleate or dikaryon.
34. (a) In many members of basidiomycetes, cell division accompanied by clamp connection. These are bridge (hook) like connection. They function as bypass hyphae through which nuclei migrate to make all of mycelium *dikaryotic*.
35. (a)
36. (b) *Rhizopus* (pin mould or black mould) grows on bread and hence also called bread mould.
37. (b) 38. (b) 39. (d) 40. (b) 41. (d)
42. (b) 43. (c)
44. (d) Pseudomycelium is characteristic feature of yeast.
45. (a) 46. (a) 47. (b) 48. (a) 49. (a)
50. (d) 51. (b) 52. (c)
53. (a) Members of kingdom Protista have diverse mode of nutrition. They are photosynthetic, saprophytic parasitic and ingestive. They are majorheterotrophs.
54. (d) 55. (a)
56. (a) These are archaebacteria which can tolerate high temperature
57. (d) The most abundant prokaryotes helpful to humans in making curd from milk and in production of antibiotics are the heterotrophic bacteria. *Lactobacillis* bacteria convert milk into curd.
58. (d) Cyanobacteria are also referred to as blue green algae, they perform oxygenic photosynthesis. They are most successful autotrophic organisms on earth which are found in all types of environment - fresh water, sea water, salt marshes, moist rocks, tree trunks, moist soils, hot springs, frozen waters.
59. (d)
60. (a) The symbiotic association of fungi and algae is called lichen.
61. (b)
62. (a) Lichens (coined by Theophrastus) are composite or dual organisms which are formed by a fungus partner or mycobiont (mostly ascomycetes) and an algal partner (mostly blue green algae). Fungus forms the body of lichen as well as its attaching and absorbing structures. Algae performs photosynthesis and provides food to the fungus.
63. (a) The thalloid body of slime moulds is made up of multinucleated cell which lacks septa in between and hence it is a multinucleated single celled mass called plasmodium.
64. (d) The class Basidiomycetes includes those members that produce their basidia and basidiospores on or in a basidiocarp.
65. (a) *Physarum polycephalum* belongs to phylum Amoebozoa, infraphylum Mycetozoa, and class Myxogastrea. *P. polycephalum*, often referred to as the "many-headed slime," is a slime mold that inhabits shady, cool, moist areas, such as decaying leaves and logs.
66. (a) *Thermococcus*, *Methanococcus* and *Methanobacterium* exemplify archaebacteria that contain protein homologous to eukaryotic core histones.

67. (b) Mannitol is a food stored in *Fucus*. *Fucus* is a genus of brown alga in the class Phaeophyceae found in the intertidal zones of rocky sea shores almost everywhere in the world. Primary chemical constituents of this plant include mucilage, algin, mannitol, beta-carotene, zeaxanthin, iodine, bromine, potassium, volatile oils, and many other minerals.

68. (a) Single celled eukaryotes are included in protista. Protista includes all unicellular and colonial eukaryotes except green and red algae. It is also known as kingdom of unicellular eukaryotes.

69. (b) Ring worm is a fungal disease caused by the dermatophyte fungi species of *Microsporum*, *Trichophyton* and *Epidermophyton*.

70. (b) *E. coli* is a prokaryotic celled gram negative bacterium.

71. (a) Eubacteria are prokaryotic but eubacteria are enclosed by plasma membrane like eukaryotic cells.

72. (b) Methanogens are archaebacteria abundant in cattle yard and paddy fields.

73. (a)

74. (b) *Chlamydomonas* & *Chlorella* have been included in algae. Algae are chlorophyllous, thalloid avascular plants with no cellular differentiation. Algae belong to thallophyta of plant kingdom.

75. (c)

EXERCISE - 2

1. (c) 2. (b) 3. (c) 4. (b) 5. (a)

6. (b) 7. (c) 8. (b)

9. (b) *Frankia*, is a nitrogen fixing mycelial bacterium which is associated symbiotically (and not free living) with the root nodules of several non legume plants.

10. (b) While working at the Rockefeller Institute, Brown reported isolation of a PPLO from human arthritic joint tissue in 1938. In discussing the significance of this observation, Brown reported successful treatment of arthritic patients in 1949 with a new antibiotic called aureomycin (Clark, 1997).

11. (b) A domain of prokaryotic organisms containing the archaebacteria including the methanogens, which produce methane; the thermoacidophilic bacteria, which live in extremely hot and acidic environments, & the halophilic bacteria, which can only function at high salt concentrations are abundant in the world's oceans.

12. (d) Late blight is caused by the fungus *Phytophthora infestans*. Late blight appears on potato or tomato leaves as pale green, water-soaked spots, often beginning at leaftips or edges.

13. (a) Virus envelope is known as capsid. The capsid is composed of protein subunits called capsomere.

14. (c) *Saccharomyces cervisiae* is a yeast used in making bread (Baker's yeast) and commercial production of ethanol.
Paramoecium & *Plasmodium* are of animal kingdom while *Pencillium* is a fungi. Lichen is composite organism formed from the symbiotic association of an algae and a fungus. *Nostoc* & *Anabaena* are examples of kingdom monera.

15. (a) 16. (c) 17. (a) 18. (b)

19. (d) Archaebactera live in some of the most harsh habitats such as extreme salty areas (halophiles), hot springs (thermoacidophiles) and marshy areas (methanogens) and in deep sea water.

20. (c) Fungi lack chlorophyll, hence, they do not prepare their food by photosynthesis. They can grow where organic material is available. So, they are heterotrophs that acquire their nutrient by absorption and store in the form of glycogen.

21. (b) Heterocysts are large sized, thick-walled specialised cells which occur in terminal, intercalary or lateral position in filamentous cyanobacteria, *e.g.*, *Nostoc*. They have enzyme nitrogenase and specialised to perform biological nitrogen fixation.

22. (a) Plant viruses often contain parasites of their own, referred to as satellites. Satellite RNAs are dependent on their associated (helper) virus for both replication and encapsidation. Example—Tobacco Necrosis Virus (TNV).

23. (c) 24. (d) 25. (b)

26. (d) Binary fission in diatoms reduces the size of most daughters which is corrected through the development of auxospores.
In some filamentous cyanobacterial forms unisexual reproduction occurs by hormogonia (hormocysts). They are identified by presence of biconcave (one disk or separation disc between two adjacent cells e.g. *Oscillatoria*).

27. (a) Retroviruses have RNA as the genetic material and hence they exhibit reverse transcription whereby DNA is synthesized on RNA template. They have reverse transcriptase as the enzyme.

28. (b) This phenomenon has been successfully used in genetic engineering to produce disease resistant varieties of plants.

29. (a) Viruses can live only inside the host cell, using their machinery for its own metabolism.

30. (a) These are archaebacteria which can tolerate high temperature.

31. (c) Phytoalexins are non-specific antibiotic substances produced by plants in response to infection by a fungus.

32. (b) All viruses are nucleoprotein (Nucleic acid + Protein) in their structure. The nucleic acid (DNA and RNA) is genetic material. In a particular virus either DNA or RNA is the genetic material. Both are never present in a virus. Hence, viruses contains:
(i) Double stranded DNA (ds DNA) - Hepatitis B
(ii) Single stranded DNA (ss DNA) - Coliphage
(iii) Double stranded RNA (ds RNA) - Reo virus, wound Tumor virus
(iv) Single stranded RNA (ss RNA) - Tobacco mosaic virus (TMV)

33.	(b)	34.	(d)	35.	(a)	36.	(c)	37.	(d)	38.	(d)
39.	(a)	40.	(d)	41.	(d)	42.	(c)	43.	(a)	44.	(a)
45.	(d)	46.	(d)	47.	(c)	48.	(a)	49.	(d)	50.	(c)

EXERCISE - 3

Exemplar Questions

1. (b) **Protista** is a group comprising of all unicellular eukaryotic plants and animals. The organisms included in this group are either photoautotrophs, heterotrophs or parasites.
   Monera includes prokaryotic organisms like bacteria, unicellular organism.
   Fungi are eukaryotic but are mostly multicellular (yeast is unicellular).
2. (a) R.H. Whittaker (1969), an American taxonomist divided organism into five kingdoms, in order to develop phylogenetic classification.
   (i) Monera (ii) Protista
   (iii) Fungi (iv) Plantae
   (v) Animalia
   C Linnaeus developed two kingdom classification.
   (i) Kingdom-Plantae
   (ii) Kingdom-Animalia.
   and Virchow is associated with the discovery of cell theory.
3. (b) **Halophiles** are organisms inhabiting areas with high concentration of salts. The name halophiles means 'salt loving'.
   Heliophytes are the plants that grow best in sunlight and can not survive in dark conditions.
   Methanogens are the bacteria that produce methane as a metabolic byproduct under anaerobic conditions.
   Thermoacidophiles are archaebacteria able to survive under strong acidic environments and high temperatures, but cannot tolerate high salt concentrations around them.
4. (d) **Slime molds** are saprophytic protists, that move along the dead leaves engulfing organic matter. These are multinucleated with no cell wall and have naked cytoplasm.
   Monerans are prokaryotes, comprised of all bacteria.
   Protists are a group of eukaryotic organisms, that bear a well defined membrane around cytoplasm, may be uninucleate or multinucleated. Their cell has well developed cell wall made of chitin.
5. (c) **Mycorrhiza** is a symbiotic association of fungus with the roots of a higher plants like gymnosperms and angiosperms.
   The fungus is dependent on plants for food and shelter, while the plants are benefitted by the fungal hyphae as they help in absorption of water and dissolved minerals present in the soil debris and make it available to the plants.
   Whereas lichens are the symbiotic association between algae and fungi. Ferns are a group of plants, belonging to pteridophytes like other vascular plants and BGA is blue-green algae with a prokaryotic cell.
6. (b) Dikaryon is a cell with two nucleus. This results when two somatic cells fuse but their nucleus do not fuse immediately. Meiosis does not result in such conditions.
7. (b) **M.W. Beijerinck** proposed contagium vivum fluidum which means contagious living fluid. This phrase was first used to describe virus, characteristic in escaping from the finest mesh available.
   D.J. Ivanowsky was a Russian botanist who discovered the filterable nature of viruses and is one of the founders of virology.
   Stanley Miller was a Jewish American chemist who experimented on **origin of life on primitive earth.**
   Robert Hooke was the first to study and visualise cells using his primitive microscope.
8. (c) **Lichens** are organisms comprised of a permanent symbiotic association of a fungus and an alga.The fungal partner is called mycobiont an the algal partner is called phycobiont.
   Mycorrhiza is an association of fungus with the roots of higher plants, but not with an algae, while BGA is blue green algae, a member of Monera with a prokaryotic cell structure.
9. (a) Viruses contain DNA or RNA as the genetic material and a protein coat, whereas viroids have no protein coat, but only RNA as their nucleic acid. This is the reason why viroids are carried inside viruses. *e.g.*, hepatitis-D is a viroid carried inside the capsid of hepatitis-B virus.
10. (c) Plasmogamy means fusion of protoplasm while karyogamy means fusion of nucleus. These two events lead to the formation of zygote ($2n$) which is a diploid structure where meiosis occurs.
11. (d) In the five kingdom classification proposed by Whittaker, non-cellular organisms like viruses and viroids are not included. Viruses were not placed in the classification since they are not truly 'living' and hence, they are considered as non-cellular.
12. (d) Phycomycetes are fungi that can thrive on dead and decaying wood as saprophytes. These prefer to live in moist and damp places and need water for the movement of zoospore and sexual gametes.
    Few members of phycomycetes are obligate parasites like *Phytophthora infestans* that causes late blight of potato and *Peronospora viticola* causing downy mildew of grapes.

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13. (d) Archaebactera live in some of the most harsh habitats such as extreme salty areas (halophiles), hot springs (thermoacidophiles) and marshy areas (methanogens) and in deep sea water.
14. (c) Fungi lack chlorophyll, hence, they do not prepare their food by photosynthesis. They can grow where organic material is available. So, they are heterotrophs that acquire their nutrient by absorption and store in the form of glycogen.
15. (b) Heterocysts are large sized, thick-walled specialised cells which occur in terminal, intercalary or lateral position in **filamentous cyanobacteria,** *e.g.*, *Nostoc*. They have enzyme **nitrogenase** and are specialised to perform biological nitrogen fixation.
16. (a) Plant viruses often contain parasites of their own, referred to as satellites. Satellite RNAs are dependent on their associated (helper) virus for both replication and encapsidation. Example—Tobacco Necrosis Virus (TNV). Viroids are infectious agents smaller than viruses. Bacteriophages are viruses that infect the bacteria. A prion is an infectious agent that is composed primarily of protein.
17. (a) **Five kingdom system of classification** was proposed by **R.H. Whittaker** (1969). The five kingdom classification is based on the following criteria :
    - Complexity of cell structure – Prokaryotes or Eukaryotes
    - Complexity of organisms body – Unicellular or Multicellular
    - Mode of obtaining nutrition – Autotrophic or Heterotrophic
    - Phylogenetic relationships
18. (b) Several mushrooms such as *Amanita muscaria*, *Psilocybe mexicana* and *Panaeolus* spp. secrete hallucinogenic substances like psilocybin and psilocin. These substances may destroy brain cells and power perception of in human beings.
19. (a) Archaebacteria differ from other bacteria in having a different cell wall structure. They lack peptidoglyan in cell wall and possess a monolayer of branched fatty acids attached to glycerol by ether bonds in their cell membranes.
20. (b) **TMV** (**Tobacco Mosaic Virus**) is a rod-shaped virus. The rod has a core which contains helically coiled single stranded **RNA.** There is a protective covering of protein called **capsid** around the infective part. Capsid consists of small subunits called **capsomeres** and has antigenic property.
21. (a) All viruses are nucleoproteins (Nucleic acid + Protein) in the structure. The nucleic acid (DNA and RNA) is the genetic material. In a particular virus either DNA or RNA is the genetic material. Both are never present in a virus. Single stranded RNA or ss RNA - Tobacco mosaic virus (TMV)
    Virus envelope is known as capsid. The capsid is composed of protein subunits called capsomere.
22. (b) Motile bacteria have thin filamentous extensions on their cell wall called flagella.
23. (a) *Alternaria* belongs to class - Deuteromycetes, which lack sexual reproduction. Asexual reproduction takes place by conidia produced on conidiophores.
24. (d) *Anabaena* is a cyanobacteria which lack a true nucleus because of absence of nuclear membrane.
25. (d) Nuclear envelope is not found in a prokaryotic cell.
26. (d) Class- deuteromycetes comprises of imperfect fungi which play role in decomposition of organic wastes.
27. (a) Fimbriae assist some bacteria in attaching to rocks or host body for obtaining establishment and nutrition.
28. (c) The kingdom Monera possesses unicellular organisms (e.g - bacteria) having no nuclear membrane.
29. (d) In chrysophytes, the cell walls form two thin overlapping shells held together. The body of Diatoms appear like soap box due to overlapping shells.
30. (b) Morel and truffles are used as food and they are members of Ascomycetes fungi.
31. (d) Lichens cannot grow in places where sulphur dioxide is present in the environment.
32. (d) Viroids, the smallest known pathogens, are naked, circular, single-stranded RNA molecules that do not encode protein but autonomously replicate when introduced into host plants. Viroids only infect plants; some cause economically important diseases of crop plants, while others appear to be benign.
33. (a) A cell wall is a rigid structural layer, which provides protection and structural support to the cells. The composition of cell wall varies from one species to another. In fungi, the cell wall is composed of strong covalent linkages of chitin, glucans and glycoproteins. Alternatively, in case of land plants, the cell wall is composed of cellulose and hemicellulose. Archean cell walls consists of peptidoglycans.
34. (c) Eubacteria are the true bacteria.
35. (b) All unicellular eukaryotic organism like diatoms, desmids (chrysophytes), euglenoids, dinoflagellates and slime mould are included in Protista.
36. (d) Archaebacteria are able to survive in harsh conditions due to the presence of branched lipid chain in cell membrane that reduces fluidity of cell membrane.
    It includes halophiles which are exclusively found in saline habitats.
37. (c) Sticky character of the bacterial wall is due to glycocalyx which is rich in glycoproteins.
38. (c) Viroids in nature are sub-viral agents as infectious RNA particles, without protein coat.
39. (b) Mycoplasmas are smallest, prokaryotes lacking cell wall and are pleomorphic in nature. These are pathogenic to both plants and animals.