CHAPTER-02

BIOLOGICAL CLASSIFICATION

DEFINITION

Biological classification is defined as the process of grouping the organisms according to certain similarities

Linnaeus proposed the **two kingdoms of classification**. He classified organisms into animal kingdom as **Animalia** and plant kingdom as **Plantae**. There were certain limitations associated with two kingdom classification such as- it does not differentiate between eukaryotes and prokaryotes, unicellular and multicellular organisms, and photosynthetic and non-photosynthetic organisms.

FIVE KINGDOM CLASSIFICATIONS

R.H. Whittaker proposed the five kingdoms of classification. The five kingdoms' classification is as follows- **Monera, Protista, Fungi, Plantae, and Animalia**.

The classification was based on thallus organization, cell structure, mode of nutrition, phylogenetic relationship, and reproduction.

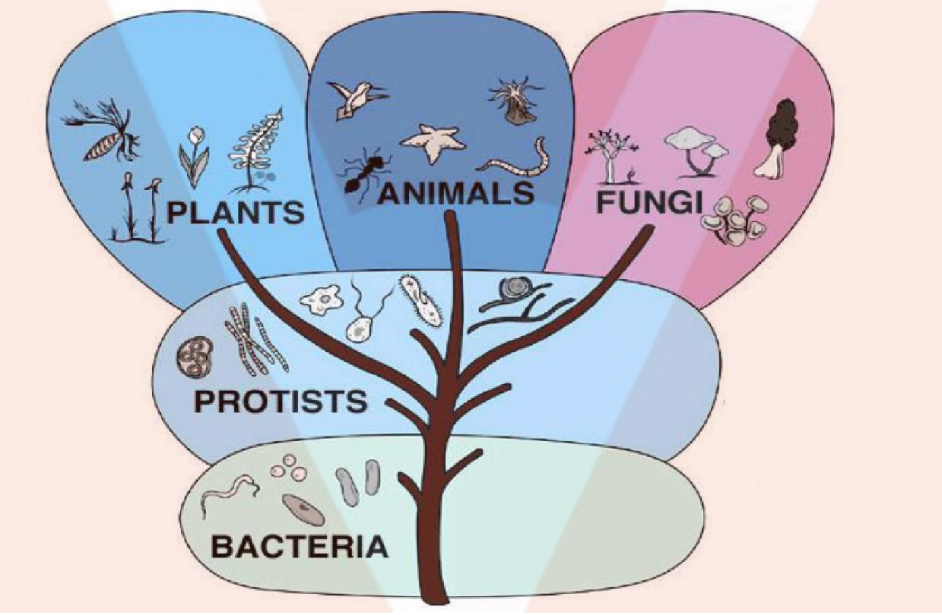


Fig.1. Five kingdom classifications

Kingdom Monera

The most important members of Monera are Bacteria.

All monerans are prokaryotes.

They do not have the true nucleus, that is, nucleus not surrounded by a nuclear membrane. It includes bacteria as well as blue-green algae
They can be present in extreme habitats such as hot springs, deserts, snow as well as deep oceans.

Certain organisms act as parasites also.

They can be autotrophs, heterotrophs as well as parasites. They do have a cell wall. Their respiration can be aerobic as well as anaerobic.

The movement occurs through flagella. Exchange of nutrients or gases occurs by diffusion.

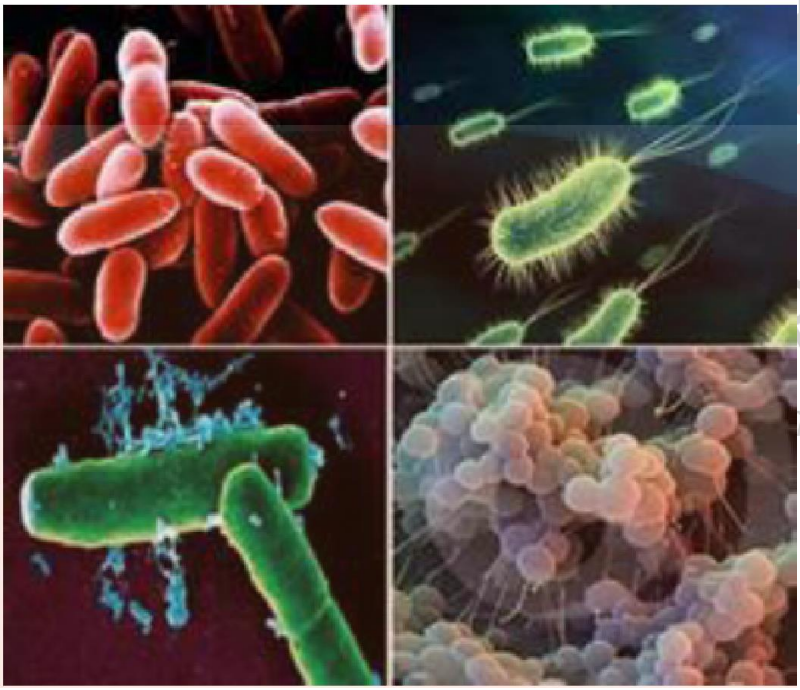


Fig.2. Examples of Kingdom Monera

They are divided into *Archaebacteria* and *Eubacteria*.

1.Archaebacteria:

- Archaebacteria has different cell wall structure due to which they can live in most harsh habitats.
- **Halophiles** (salt-loving), e.g., halobacterium and halococcus
  Thermoacidophiles (in hot springs), e.g., sulfobolus and thermoplasma

Methanogen (marshy area),e.g., Methanobacterium. Methanogens are also found in the guts of several ruminant animals such as cows and buffalos and they are responsible for the production of methane (biogas) from the dung of these animals.

2.Eubacteria:

- These are also known as true bacteria.
- They have a rigid cell wall.
- They possess flagellum, if motile.
- They are also known as blue-green algae or **Cyanobacteria**.
- Cyanobacteria are **photosynthetic autotrophs**.
- These are unicellular, colonial or filamentous algae.
- Colonies are surrounded by **a gelatinous sheath**.
- Some of the eubacteria can fix atmospheric nitrogen by specialized cells, e.g. *Anabaena* and *Nostoc*. These special cells are called **heterocyst.**

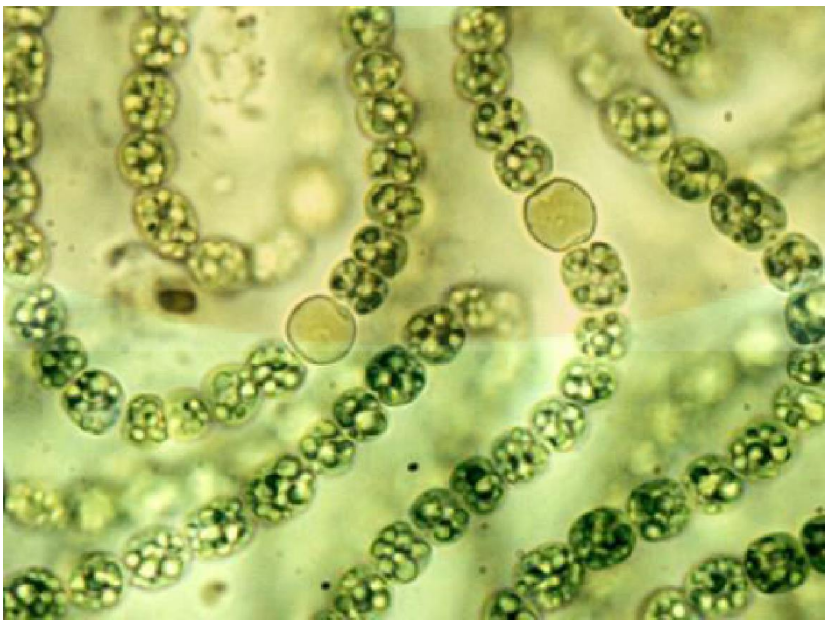


Fig.3. *Nostoc*

- **Chemosynthetic autotrophs**:
  Oxidize various inorganic substances such as nitrates, nitrites and ammonia and use the released energy for their ATP production. They play a great role in recycling nutrients like nitrogen, phosphorous, iron and sulphur.

- **Heterotrophic bacteria**:
  a. The most abundant in nature
  b. Most of them are decomposer
  c. They are helpful in making curd from milk.
  d. They are helpful in the Production of antibiotics
  e. Some are pathogen causing diseases like cholera, typhoid, and tetanus.

f. Bacteria reproduce mainly by **fission**, also produce **spore** in unfavourable condition.
g. Reproduce sexually by transfer of DNA from one bacteria to others, the process called **conjugation**.

- **Mycoplasma:**
  a. Completely lack a cell wall.
  b. Smallest living cells are known.
  c. Can survive even without oxygen.
  d. Pathogenic in animals and plants.

Kingdom Protista

Single-celled eukaryotes are kept under Protista.

They are mostly aquatic in nature. For example, Algae serves as primary producers in the aquatic ecosystem.

They are unicellular, eukaryotic organisms. They have a true nucleus, bounded by a nuclear membrane.

They can move by cilia as well as via flagella. Respiration can be both aerobic as well, as anaerobic.

Reproduce asexually and sexually by a process involving cell fusion and zygote formation.

They are divided into **Chrysophytes, Dinoflagellates, Euglenoids, Slime moulds and Protozoans**.

1. Chrysophytes

- Includes diatoms and golden algae (desmids).
- They can live in freshwater water as well as marine water.
- Mostly they are photosynthetic.
- Mostly they are unicellular flagellates. But some are amoeboid.
- Mostly planktonic (passive swimmer)
- Cell walls overlap to fit together like a soapbox. Cell wall contains silica hence indestructible. Their accumulation forms 'Diatomaceous Earth'.
- Used in polishing, filtration of oils and syrups.
- Diatoms are the chief 'producers' in the oceans.

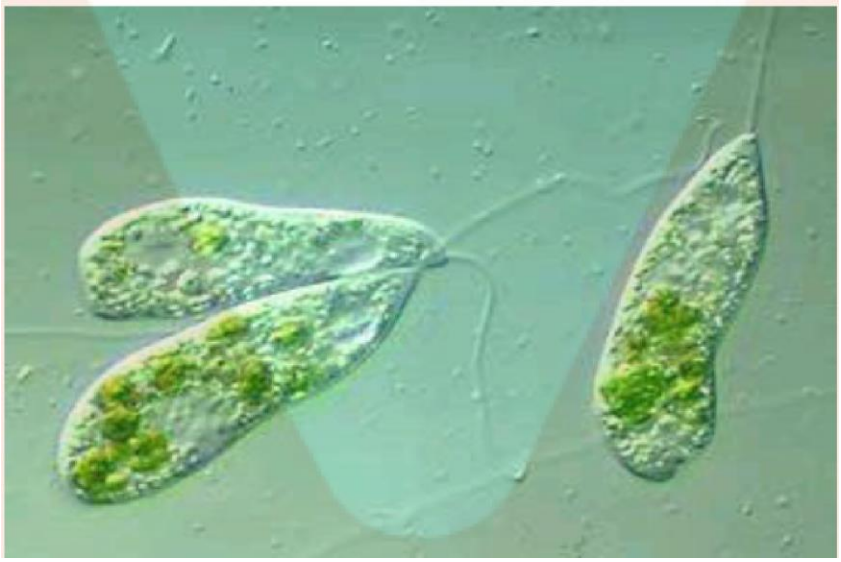


Fig.4. Diatoms

2. Dinoflagellates

- Dinoflagellates are marine and photosynthetic organisms.
- They can be of different colours such as yellow, brown, red, or blue. The colour is due to the presence of different coloured pigments present in the cells of the dinoflagellates.
- The cell wall is made up of stiff cellulose plates.
- They are biflagellate with one flagellum placed longitudinally and other flagella placed transversely. For example, *Gonyaulax catenella*, *Noctiluca scintillans*.
- Red Dinoflagellates (Gonyaulax) form red tides.

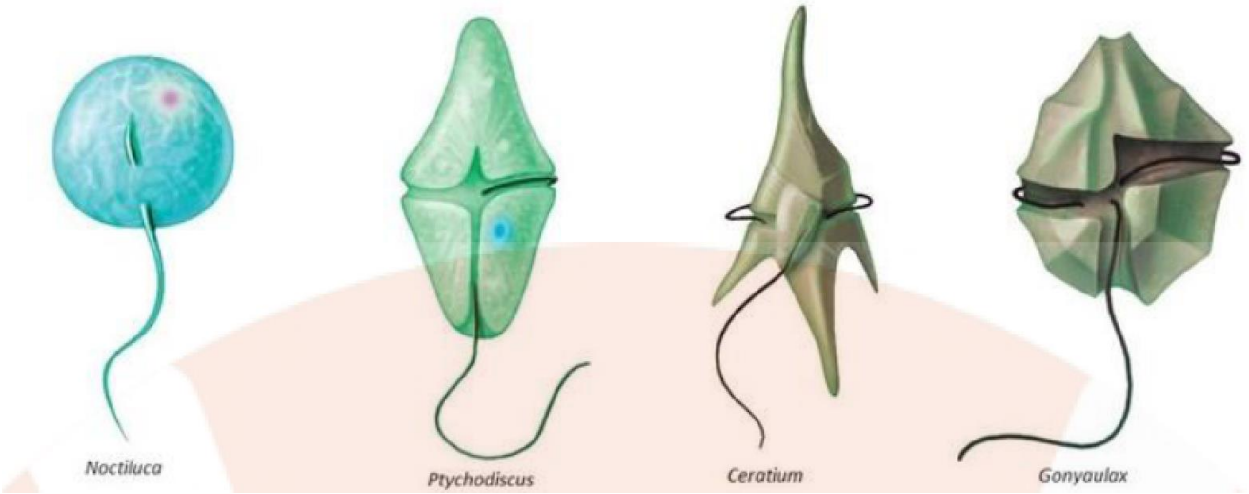


Fig.5*. Example of dinoflagellates*

3. Euglenoids

- Euglenoids are freshwater organisms that are found in stagnant water.
- They are surrounded by a protein-rich layer known as a pellicle.
- They have one short flagellum and one long flagellum.
- They can behave as autotrophic as well as heterotrophic organisms.
- For example, *Euglena*.
- Most of the euglenoids have chloroplast so they can synthesize their own food.

- The reserve food material found is euglenoids are Paramylon (carbohydrate).

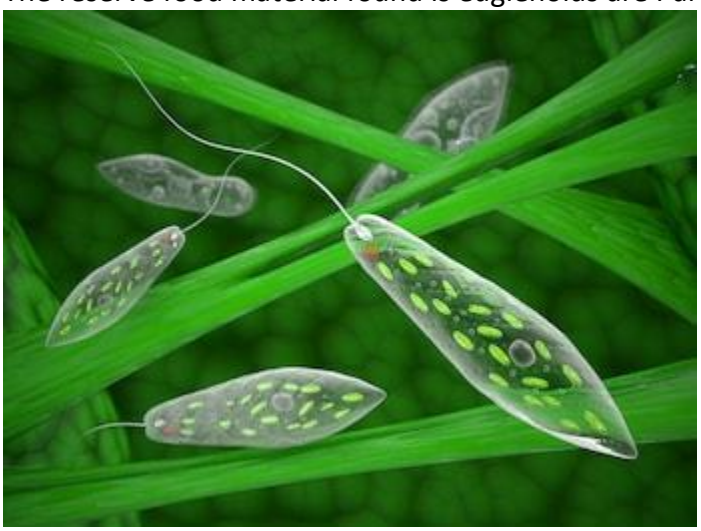


Fig.6. *Euglena*

4. Slime moulds

- They are saprophytic in nature.
- Under favourable conditions, they form aggregates which are known as *Plasmodium*.
- During the unfavourable condition, they form fruiting bodies with spores. They possess true cell walls.
- They are extremely resistant to adverse conditions.

5. Protozoan like protists

They are heterotrophs. They can live as predators as well as parasites. There are four major types of protozoans found-

• **Amoeboid protozoans** are found in freshwater, moist soil, or seawater. They possess pseudopodia for engulfing the food particles, such as *Amoeba*.

• **Flagellated protozoans** can be free-living or parasitic. This group of organisms are responsible for different parasitic diseases. For example, *Trypanosoma* causes sleeping sickness.

• **Ciliated protozoans** possess thousands of cilia. The movement of cilia helps in propelling forward or backwards. It also helps in obtaining food from the outside. For example, *Paramecium*.

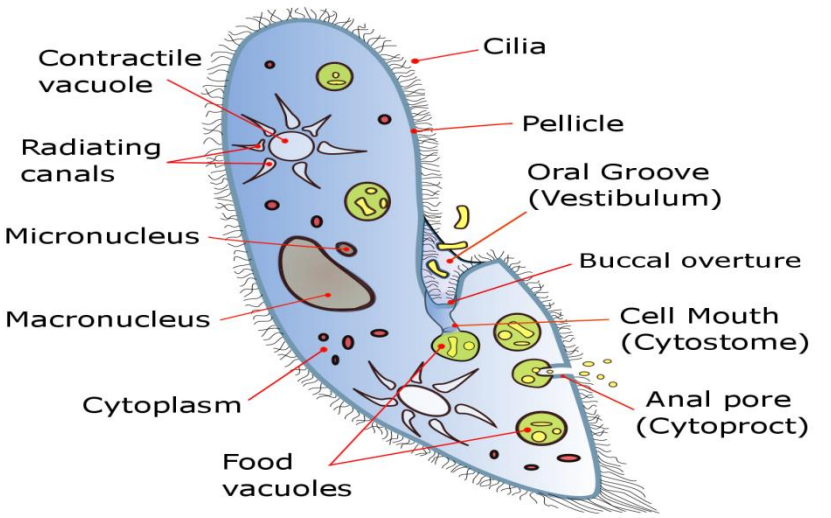


Fig.7. *Paramecium*

• **Sporozoans** form reproductive cells which are known as spores. They are parasitic and pathogenic in nature. For example, *Plasmodium* species causes Malaria. Reproduction can be asexual or sexual.

Fig.8. *Plasmodium* species

Kingdom Fungi

Fungi are heterotrophic in nature. Some acts on dead organic matter and so-known as saprophytes. Some can feed on living organisms so-known as parasites.

Some fungi can live in mutual relationship with other organisms such as algae, they are known as lichens. Such fungi are known as symbionts. Lichens are a symbiotic association between the fungi and the algae. Mycorrhiza is the symbiotic association between the fungi and the roots of the higher plants.

Reproduction in fungi can occur by- **budding, fragmentation, and fission**.

Asexual reproduction occurs through spores known as **conidia, zoospores or sporangiospores**.

Sexual reproduction occurs by **oospores, ascospores and basidiospores**.

There are three steps of the sexual cycle in fungi-

a. The first step is the fusion of the protoplasm which is known as **plasmogamy**.
b. Then, the fusion of nuclei occurs which is known as **karyogamy**. This results in the formation of the zygote.
c. Then finally, the meiosis of zygote results in the formation of the spores.

The vegetative part of the fungus is known as **mycelium**. The network of hyphae is known as mycelium. During the sexual cycle of fungi, two haploid hyphae fuse to form diploid cells.

KINGDOM FUNGI IS DIVIDED INTO DIFFERENT CLASSES-

1. Phycomycetes (lower fungi)-Asexual reproduction occurs by motile spores known as zoospores and nonmotile spores are known as aplanospores. Spores are produced inside the sporangium. The fusion of gametes gives rise to zygospore. Mycelium is coenocytic (multiple nuclei) and multicellular. For example, such as *Mucor, Rhizopus, Albugo*.

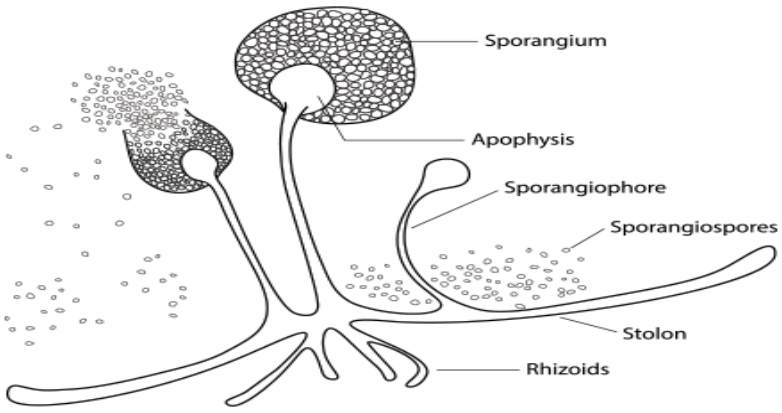


Fig.9. Common fungi

2. Ascomycetes (sac fungi)-They can be saprophytic as well as parasitic. Asexual reproduction occurs by conidia. Sexual reproduction occurs through ascospores. Branched and septate mycelium is found in Ascomycetes. For example, *Penicillium, Aspergillus, Claviceps* etc.

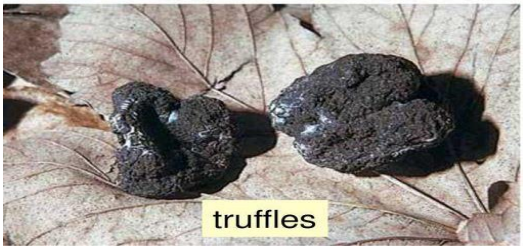
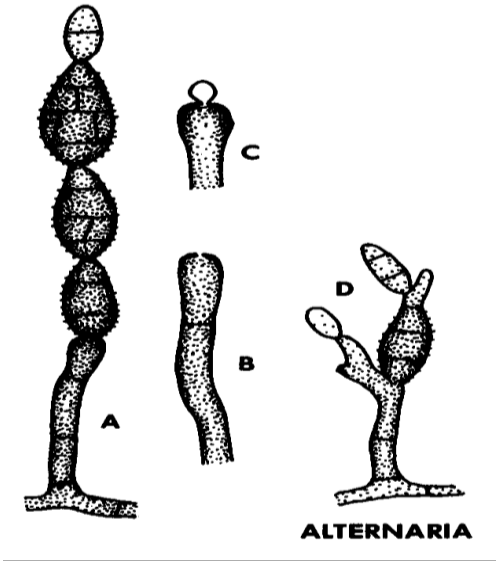


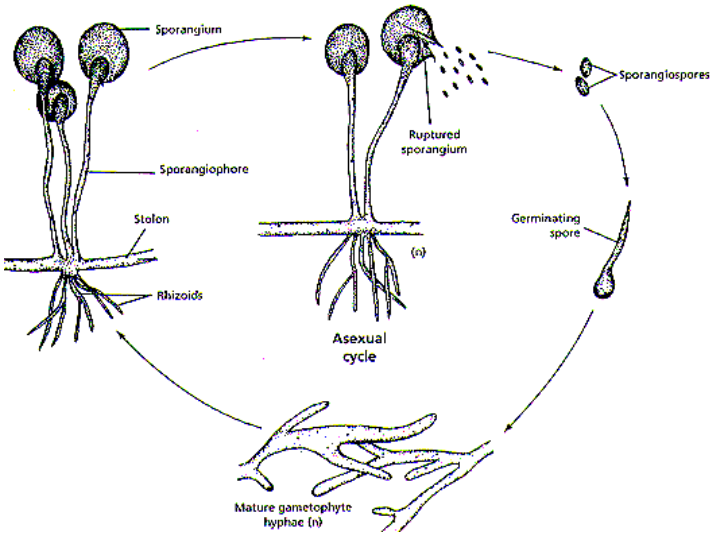
Fig.10. Ascomycetes

3. **Basidiomycetes (club fungi)-**Vegetative reproduction occurs through fragmentation. Absence of sex organs. Plasmogamy between two vegetative or somatic cells results in the formation of the basidium. Basidium undergoes karyogamy and meiosis to form four basidiospores. For example, *Agaricus* (mushrooms), *Ustilago* (smut) etc.

Fig.11. Basidiomycetes

• **Deuteromycetes are** commonly known as *imperfect fungi* as they do not have sexual reproduction at any stage of life. Asexual reproduction occurs by conidia. Mycelium is septate and branched. For example, *Alternaria, Trichoderma* etc.





• **Zygomycetes (conjugation fungi)** are a primitive group of fungi. Asexual reproduction occurs by nonmotile sporangiospores. For example, *Rhizopus*.

Kingdom Plantae

It includes all photosynthetic, multicellular, eukaryotic plants. Characteristics of members of Plantae are as follows-

Mostly they are eukaryotic in nature.

The main pigment present is chlorophyll.

Their cell wall is made up of cellulose.

Photosynthesis helps in the synthesis of the food.

Reproduction can be sexual as well as asexual.

They exhibit the phenomenon of alternation of generation, that is, diploid sporophyte and haploid gametophyte.

Kingdom Animalia

They are heterotrophic, eukaryotic organisms.
Some of the characteristics of members of Animalia are as follows-

They are multicellular organisms with variable size.

They have well-developed organ system such as skeleton system, circulatory system, respiratory system etc

They are bilaterally symmetrical.

They have well developed locomotory organs.

Respiration occurs by gills, book lungs, book gills, skin, lungs etc.

Membrane-bound cell organelles with nucleus bounded by a nuclear membrane.

Circulation occurs via blood, blood vessels, and heart.

Reproduction occurs by the formation of the haploid gametes. The fusion of gametes gives rise to a new diploid organism.

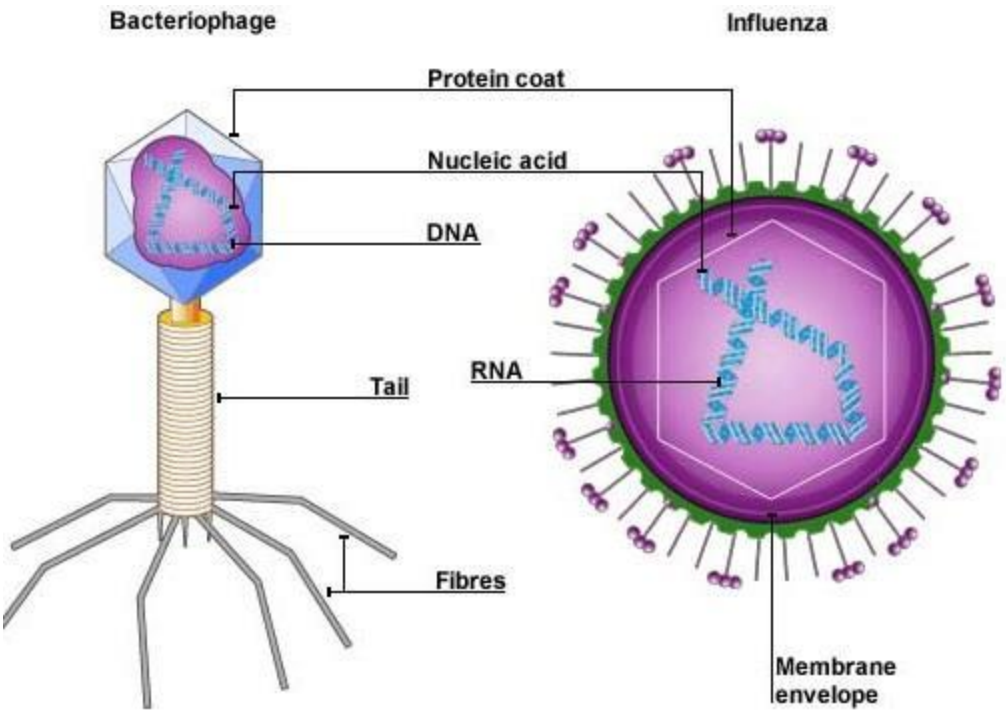
Kidneys are the main respiratory organs.

Viruses, Viroids and Lichens

viruses

The viruses are non-cellular organisms that are characterised by having an inert crystalline structure outside the living cell. Once they infect a cell they take over the machinery of the host cell to replicate themselves, killing the host.

- The name virus that means venom or poisonous fluid was given by Pasteur. D.J. Ivanowsky (1892) recognised certain microbes as the causal organism of the mosaic disease of tobacco. These were found to be smaller than bacteria because they passed through bacteria-proof filters.



Virus Diagram

- M.W. Beijerinek (1898) demonstrated that the extract of the infected plants of tobacco could cause infection in healthy plants and called the fluid as Contagium vivum fluidum (infectious living fluid).
- W.M. Stanley (1935) showed that viruses could be crystallised and crystals consist largely of proteins. They are inert outside their specific host cell.
- Viruses are obligate parasites.
- In addition to proteins viruses also contain genetic material, that could be either RNA or DNA.
- No virus contains both RNA and DNA.
- A virus is a nucleoprotein and the genetic material is infectious. In general, viruses 'that infect plants have single-stranded RNA and viruses that infect animals have either single or double-stranded RNA or double-stranded DNA. Bacterial viruses or bacteriophages (viruses that infect the bacteria) are usually double-stranded DNA viruses.

- The protein coat called capsid made of small subunits called capsomeres protects the nucleic acid. These capsomeres are arranged in helical or polyhedral geometric forms.

- Viruses cause diseases like mumps, smallpox, herpes and influenza. AIDS in humans is also caused by a virus. In plants, the symptoms can be mosaic formation, leaf rolling and curling, yellowing and vein clearing, dwarfing and stunted growth.

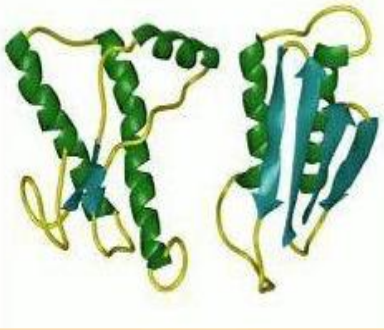
Viroids:

- In 1971 T.O. Diener discovered a new infectious agent that was smaller than viruses and caused potato spindle tuber disease. It was found to be a free RNA; it lacked the protein

coat that is found in viruses, hence the name viroid. The RNA of the viroid 'was of low molecular weight.

Viroids

- **Prions**



Viruses	Viroids	Prions
Obligate intracellular agents	Obligate intracellular agents	Abnormal form of a cellular protein
Consist of either DNA or RNA, surrounded by a protein coat	Consist only of RNA; no protein coat	Consist only of protein; no DNA or RNA

Lichens:

- Lichens are symbiotic associations i.e, mutually useful associations, between algae and fungi. The algal component is known as phycobiont and fungal component as mycobiont, which is autotrophic and heterotrophic, respectively.
- Algae prepare food for fungi and fungi provide shelter and absorb mineral nutrients and water for its partner.


- Lichens are very good pollution indicators - they do not grow in polluted areas.

IMPORTANT TERMS

ALGORITHM:

A specific set of step-by-step procedures for computing answers toa mathematical problem.

ANALOGOUS FEATURES:

Morphological characteristics of two or more taxa that are superficially similar but not as a result of any common evolutionary origin.

BINOMIAL NOMENCLATURE:

A system of nomenclature in biological taxonomy whereby each type of plant or animal is given a two-word name, with the first name identifying the genus and the second the species. Genus name is always capitalized and abbreviated after the first use, and the species name is lowercased. Both are always shown in italics; thus, *Homo sapiens* and, later in the same document, *H. sapiens.*

BIOME:

A large ecosystem (community of interdependent organisms and their inorganic environment) characterized by its dominant life-forms. There are two basic varieties of a biome: terrestrial, or land-based, and aquatic.

CLADISTICS:
A system of taxonomy that distinguishes taxonomic groups or entities (i.e., taxa) based on shared derived characteristics, hypothesizing evolutionary relationships to arrange these in a tree-like, branching hierarchy. Cladistics is one of several competing approaches to taxonomic study.

CLASS:

The third most general obligatory of the taxonomic classification ranks, after *phylum* but before *order.*

CLASSIFICATION:

A very broad term, with application far beyond the biological sciences, that refers to the act of systematically arranging ideas or objects into categories according to specific criteria. A more specific term is *taxonomy.*

EUKARYOTE:

A cell that has a nucleus, as well as organelles (sections of the cell that perform specific functions), bound by membranes.

FAMILY:
The third most specific of the seven obligatory ranks in taxonomy, after the *order* but before *genus.*

FUNGI:

One of the five kingdoms of living things, consisting of multicellular eukaryotic cells arranged in a filamentous form (that is, a long, thin series of cells attached either to one another or to a long, thin cylindrical cell.) Fungi include "true" fungi, moulds, mushrooms, yeasts, mildews, and smuts (a type of fungus that afflicts certain plants).

GENUS:

The second most specific of the obligatory ranks in taxonomy, after *family* but before *species.*

HOMOLOGOUS FEATURES:

Morphological characteristics of two or more taxa that indicate a common evolutionary origin, even though the organisms may differ in terms of other morphological features. An example is a pentadactyl limb, common to many birds and most mammals (e.g., the human's four fingers and thumb), which indicates a common ancestor. Compare with *analogous features.*

KINGDOM:

The highest or most general ranking in the obligatory taxonomic system. In the system used in this book, there are five kingdoms: Monera, Protista, Fungi, Plantae, and Animalia.

MONERA:

One of the five kingdoms of living things, consisting of single-cell prokaryotes, including bacteria, blue-green algae, and spirochetes (spiral-shaped undulating bacteria that may cause such diseases as syphilis).

MORPHOLOGY:

Structure or form, or the study thereof.

NOMENCLATURE:

The act or process of naming, or a system of names—particularly one used in a specific science or discipline. See also *binomial nomenclature.*

NUMERICAL TAXONOMY:

An approach to taxonomy in which specific morphological characteristics of an organism are measured and assigned a numerical value so that similarities between two types of the organism can be compared mathematically using an algorithm. Numerical taxonomy also is called *phenetics.*

OBLIGATORY TAXONOMY (OROBLIGATORY HIERARCHY):

The seven taxonomic ranks by which all species must be identified, whether or not they also are identified according to nonobligatory categories, such as subphylum, cohort, or tribe. These ranks are *kingdom, phylum, class, order, family, genus,* and *species.*

ORDER:

The middle of the seven obligatory ranks in taxonomy, more specific than *class* but more general than *family.*

PHENETICS:

Another name for *numerical taxonomy.*

PHOTOSYNTHESIS:

The biological conversion of light energy (that is, electromagnetic energy) from the Sun to chemical energy in plants. In this process, carbon dioxide and water are converted to sugars.

PHYLOGENY:

The evolutionary history of organisms, particularly as that history refers to the relationships between life-forms, and the broad lines of descent that unite them.

PHYLUM:

The second most general of the obligatory taxonomic classification ranks, after *kingdom* and before *class.*

PROKARYOTE:

A cell without a nucleus.

PROTISTA (OR PROTOCTISTA):

One of the five kingdoms of living things, consisting of single-cell eukaryotes. Protista includes protozoans, slime moulds (which resemble fungi), and algae other than the blue-green variety.

SPECIES:

The most specific of the seven obligatory ranks in taxonomy.

SYSTEMATICS:

The science of classifying and studying organisms concerning their natural relationships.

TAXON:

A taxonomic group or entity.

TAXONOMY:

The area of the biological sciences devoted to the identification, nomenclature, and classification of organisms according to apparent common characteristics. The word taxonomy also can be used more generally to refer to the study of classification or methods of classification (e.g., "the taxonomy of Dickens's characters.")