Biological Classification

The scientific procedure of arranging organisms into groups and subgroups on the basis of their similarities and dissimilarities and placing the group in a hierarchy of categories.

Importance of classification-

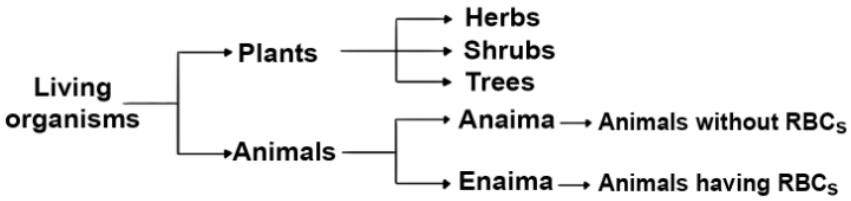
- It is not possible to study every organism. Study of one or two organism of a group gives sufficient information about the essential features of the group.
- It helps in identification of new organism.
- Classification helps in knowing the relationship amongst different groups of organisms.
- The organism of past cannot be studied without a proper system of classification.

Classification

- Artificial system of classification
- Natural system of classification
- Phylogenetic system of classification

Kingdom system of classification

- **Earliest Classification:** Aristotle used simple morphological characters



- **Two Kingdom Classification:** Organisms are grouped on the basis of presence and absence of cell wall as proposed by Linnaeus. *Plantae & Animalia*

What were the demerits of two kingdom classification?

Ans: This system did not distinguish between the eukaryotes and prokaryotes, unicellular and multicellular organisms and photosynthetic (green algae) and non-photosynthetic (fungi) organisms. A large number of organisms did not fall into either category. Characteristics like cell structure, nature of wall, mode of nutrition, habitat, methods of reproduction, evolutionary relationships, etc were also not included.

- **Three kingdom :** *Plantae Protista Animalia*
  Haeckel separated unicellular animals, algae and fungi on the basis of lack of tissue differentiation and new kingdom Protista was introduced.

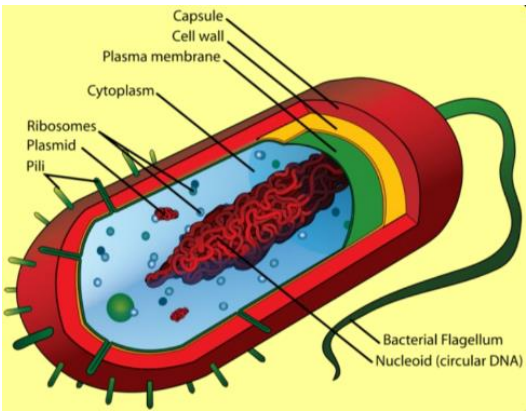
- **Five kingdom :** *Monera Protista Fungi Plantae Animaila*
  Main criteria used by R.H.Whittaker for classification include cell structure, body organisation, mode of nutrition, reproduction and phylogenetic (evolutionary) relationships.

Characters	Five Kingdoms				
	Monera	**Protista**	**Fungi**	**Plantae**	**Animalia**
Cell type	Prokaryotic	Eukaryotic	Eukaryotic	Eukaryotic	Eukaryotic
Cell wall	Noncellulosic (Polysaccharide + amino acid)	Present in some	Present with chitin	Present (cellulose)	Absent
Nuclear membrane	Absent	Present	Present	Present	Present
Body organisation	Cellular	Cellular	Multiceullar/ loose tissue	Tissue/ organ	Tissue/organ/ organ system
Mode of nutrition	Autotrophic (chemosyn-thetic and photosynthetic) and Hetero-trophic (sapro-phytic/para-sitic)	Autotrophic (Photosyn-thetic) and Hetero-trophic	Heterotrophic (Saprophytic/ Parasitic)	Autotrophic (Photosyn-thetic)	Heterotrophic (Holozoic/ Saprophytic etc.)

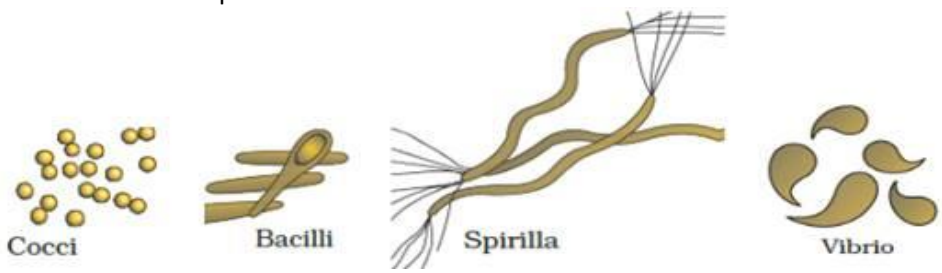
- **Six Kingdom:** Kingdom Monera was divided into two domains, leaving the remaining eukaryotic kingdoms in the third domain and thereby a six-kingdom classification.

Kingdom Monera– (Sole member Bacteria) Includes all Unicellular prokaryotes (primitive living forms)

1. Most abundant- occur almost everywhere & can survive in all kinds of climate.
2. Majority are heterotrophs some are Autotrophs (Chemosynthetic & Photosynthetic)
3. Microscopic and cell wall is generally present.
4. Genetic materials are not organized into nucleus and contain naked DNA.
5. Membrane bounded organelles are absent.
6. Reproduction is asexual except gene recombination.
7. Flagella may be present and are of single stranded.



On the basis of shape classified as:



Spherical Shaped Rod Shaped Spiral Shaped Comma Shaped

Archaebacteria – Lives in Extreme condition. They differ from other bacteria in having different cell wall structure.

- **Halophiles**- Extreme Salty area
- **Thermoacidophiles**- Hot springs
- **Methanogens-** marshy area. Present in the gut of several ruminant animals like cows and buffalo, responsible for production of biogas (methane).

Eubacteria – True bacteria.

They contain rigid cell wall

Photosynthetic Autotrophs- Cyanobacteria (Blue-Green Algae)	**Chemosynthetic Autotrophs**
• Have Chlorophyll A • Unicellular, colonial or filamentous, marine or terrestrial algae. • Colonies are surrounded by Gelatinous sheath. • Often blooms under polluted water. • Some of them fix atmospheric Nitrogen with specialised cell called Heterocyst's. • Eg: Nostoc & Anabaena	• Oxidised inorganic substances such as nitrates, nitrites & ammonia and use released energy for ATP synthesis. • Help recycling Nitrogen, Phosphorous, Iron & Sulphur. • Eg: Green Sulphur Bacteria, Purple Sulphur Bacteria, Iron bacteria etc.

Heterotrophic bacteria- Most abundant

- Mostly act as decomposer.
- Some are helpful in production of curd- (Lactobacillus), antibiotic and fixing nitrogen in leguminous plants.
- Some are disease causing pathogen like cholera, typhoid, tetanus and citrus canker.
- Reproduce mainly by Fission. Sometimes, under unfavourable conditions produce spores.
- Also reproduce by sexual reproduction by adopting a primitive DNA transfer from one bacterium to the other.
- **Mycoplasma** - smallest living cells that completely lack a cell wall, can survive without oxygen. Many are pathogenic in animals and plants.

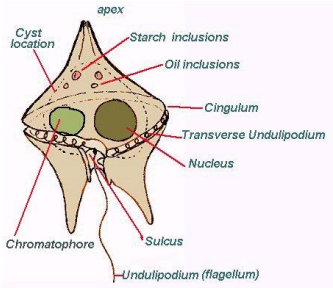
Kingdom Protista–It includes all unicellular and colonial eukaryotes.

1. Most of them are aquatic forming plankton.
2. Mode of nutrition may be photosynthetic, saprophytic, parasitic or holozoic.
3. Flagella if present are 11 stranded with 9+2 arrangement of microtubules composed of tubulin.
4. Genetic material consists of 2 or more DNA molecules.

Chrysophytes (Diatoms & Golden Algae(desmids)**)** - chief producer in oceans.

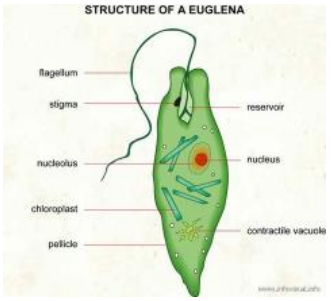
- Found in fresh water as well as marine water.
- Microscopic and float passively in water currents (plankton) & mostly Photosynthetic.
- In diatoms cell wall forms two thin overlapping cells which fit together as in soap box.
- The siliceous indestructible cell wall pile up at the bottom of water reservoirs and this accumulation over billions of years is referred to as **diatomaceous earth**.
- Being gritty this soil is used for polishing, filtration of oil and syrups.

Dinoflagellates



- Motile, biflagellate and photosynthetic.
- Appears yellow, green, brown, red and even blue.
- The cell wall has stiff cellulose plates on the outer surface.
- Most of them have two flagella; one lies longitudinally & other transversely in a furrow between the wall plates.
- Red Dinoflagellates like *Gonyaulax* grow in large number in the sea and make the water look red and cause the so called "**red tide**". They release toxins that kill marine animals.

Euglenoids-



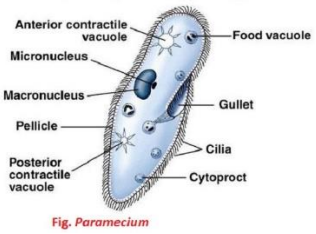
- Possess protein rich layer- pellicle instead of cell wall which make their body flexible.
- Mainly freshwater organism, found in stagnant water.
- They have two flagella, one short and other long.
- Link between plant and animal as it shows Mixotrophic Nutrition- Photosynthetic in presence of sunlight and heterotrophic (predating) in absence of sunlight.
- Example- *Euglena, Peranema.*

Slime Moulds

- Saprophytic and feeds on decaying twigs and leaves.
- Under favourable condition, forms aggregation called plasmodium which may grow to several feets.
- Under unfavourable condition produce fruiting bodies bearing spores (contains cell wall- resistant to extreme condition)
- The spores are dispersed by air currents.
- Example- *Physarum, Fuligo*.

Protozoans

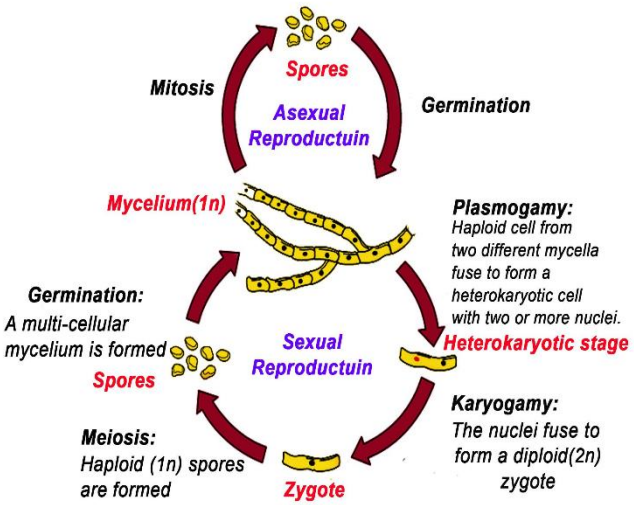
- All protozoans are heterotrophs and live as predators or parasites.
- They are considered as primitive relatives of animals.

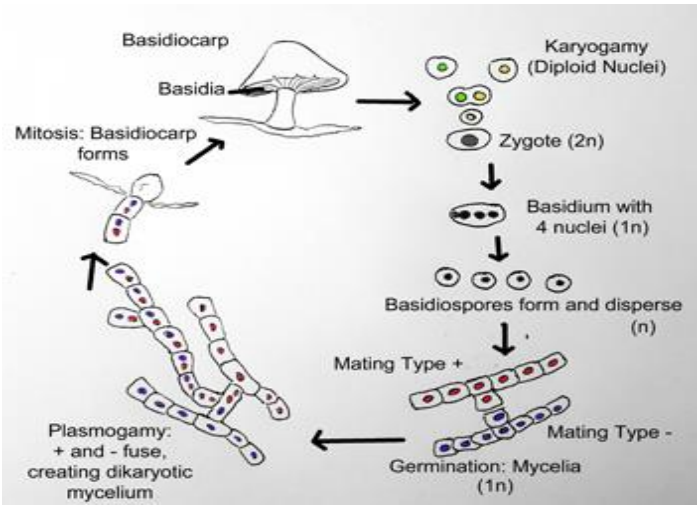
Amoeboid	Flagellated	Ciliated	Sporozoans
• Lives in freshwater, sea or most soil. • Marine form have silica shells on their surface.	• Free living or Parasite • Have Flagella (helps in movement)	• Aquatic, actively moving • Have cavity (Gullet) open outside cell surface.	• Diverse organism have infectious spore like stage.
Eg: Amoeba (Catch its prey using pseudopodia) Entamoeba (Parasite cause Amoebic dysentery)	Eg: Trypanosoma (Sleeping Sickness)	Eg: Paramecium  Fig. Paramecium	Eg: Plasmodium (malarial parasite)

Kingdom Fungi–

- Lack chlorophyll, heterotrophic, spore forming, eukaryotic
- Cell wall is made up of chitin (amino acid) or polysaccharides
- Reserved food is glycogen.
- Mode of nutrition is saprophytic, parasitic or symbiotic.
- Reproduction may be vegetative (fragmentation, fission or budding), asexual (conidia, sporangiospores or zoospores) or sexual reproduction by oospores, ascospore and basidiospores.
- Sexual cycles involves the following steps-

1. Plasmogamy, fusion of male and female gametes.
2. Karyogamy, fusion of two nuclei.
3. Meiosis in zygote to produce haploid spores.



Class of Fungi	Hypha/ Mycelium	Type of Reproduction	Characteristic of Spore	Origin of Spore	Characteristics & Example
Phycomycetes	Aseptate Multinucleated (Coenocytic)	Asexually	Zoospore (motile) Aplanospore (Non-Motile)	Endogenously in Sporangium	• Found in Aquatic & Damp places or as parasite on plants. • Eg: Rhizopus (Bread Mould), Albugo (Parasitic fungi on Mustard)
		Sexually	Zygospore	Formed by fusion of Gametes Isogamous (similar) Anisogamous/ Oogamous (Dissimilar)	
Ascomycetes (Sac Fungi)	Branched & Septate	Asexually	Conidia	Exogenously on Conidiophores	• Saprophytic, decomposer, parasitic & coprophilous (Cow dung) • Asci arranges to form Ascocarp (Fruiting Bodies) • Eg: Unicellular- Saccharomyces cervices (Yeast) Multicellular: Penicillium, Aspergillus Neurospora (Biochemical & genetic Work) Morels & Truffles (Edible & delicate)
		Sexually	Ascospore	Endogenously in Asci (Sac)	
Basidiomycetes (Bracket, Club or Puffball fungi)	Septate & Branched	Sexually	Basidiospore	Exogenously on Basidia arranged in fruiting bodies- Basidiocarp.	• Grow in soil, on log & tree stumps & as parasite on plants. • Sexual Organ Absent but plasmogamy occur by fusion of two vegetative/somatic cells of different genotypes result in Dikaryotic structure that give rise to Basidium. • Karyogamy & meiosis occur in basidium producing 4 Basidiospores • Vegetative reproduction by Fragmentation • Eg: Agaricus (Mushroom), Puccinia (Rust), Ustilago (smut)
					
Deuteromycetes (Imperfect Fungi)	Septate & Branched	Asexually	Conidia	Exogenously on conidiophores	• Saprophytic, Parasitic, majority are decomposer of litter & help in mineral cycling. • Sexual stages were transferred to Ascomycetes or Basidiomycetes. • Eg: Alternaria, Trichoderma

Kingdom Plantae

1. Eukaryotic, Autotrophic-chlorophyll bearing organism with Cell Wall.
2. Life cycle is divided into diploid saprophytic and haploid gametophytic, which alternate with each other.
3. Kingdom Plantae includes Algae, Bryophytes, Pteridophytes, Gymnosperms and Angiosperms.

Kingdom Animalia

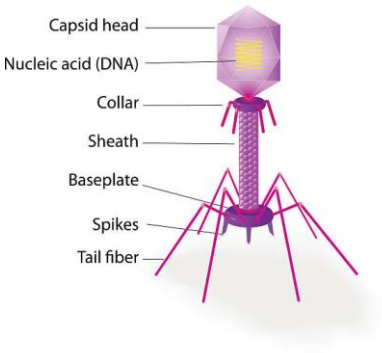
1. Heterotrophic, eukaryotic organisms that are multicellular and cell wall is absent in the cell.
2. Mode of nutrition is holozoic and reserve food is glycogen or fats.
3. Sexual reproduction is by copulation between male and female followed by embryological development.

Five kingdom system of classification do not includes Virus, Viroids and Lichens.

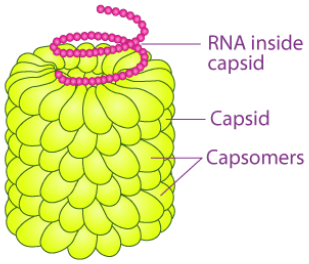
Virus are non-cellular organisms having inert crystalline structure outside the living. When they enter the living cell, they take over the machinery of living cell to replicate themselves.

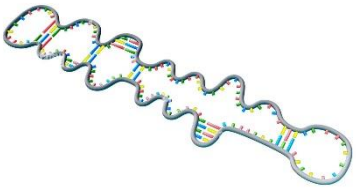
- D.J.Ivanowsky recognized certain microbes as causal organism of mosaic disease of tobacco.
- In addition to proteins, viruses also contain genetic material that could be DNA or RNA. In general, virus that infect plants have single stranded RNA and virus that infect animals have double stranded DNA.
- Some common diseases caused by virus are common cold, influenza, AIDS, small pox, leaf rolling and curling.
- Bacteria feeding virus are called Bacteriophage.They are usually double stranded DNA viruses.
- The protein coat called capsid is made of small subunits called capsomeres, protects the nucleic acid. These capsomeres are arranged in helical or polyhedral geometric forms.

Structure of bacteriophage



Tobacco Mosaic Virus

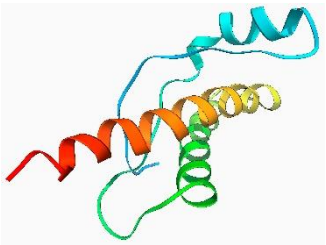




Viroids -discovered by T.O.Diener

- New infectious agent smaller than virus causing potato spindle tuber disease.
- They are free RNA (low molecular weight) without protein coat.

Prions :



- Abnormally folded protein causing neurological diseases.
- Size similar to viruses.
- Bovine spongiform encephalopathy (BSE) commonly called mad cow disease in cattle & Cr–Jacob disease (CJD) in humans.

Lichens-

- Symbiotic association between algae (**Phycobiont)** and fungi (**Mycobiont).**
- Algae prepare food and Fungi provide shelter and raw material.
- They are good pollution indicator as they do not grow in polluted area.