

Biological classification

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

Linnaeus proposed the **two kingdoms of classification**. He classified organism 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.

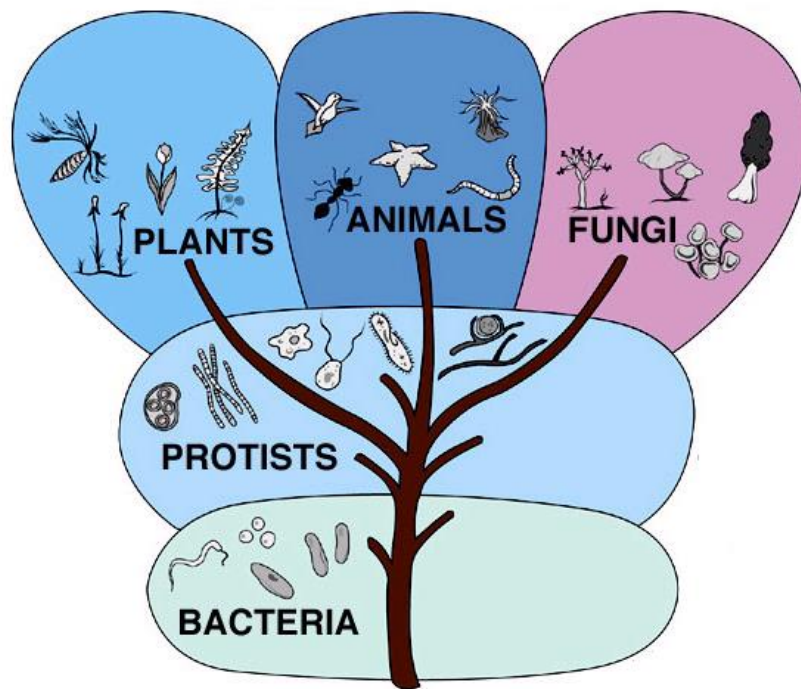


Fig.1. Five kingdom classifications

Kingdom Monera

The most important members of Monera are Bacteria. All organisms present in this kingdom are prokaryotes. 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. All monerans are prokaryotes. They do not have the true nucleus, that is, nucleus not surrounded by nuclear membrane. They can be autotrophs, heterotrophs

as well as parasites. They do have 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 *Archaeobacteria* and *Eubacteria*.

Archaeobacteria

Archaeobacteria can be thermoacidophiles (hot springs), halophiles (survive in high salt concentration), and methanogens (marshy areas). Their structure of cell wall is different from other monerans. Methanogens are found in the gut of some ruminants such as buffaloes and cows. This helps in production of biogas from the dung of the animal.

Eubacteria

They are referred to as “**True bacteria**”. The presence of motile flagellum and a rigid cell wall characterize them. It includes cyanobacteria (blue-green algae). They are like plants in having chlorophyll *a*. So, known as **photosynthetic autotrophs**.

Cyanobacteria are unicellular, filamentous algae. They form colonies which are surrounded by gelatinous sheath. Some have specialized structures known as heterocyst which helps in fixing nitrogen. For example, *Nostoc*.

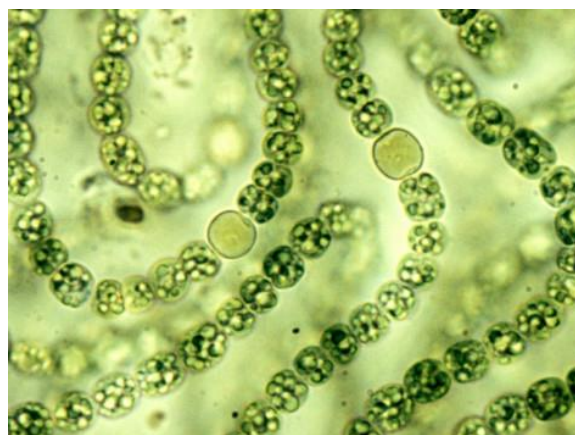


Fig.3. Nostoc

There are certain bacteria that can oxidize certain inorganic substances such as nitrites, nitrates, they are known as **chemosynthetic autotrophs**. The energy released during oxidation is used in the production of the ATP.

Bacteria can reproduce asexually by fission. They can also reproduce through spores under unfavorable conditions. Monera also includes **Mycoplasma**. They do not have cell wall and survive in anaerobic conditions. Mycoplasma are the smallest living organisms known.

Kingdom Protista

Single celled eukaryotes are kept under Protista. They are mostly aquatic in nature. For example, Algae serves as primary producers in aquatic ecosystem. They are unicellular, eukaryotic organisms. They have true nucleus, bounded by nuclear membrane. They can move by cilia as well as via flagella. Respiration can be both aerobic as well as anaerobic. Similarly, reproduction can be sexual as well as asexual.

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

1. Chrysophytes

It consists of diatoms and golden algae. They can live in freshwater water as well as marine water. Mostly they are photosynthetic. Their cell wall is impregnated with silica. They are the major producers in the oceans. Mostly they are unicellular flagellates. But some are amoeboid.



Fig.4. Diatoms

2. Dinoflagellates

Dinoflagellates are marine and photosynthetic organisms. They can be of different colors such as yellow, brown, red, or blue in color. The color is due to the presence of different colored pigments present in the cells of the dinoflagellates. The cell wall is made up of cellulose. They are biflagellate with one flagella placed longitudinally and other flagella placed transversely. For example, *Gonyaulax catenella*, *Noctiluca scintillans*.

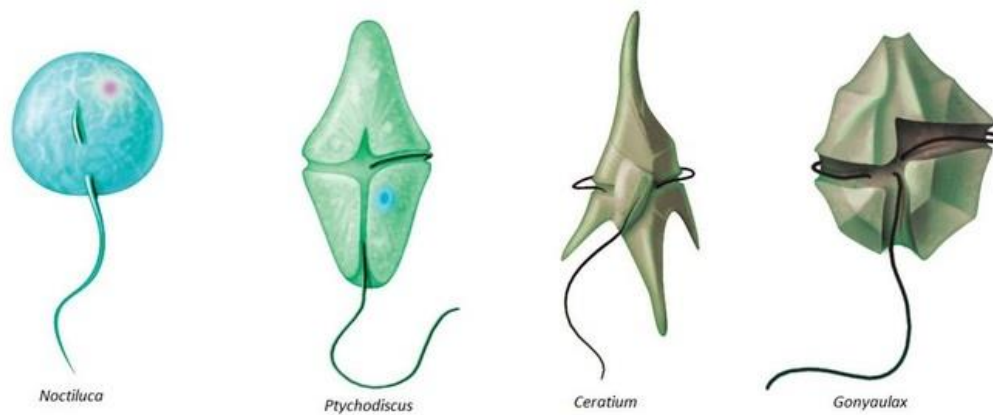


Fig.5. Example of dinoflagellates

3. Euglenoids

Euglenoids are freshwater organisms that are found in stagnant water. They are surrounded by a protein rich layer known as pellicle. They have one short flagella and one long flagella. 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 in euglenoids is Paramylon (carbohydrate).



Fig.6. Euglena

4. Slime moulds

They are saprophytic in nature. Under favorable conditions, they form aggregates which are known as *Plasmodium*. During unfavorable 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 fresh water, moist soil, or sea water. 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 backward. It also helps in obtaining food from the outside. For example, *Paramecium*.

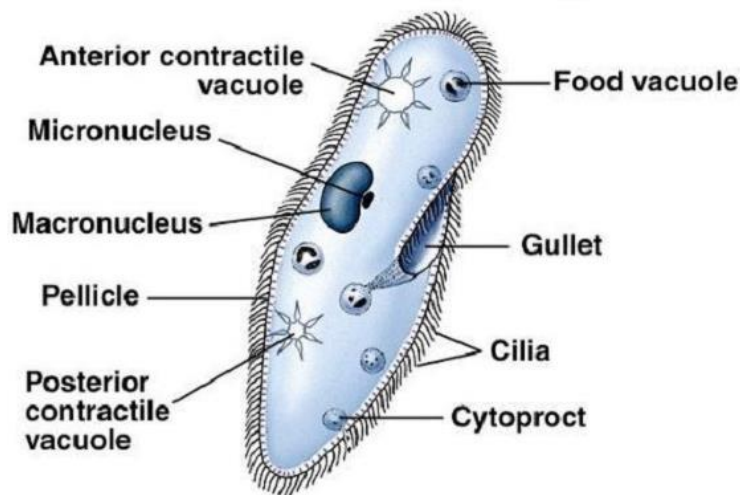


Fig.7. *Paramecium*

- **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.

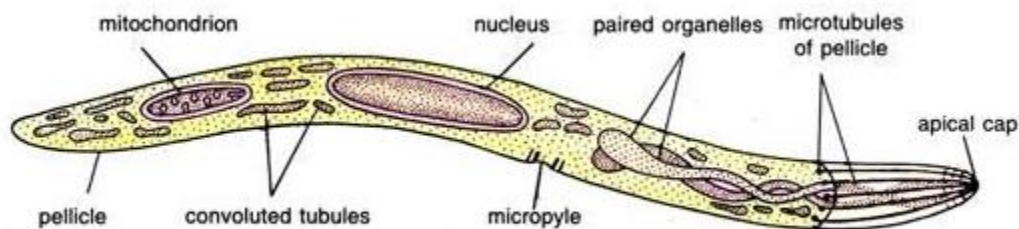


Fig.8. *Plasmodium* species

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 symbiotic association between the fungi and the algae. Mycorrhiza are 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 by means of spores known as **conidia, zoospores or sporangiospores**.

Sexual reproduction occurs by **oospores, ascospores and basidiospores**. There are three steps of sexual cycle in fungi-the first step is the fusion of the protoplasm which is known as **plasmogamy**. Then, the fusion of nuclei occurs which is known as **karyogamy**. This results in the formation of the zygote. 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 sexual cycle of fungi, two haploid hyphae fuses to form diploid cells. Kingdom fungi is divided into different classes-

- **Phycomycetes (lower fungi)**-Asexual reproduction occurs by motile spores known as zoospores and non-motile spores are known as aplanospores. Spores are produced inside the sporangium. Fusion of gametes give rise to zygosporangium. Mycelium is coenocytic (multiple nucleus) and multicellular. For example, such as *Mucor*, *Rhizopus*, *Albugo*.

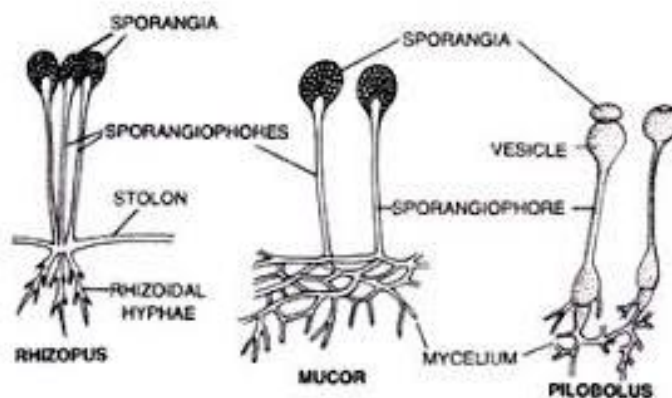


Fig.9. Common fungi

- **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.

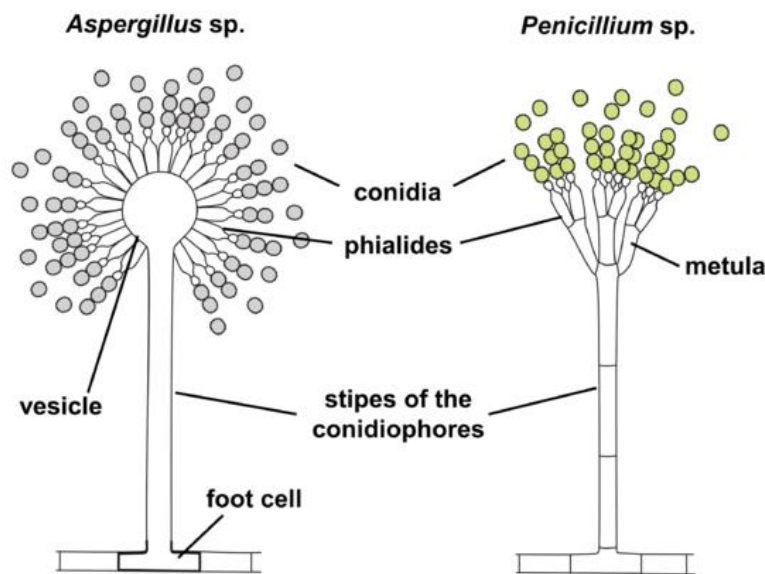


Fig.10. Ascomycetes

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



Fig.11. Agaricus

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

- **Zygomycetes (conjugation fungi)** are primitive group of fungi. Asexual reproduction occurs by non-motile 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 give rise to a new diploid organism.
- Kidneys are the main respiratory organs.

Viruses:

They are acellular structures and therefore do not find a place in Whittaker's five kingdom classification. They consist of a nucleic acid (either DNA or RNA) that is surrounded by a protein coat. They can grow and multiply

only inside a host cell. Outside the host cell the viruses exist as crystals. They cause diseases and damage to the host. Examples of common viruses are the viruses causing common cold, influenza, polio, AIDS, etc.

Viroids:

They are the smallest structures known that are capable of infection. They consist only of the nucleic acid without the protein coat.

Lichens:

They are symbiotic associations of algae and fungi. The algal partner is autotrophic and synthesizes and provides food. The fungal partner offers protection and shelter.