

BIOLOGICAL CLASSIFICATION

- Biological classification is the scientific procedure of arranging organisms into groups on the basis of their similarities and dissimilarities and placing the groups in a hierarchy of categories. Groups are assigned to a fixed hierarchy of categories such as species, genus, family, order, class and division (or phylum).

KINGDOMS OF CLASSIFICATION

- With gradual improvement of tools and techniques, classification systems keep on changing.
- The kingdoms included in five kingdom system of **R.H. Whittaker** are discussed in brief in table hereafter.

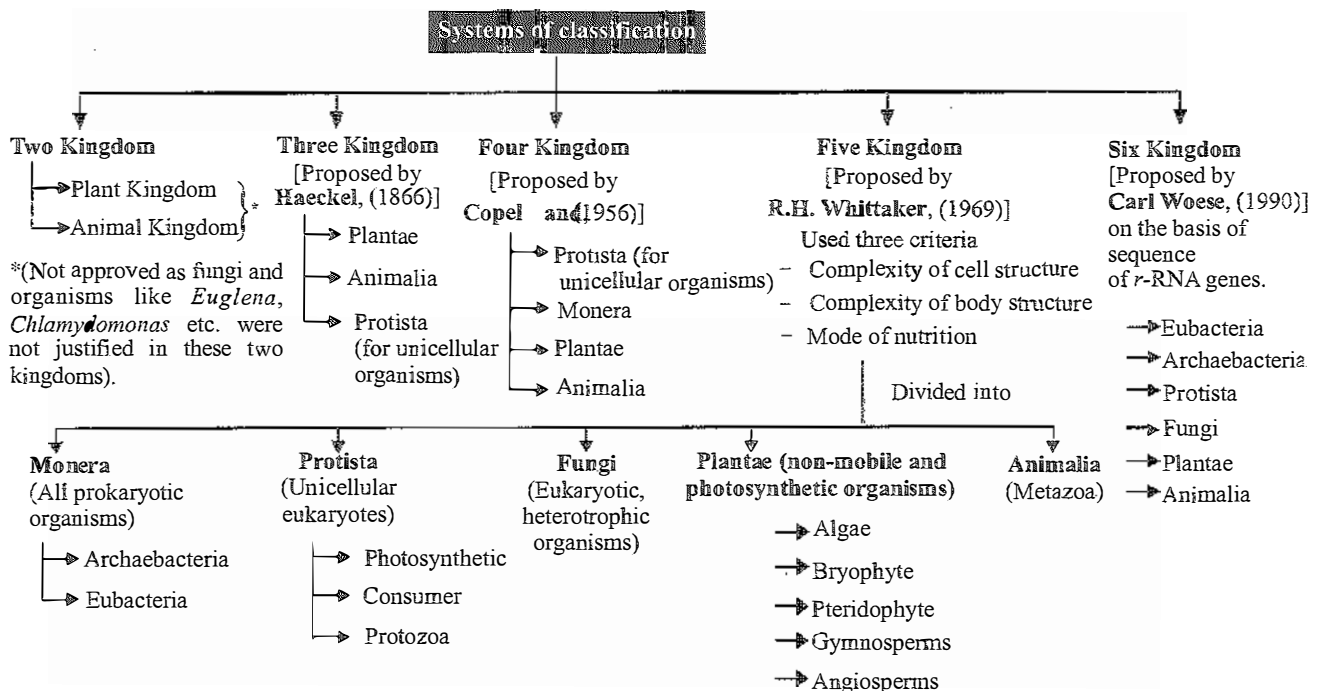


Table: Kingdoms of classification

Kingdom	Classification/ Groups	Habitats/ Occurrence	Organisation of body	Locomotion	Nutrition	Respira- tion	Reproduction	Distinct features
Monera (all prokaryotes)	Archaeobacteria e.g., <i>Methanobacterium</i> , <i>Methanococcus</i> .	Extremophiles found in temp. upto 113°C (thermophiles) and below to 4°C (psycrophiles), hot springs (thermoacidophiles), marshy areas, (methanogens), salty areas (halophiles), alkaliphiles, etc.	Prokaryotic, cell wall lacks murein, unicellular, may be rod, spiral or marble shaped. Plasma membrane uniquely has isopranyl ether lipids.	Flagella may be found.	Mostly chemo-synthetic.	Mostly anaerobic.	Asexual reproduction by binary fission,	Their presence in ancient earth like environment, points to their primitive origin.
	Eubacteria e.g., <i>Vibrio cholerae</i> , <i>Xanthomonas citri</i> .	Cosmopolitan	Prokaryotic, murein/ mucopeptide present, glycocalyx capsule present, may be spiral, rod shaped, round or comma shaped, hair like fimbriae and pili (made of pilin) may be present over the body surface.	Flagellar or gliding movement.	Autotrophic (chemo or photosynthetic) or heterotrophic (saprophytic, parasitic or symbiotic).	Mostly anaerobic.	Vegetative (budding and fission) Asexual (conidia, endospore, zoospore). Sexual in the form of genetic recombination through transformation or Griffith effect (Griffith 1928), transduction (using bacteriophage; Zinder and Lederberg, 1952) or conjugation (Lederberg & Tatum, 1946).	Economically important as scavengers, fermenters, nitrogen fixers and pathogens.
	Cyanobacteria e.g., <i>Nostoc</i> , <i>Anabaena</i> .	Cosmopolitan	Prokaryotic, unicellular, filamentous or colonial, cell wall with murein.	Flagella present, motile.	Autotrophic with chl- <i>a</i> , <i>c</i> -phycocyanin and <i>c</i> -phycoerythrin.	Aerobic	Vegetatively through fission (in unicellulars) and hormogonia (in filaments), asexually by akinetes, exospores, endospores, nanospores etc. Recently, genetic recombination is reported in some.	Heterocysts are uniquely found in cyanobacteria. Economically some of them are important as nitrogen fixers, food sources, antibiotic (e.g., <i>Lyngbia</i>), pollution indicator, assist sewage disposal, etc. They also cause algal blooms.

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	Actinomycetes <i>e.g., Microbispora,</i> <i>Streptomyces.</i>	Mostly found in soil.	Prokaryotic, mycelial (aseptate, coenocytic, branched filaments).	Non-motile.	Mostly saprotrophic some pathogenic.	Aerobic	By conidia, sporangiospores, oidia or arthrospores, fragmentation etc.	Also called ray fungi as morphology resemble fungi, are source of many antibiotics (streptomycin, chloramphenicol, etc.)
	Mycoplasma/ mollicutes/PPLO/ <i>e.g. M. hominis</i> (causes human infertility), <i>M. pharynges</i> etc.	Simplest, smallest, free living prokaryotes found in soil, sewage, other organism's body etc.	Highly pleiomorphic due to absence of cell walls, prokaryotic cell structure, filterable through bacterial filters, murein absent in cell wall.	Usually non- motile	Saprophytic, parasitic	Mostly aerobes or facultative anaerobes	Binary fission, budding or by spherical, intracellular structures called elementary units.	Insensitive to cell wall affecting antibiotics, can produce filaments resembling fungus thus named mycoplasma (<i>mycos-fungus</i>), they form characteristic 'fried egg' colony, may be pathogenic <i>e.g.</i> <i>M. pneumoniae</i> .
Protista Kingdom created by Haeckel (1966). Includes all unicellular colonial eukaryotes except that of red and green algae. Connects, monerans with other 3 kingdoms.	Photosynthetic protists (protistan algae) <i>e.g., Diatoms,</i> <i>Euglena.</i>	Aquatic	Eukaryotic	Usually motile	Photosynthetic	Aerobic	Vegetative, asexual and sexual.	Constitutes the main portion of phytoplanktons.
	(i) Dinoflagellates <i>e.g., Noctiluca,</i> <i>Gonyaulax.</i>	Mostly marine, a few fresh water ones	Eukaryotic unicellular with thick cell wall (theca or lorica) having one vertical (sulcus) and one horizontal (cingulum/ annulus/ girdle) groove; eye spots, nematocysts may be found, golden brown in colour; chromosomes lack histone.	Motile with two different (heterokont) flagella	Mostly photosynthetic with chlorophyll- <i>a, c,</i> and xanthophylls (diadinoxanthin, dinoxanthin). Reserve food is oil and polysaccharides.	Aerobic	Only asexually, sexual reproduction absent, except <i>Ceratium.</i>	Some forms show bioluminescence/ phosphorescence, some are toxic to invertebrates, and may cause PSP (paralytic shellfish poisoning) in man; presence of theca gives them the name 'armoured' dinoflagellates.

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	(ii) Chrysophytes e.g., <i>Navicula</i> , <i>Ambipileura</i> , <i>Cymbella</i> .	All aquatic and moist terrestrial habitats.	Unicellular, cell is called as frustule/shell which has a siliceous, patterned cell wall (theca) consisting of epitheca and hypotheca. Two types of frustule s-pinnate (rectangular like soap box), centric (circular like petridishes).	Lack flagella thus float passively or glide (due to cytoplasmic streaming).	Photosynthetic with chl- <i>a</i> , chl- <i>c</i> and fucoxanthin (provides brownish tinge). Reserve food is oil; chrysolaminarin or leucosin (β -1-3 glucan).	Aerobic	Mainly through binary fission which reduces cell size. Auxospores/restitution spores develop to re-establish original size. Sexual reproduction (iso, aniso and oogamy) also occur.	Indestructible silica wall produces economically important diatomaceous earth, they are called jewels of plant kingdom due to patterned cell wall.
	(iii) Euglenophytes e.g., <i>Euglena</i> , <i>Peranema</i> , <i>Astasia</i>	Fresh water and damp soils.	Eukaryotic, flexible proteinaceous pellicle present instead of cell wall, eye spot with astaxanthin (found in euglenoids and crustacea only) gullet and paraflagellar body are present.	Flagellar motion (1 or 2 flagella), can also show creeping movement called metaboly or euglenoid movement.	Photosynthetic, saprobic, holotrophic or mixotrophic nutrition. Reserve food is paramylon or paramylum bodies. Photosynthetic ones have chl- <i>a</i> & <i>b</i> like advanced plants.	Aerobic	By cell division; cysts may also be formed; sexual reproduction has not yet been definitely proved.	Plant-like animals as they resemble both of them. Photosynthetic euglenoids are more advanced than photosynthetic cyanobacteria. They have well organised nucleus and chloroplasts.
	Consumer decomposer protists (slime moulds) (i) Acellular slime moulds	Widely distributed in damp and shady places. But move to drier and exposed places during reproduction.	Vegetative thallus is free living plasmodium, i.e., naked, multinucleated mass of protoplasm (Protoplasmodium), without or with branched veins showing cyclosis (Phaneroplasmodium).	Amoeboid movement by pseudopodia thus asymmetric in shape, flagellate swarm cells present.	saprobic or phagotrophic, rarely parasitic.	Aerobic	Asexually by spores, cyst, sclerotium, plasmotomy and binary fission, spores form myxamoebae or bi-flagellate swarm cells that fuse to form zygote (isogamy). Zygote through repeated mitosis forms plasmodium. Sporangia are covered by peridium that forms internal branched capillitium.	They have characters of plants (cellulosic cell wall, animals (phagotrophy) and fungus (spores). They are also called fungus animals or protistan fungi.
	(ii) Cellular slime moulds	-do-	Vegetative thallus is uninucleate, haploid amoeboid cell called myxamoeba.	Amoeboid movement, complete absence of flagella in life cycle.	-do-	-do-	Sporangia lack peridium and capillitium. Spores form a myxamoeba that repeatedly divides to form several of them. These myxamoebae show anisogamous sexual reproduction during which pseudoplasmodium is formed.	- do -

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	Protozoan protists First studied by Leeuwenhoek (1677), Goldfuss (1857) coined the term protozoa. <i>e.g., Entamoeba histolytica, Leishmania donovani.</i>	Aquatic, terrestrial, free living or parasites.	Acellular eukaryotes, pellicle or calcareous or siliceous shell may be present. Nucleus one to many.	Either non motile (sporozoa) or movement by pseudopodia (sarcodines), flagella (zooflagellata) or cilia (ciliata).	Mainly holozoic, some forms are saprobic or parasitic. Reserve food is glycogen.	Aerobic	Mainly asexual by binary fission, multiple fission or budding. Some reproduce sexually through conjugation or syngamy.	Economically important as many of them are pathogens <i>e.g., Trypanosoma gambiense</i> (sleeping sickness), <i>Plasmodium vivax</i> (malaria) etc. All members of sporozoa are endoparasites.
Fungi P. Antonio - Father of mycology. <i>E.g., Rhizopus, Aspergillus, Saccharomyces</i>		Ubiquitous, mostly terrestrial but a few aquatic.	Eukaryotic, cell wall has cellulose or chitin (fungal cellulose) or both, except yeasts (unicellular) they are filamentous. Hyphae may be septate or aseptate coenocyte.	Non-motile, flagellate spores present.	Parasitic, saprophytic, and symbiotic (<i>e.g., lichens and mycorrhiza</i>). Reserve food is glycogen and oil globules.	Aerobic	Vegetative (fragmentation, fission, budding, sclerotia, oidia and chlamydospores) asexual (zoospores, aplanospores, conidia, etc) and sexual (isogamy, anisogamy, oogamy); fertilisation is aided by gametangial contact, gametangial copulation (fusion) or spermatization (through an agent).	Fungi may be eucarpic (a part of thallus turns reproductive) or holocarpic (entire thallus turns reproductive); homothallic or heterothallic (discovered Blakeslee, 1904); harmful (as pathogen, pests, food contaminator etc) or useful (in genetic engineering, antibiotic production, alcohol production, nitrogen fixation <i>e.g., Rhodotorula</i> , etc).
	Phycomycetes	In water or in damp places, known as water moulds.	Eukaryotic, cell wall present, coenocytic hyphae found.	Saprobic or parasitic.	Vegetative thallus, non-motile	Aerobic	Asexual (zoospores, aplanospores, chlamydospores, sporangiospores); sexual (isogamy, anisogamy & oogamy) by planogametic copulation, gametangial contact or gametangial copulation, fruiting body is zygosporangium.	They are called algae like fungi thus named so (<i>phycos-algae</i>). They are most primitive true fungi.

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	Ascomycetes <i>e.g.</i> <i>Penicillium</i> , <i>Claviceps</i> , etc.	Typically, terrestrial but many live in water.	Eukaryotic, cell wall present, mostly multicellular mycelial except a few (<i>e.g.</i> , yeast), septate branched mycelium.	Non-motile.	Saprophytic decomposer, parasitic or coprophytic (on dung).	Usually aerobic, yeast may respire aerobically	Asexual spores are conidia, sexual spores ascospores produced in ascus, fruiting body ascocarp (contains many asci) which may be cleistothecium, apothecium or perithecium, specialised sex organs present which gradually decline in advanced forms.	<i>Neurospora</i> used in biochemical and genetic work; morels and truffels are edible, yeast is used in bakery and fermentation products. They are commonly called sac fungi due to the presence of sac like asci.
	Basidiomycetes <i>e.g.</i> , <i>Ustilago</i> , <i>Puccinia</i> , <i>Agaricus</i> , etc.	In soil, on logs, tree stumps or in other organism's body, typically terrestrial.	Mycelial; mycelium is branched and septate. Primary mycelium produces dikaryotic secondary mycelium by somatogamy (fusion of two somatic hyphae causing dikaryotisation).	Both vegetative thallus and reproductive cells are non- motile.	Saprophytic or parasitic.	Aerobic	Asexual spores generally absent, vegetative reproduction by fragmentation is common. Sexual reproduction by basidiospores borne in fruiting body basidiocarp, uredospores, teleutospores etc. are also present, specialised sex organs are absent.	Commonly called as club fungi. Rust and smut causing fungi are included in basidiomycetes. They peculiarly show clamp connection during reproduction.
	Deuteromycetes <i>e.g.</i> , <i>Alternaria</i> , <i>Colletotrichum</i> , <i>Trichoderma</i> .	Terrestrial	Eukaryotic, mycelial, branched, septate mycelium, hyphal cells usually multinucleate.	Non-motile.	Saprophytes, parasites or decomposers.	Aerobic	Only known method is by conidia, sexual reproduction absent, thus fruiting body absent.	Known as fungi imperfecti as their perfect (sexual) stages are either absent or not known.

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Plantae <i>E.g., Chlorella,</i> moss, ferns, pines, wheat, rice, mango, etc.	Algae, Bryophyta Pteridophyta, Gymnosperms, Angiosperms	Aquatic and terrestrial	Eukaryotic with cellulosic cell wall both unicellular and multicellular ones, ranging from microscopic algae to giant red wood tree.	Algae show motility, other groups are non-motile.	Diverse modes ranging from saprophytic, parasitic, to autotrophic (photosynthetic/ chemosynthetic) ones. In advanced ones a complex vascular system has developed.	Aerobic	All three methods (vegetative, sexual, asexual) are known.	They are the basis of continuity of life on earth as they are the 'producers'.
Animalia <i>E.g.,</i> sponges, earthworm, corals, insects, cattle, human.	Non-chordata, Chordata	Universal	Eukaryotes without cell wall, unicellular to multi-cellular, microscopic ones to blue whale. Advanced multicellular organisms have developed various organ systems. Circulatory system is of two types: (i) open type in which the blood is pumped out of the heart and the cells and tissues are directly bathed in it; (ii) closed type in which the blood is circulated through a series of vessels of varying diameters (arteries, veins and capillaries).	Locomotion may be present or absent.	Holozoic, may be parasitic, coprophilic etc.	Aerobic	Lower forms show vegetative regeneration, asexual and sexual reproduction but advanced forms reproduce only sexually. Asexual reproduction is absent.	They are the major 'consumers' of ecosystem.

Lichens

- A lichen is a composite organism consisting of a fungus living in intimate association with one or more photosynthetic partners, that may be either a green alga or a cyanobacterium. The fungal member of the lichen is called **mycobiont** and the photosynthetic partner (alga or cyanobacterium) is called **photobiont**.
- Apparently the alga or cyanobacterium (photobiont) provides the fungus with food, particularly carbohydrates produced by photosynthesis, and possibly with vitamins. The fungus probably absorbs, stores and supplies water and minerals required by the alga or cyanobacterium. The lichens are considered to be "pioneer" organisms because they may make a region suitable for other plants through the weathering of rocks and the accumulation of organic debris. Decrease in lichen population of an area is indicative of air pollution.

Mycorrhiza

- Mycorrhiza is the mutually beneficial or symbiotic association of a fungus with the root of higher plant. In a **mycorrhizal association**, the fungus may colonize the roots of a host plant either intracellularly or extracellularly.
- It provides the fungus with a renewable source of food through access to fixed carbon (sugars) from the plant photosynthate. In return, the plant gains the use of the mycelium's tremendous surface area to absorb mineral nutrients from the soil especially phosphates.

Virus

- Viruses were discovered by D.I. Vanowski (1892).
- Virus (L. Poisonous fluid) is a group of ultramicroscopic non-cellular, highly infectious agents that multiply only intracellularly *i.e.*, inside the living host cells without involving growth and division. Outside the host cells, they are inert particles. Thus they are regarded as intermediate between non-living entities and living organisms.
- Viruses have nucleic acid (either RNA or DNA), envelope, capsid and enzymes.
- **Envelope** is the outer loose covering present in certain

viruses like HIV; made of protein of viral origin, lipid and carbohydrates of host. Envelope proteins have subunits called peplomers. A virus without envelope is naked virus.

- **Capsid** is a protein covering around the genetic material. Capsid have protein subunits called capsomeres. TMV has 2130 capsomeres. They are arranged helically or in geometric forms. Capsid has antigenic properties.
- The nucleic acid present in the virus is called **nucleoid**. It is the infective part of virus (Hershey & Chase, 1952) which utilizes the metabolic machinery of the host cell for synthesis and assembly of viral components.
- The genetic material of viruses are of 4 types - double stranded DNA (ds DNA) *e.g.*, Pox virus, Hepatitis-B virus; single stranded DNA (ss DNA) *e.g.*, Coliphage $\phi \times 174$ (cyclic); double stranded RNA (ds RNA) *e.g.*, Reo virus; Single stranded RNA (ssRNA) *e.g.*, Tobacco Mosaic Virus.
- Some common viral diseases are - influenza, polio, measles, chicken pox, hepatitis, AIDS, bird flu, SARS (severe acute respiratory syndrome) etc. In plants the symptoms can be mosaic formation, leaf rolling and curling, yellowing and vein clearing, dwarfing and stunted growth. Host cells produces **interferon** proteins to prevent viral multiplication.

Viroids

- The term viroid has recently been introduced by T. O. Diener (1971) to describe the causal agent of the "potato spindle tuber disease". Viroids are the smallest known agents of infectious disease. They consist only of naked strand of nucleic acid without a protein coat. The nucleic acid of all viroids discovered so far has been shown to consists of single-stranded linear or circular RNA molecules. They all cause several important diseases of cultivated plants like potato spindle tuber, citrus exocortis, chrysanthemum stunt and cucumber pale fruit.
- Naked pathogenic protein molecules are termed prions.

CONCEPT MAP

