

BIOLOGICAL

CLASSIFICATION

Process by which anything is grouped into convenient categories based on some easily observable characters

PHYLOGENETIC SYSTEM OF CLASSIFICATION

- At present it is acceptable - based on evolutionary relationships. This assumes - organisms belonging to the same taxa have a common ancestor.
- Phylogenetic system is based on evolution, order & ancestry, based on common evolutionary descent.
- In classification of plants, the term cladistics refers to phylogenetic classification. Cladistics is classification which is based on both evolutionary & genetic relationships. First phylogenetic system was proposed by Engler & Prantl in monograph 'Die Natürlichen Pflanzen Familien'. Engler & Prantl

classification:

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Phanerogamia → Gymnospermae → Monocotyledonae
                → Angiospermae → Dicotyledonae
                                → Gamopetalae → Polypetalae
  
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- John Hutchinson (1959)** proposed phylogenetic system in his book 'Families of Flowering Plants' into two volumes. Hutchinson classification was revised in 1995.

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Angiospermae → Dicotyledonae → Lignosae → Calyciflorae
                → Monocotyledonae → Herbaceae → Corolliflorae
                                                → Columeliflorae
  
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- Takhtajan** also proposed phylogenetic system in his book 'A system of Phylogeny of Flowering Plants' & 'Flora America'.
- According to Takhtajan 'Taxonomy without phylogeny may be likened to bones without flesh'. According to Engler & Prantl 'classification of monocots were primitive than dicots'.

KINGDOMS OF LIFE

TWO KINGDOM CLASSIFICATION

- Linnaeus** • 2 Kingdoms - Plantae & Animalia • Used till very recently (Before 1969).
- Drawback** - Didn't distinguish unicellular organisms from multicellular, prokaryotic from eukaryotic & photosynthetic from non-photosynthetic.

- Exceptions:
- Chlamydomonas** - unicellular green algae
Plant feature: cell wall present, made up of hydroxyproline (AA) & glycoprotein. Animal feature: neuromotor sensory apparatus.
 - Euglena** - Plant F: Photosynthetic, saprophytic, holozoic. Animal F: cell wall x, pellicle present.
 - Slime mould** - Plant F: Spores have cell wall made of cellulose. Animal F: non-chlorophyllous, non-photosynthetic.

FOUR KINGDOM CLASSIFICATION

- Proposed by **Copeland (1956)**
- Created a separate kingdom 'Monera' (mycota) for Prokaryotes.

THREE KINGDOM CLASSIFICATION

- by **Ernst Haeckel (1866)**
- Third kingdom was **Protista**

FIVE KINGDOM CLASSIFICATION

- By **R.H. Whittaker (1969)**
- New kingdom 'Fungi'
- Based on phylogenetic relationships. He used 5 criteria for 5 Kingdom classification.

 1. Reproduction
 2. Cell structure
 3. Phylogenetic relationships
 4. Mode of nutrition
 5. Thallus organisation

SIX KINGDOM CLASSIFICATION (3-DOMAINS OF LIFE)

- by **Carl Woese (1990)**
- Based on the sequence of subosomal RNA genes
- 3 Domains:

 1. Domain **Archaea**
 2. Domain **Bacteria**
 3. Domain **Eukarya** → 4 Eukaryotic kingdoms

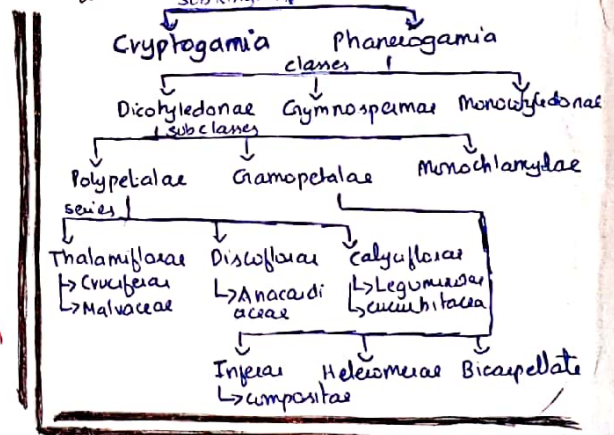
- He believed that they originated from common ancestor called pro-genote

ARTIFICIAL SYSTEM OF CLASSIFICATIONS

- Early system - used only gross superficial morphological characters such as habit, colour, number & shape of leaves, etc. Based mainly on vegetative characters
- The artificial system proposed by **Linnaeus** was based on number of stamens & carpels published in his book **Genera Plantarum (1737)**. Hence it is called **classical sexual system of classification**
- It was artificial b'coz - only few floral characters based. He divided plants into 24 classes - 23 - Flowering plants (Phanerogamia) & 24 (Cryptogamia)
- Aristotle was the earliest to attempt a more scientific basis for classification - used simple morphological characters → Plants (Trees, Shrubs, Herbs) Animals (Enaima (RBC), Anaima (WBC))
- Aristotle - Historia Animalium** (First book of zoology)
- Also wrote **Scala Naturae** • **Theophrastus** - 480 plants in 'Historia Plantarum'
- Also artificial classification → eq to vegetative & sex (1st book of Botany)

NATURAL SYSTEM OF CLASSIFICATION

- based on natural affinities among the organisms & consider not only the external features, but also internal - ultra-structure, anatomy, embryology & phytochemistry
- Based on morphology & affinities • Modern day classification employs anatomical & physiological traits • large no. of traits considered.
- Natural system of classification for Flowering Plants - **George Bentham & Joseph Dalton Hooker**, in 3 volumes of **Genera Plantarum**. → used by most of herbaria of the world.
- Bentham & Hooker described 202 families
- They divided plant kingdom into 2 subkingdom - Cryptogamia (seedless) & Phanerogamia (seeded plants) → into 3 classes. Compositae - belongs to inflorescence of Gamopetalae. Sub-class monochlamydae includes 8 series in which 8th series is Ordines Anomali (families having plants with anomalous characters). Includes two orders - couldn't place in classification conveniently rather than affinities
- PLANT KINGDOM**



CLASSIFICATION

FIVE KINGDOMS

CHARACTERISTICS	MONERA	PROTISTA	FUNGI	PLANTAE	ANIMALIA
Cell type	Prokaryotic	Eukaryotic	Eukaryotic	Eukaryotic	Eukaryotic
Cell wall	non-cellulosic (Polysaccharide + AA)	Present in some	Present (without cellulose)	Present (cellulose)	Absent
Nuclear membrane	Absent	Present	Present	Present	Present
Body organisation	cellular	cellular	Multicellular / loose tissue	Tissue / organ	Tissue / organ / organ system
mode of nutrition	Autotrophic (chemo-synthetic & photo-synthetic) & Heterotrophic (saprophytic / parasitic)	Autotrophic (photo-synthetic) & Heterotrophic	Heterotrophic (saprophytic / Parasitic)	Autotrophic (Photosynthetic)	Heterotrophic (Holozoic / saprophytic).

KINGDOM MONERA

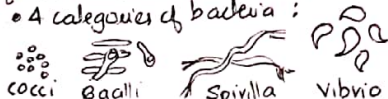
- Monera is a Kingdom of Prokaryotes.
- Bacteria are the sole members.
- On the basis of VRNA genes monera has 2 major groups - Archaeobacteria & Eubacteria.

EUBACTERIA

- True bacteria - characterised by the presence of a rigid cell wall and if mobile, a flagellum.

BACTERIA

- most abundant microorganisms, most adaptive & versatile.
- Dialysis pneumonitis is smallest bacterium. Bacteria were first discovered by Leeuwenhoek. Term bacteria by Ehrenburg. 'Germ theory of disease' given by Louis Pasteur.
- Father of bacteriology - Anton van Leeuwenhoek (Holland/Netherlands)
- Bacteria also live in extreme habitats such as hot springs, deserts, snow & deep oceans where very few other life forms can survive. Many are parasites.
- 4 categories of bacteria:



- Cocci - smallest in size
- Salmonella - rod-shaped bacterium which is gas-forming & causes food poisoning.
- Chain of rod-shaped bacteria is streptobacillus & chains of spherical bacteria is called streptococcus.
- Staphylococcus have grape or bunch like irregular colony
- Vibrio cholerae is comma shaped bacteria.

ARCHAEBACTERIA

- oldest living beings, most primitive bacteria / monerans. They are special bacteria b'coz they live in some of the most harsh habitats.
- Halophiles & methanogens are obligate anaerobes while thermoacidophiles are facultative anaerobes.
- Archaeobacteria differ from others in having a diff cell wall structure or cell membrane.
- Thermococcus, methanogens are archaeobacteria.

HALOPHILES: live in extremely salty areas.

Halobacterium found in dead sea & great salt lake can not live unless than 3 M NaCl conc. They grow in conc. salt soln due to accumulation of KCl.

THERMOACIDOPHILES: Bacteria living in hot springs / deep sea water. eg: Thermococcus.

METHANOGENS: Bacteria living in marshy areas and produce methane gas. Methanogens are present in the gut of several ruminant animals such as cows & buffaloes & are responsible for the production of biogas (methane) from dung of these animals. eg: Methanobacterium, Methanococcus.

eg: Methanobacterium, Methanococcus - contain protein homologous to eukaryotic core histones.

CYANOBACTERIA (BGA = BLUE GREEN ALGAE)

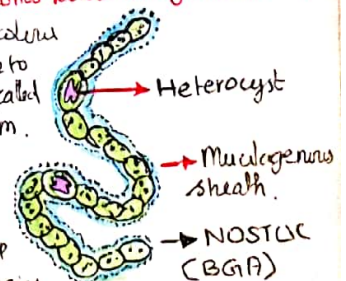
- Cyanobacteria is modern name of Myxophyceae or Myxobacteria or Cyanophyceae or Cyanophyta.
- Cyanobacteria are gram negative, unicellular, colonial or filamentous.
- They may be freshwater, marine or terrestrial algae. The colonies are generally surrounded by gelatinous / mucilaginous sheath. Colony with mucilaginous sheath → **Filament** & without sheath → **trichome**.
- The ability of BGA to change their body colour according to diff wavelength of light → Gaidukov's phenomenon or chromatic adaptation.
- Cell wall of BGA have peptidoglycan.
- have **chlorophyll a** similar to green plants, also have **phycoerythrin** & **phycocyanin** which are present in bacteria. They are photosynthetic autotrophs. In BGA photosynthesis occurs in chromophores or membranous lamellae. • **Cyanobacteria / Nostoc / Anabaena / Oscillatoria** perform oxygenic photosynthesis.
- Reserve food material - **Cyanophycin granule** or α-granule / cyanophycin starch (similar to glycogen).
- Reproduce by vegetative & asexual methods.

MYCOPLASMA → are called PPLO. They are unicellular prokaryotic organisms that completely lack a cell wall, so they are without any specific shape (pleomorphic).

- outermost - cell membrane. The plasmalemma is rich in cholesterol. Smallest living cells known that are capable of growth, division & reproduction. They can survive without oxygen.
- They are gram (-) & heterotrophic. They have elementary bodies which help in reproduction. Resistant to antibiotics which help in reproduction. Resistant to penicillin that act on cell wall but killed by the tetracycline, chloramphenicol & streptomycin that act on metabolic pathways. Many mycoplasma are pathogen to animals & plants. In plants they cause little leaf disease of Brinjal, potato purple top, witches broom of potato.
- Mycoplasma can cause abortion.





(BGA)

- Asexual rep - hormogonia - multicellular fragment of BGA capable of growth into new plant.
- Unicellular, reproduce asexually → fission eg Spirochella.
- Flagella absent but move by gliding.
- Nostoc & Anabaena fix atmospheric nitrogen in specialised cells called heterocysts - contain nitrogenase.
- Spirochella → **great nutritional value as a good source of SCP & vit B12**.
- Red colour of red sea (Red bloom) is due to a red colour cyanobacteria called Trichodesmium erythraeum.
- Dung grain - land slippery due to growth of BGA.
- Many BGA occur in thermal springs / hot water springs. Temp tolerance of these algae have been attributed to homopolari bonds in their proteins.



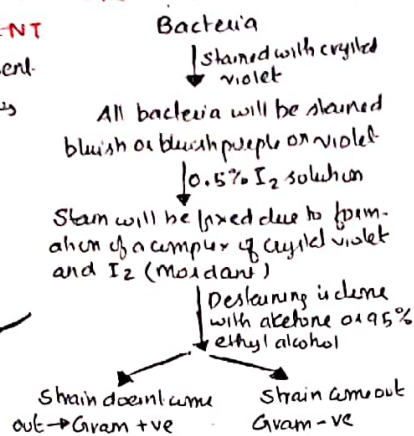
MORE ABOUT BACTERIA

FLAGELLAR ARRANGEMENT

- Atrichous → Flagella absent.
- Monotrichous →  → Monotrichous
- Lophotrichous (2 or more) →  → Lophotrichous
- Amphitrichous →  → Amphitrichous
- Pseudotrichous (all around body) →  → Pseudotrichous

Gram staining developed by Hans Christian Gram in 1884 (Denmark)

GRAM STAINING

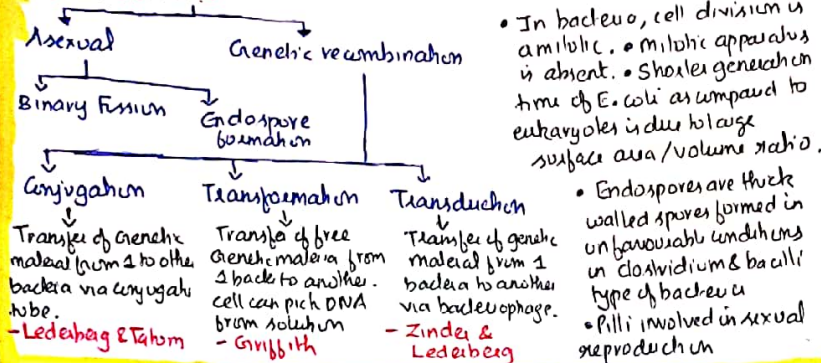


BACTERIAL CELL STRUCTURE

- Glycocalyx: most external (Present / absent) • 2 types - slimy layer, capsule.
 - Slime layer - loosely arranged, made of Dextrin, dextran, levan. helps in attachment to substratum, prevents from dehydration.
 - Capsule - compactly arranged, composed of D-glucuronic acid with polysaccharide, responsible for pathogenicity, mainly in gram -ve bacteria.
- cell wall - provides shape & prevents from bursting out.

- cell membrane - made of lipids, proteins, carbohydrates mainly composed of lipoprotein. • contains enzymes of CTS & succinate dehydrogenase of Krebs cycle.
- Mesosome - Extension of cell membrane. Analogous to mitochondria.
- NUCLEOID
- PLASMIDS
- CYTOPASM - granular due to 70S ribosomes. Polysome bound.
- FLAGELLA: 2 types of gram -ve. 3 parts - basal body, filament & hook (middle)

REPRODUCTION



MODE OF NUTRITION

- Photosynthetic autotrophs: eg. Cyanobacteria (BGA)
- Chemosynthetic autotroph - They oxidize inorganic substances such as nitrate, nitrite & ammonia for ATP production. eg: Nitrifying bacteria, iron bacteria, sulfur bacteria, etc.
- Decomposer heterotroph - Most important in recycling of nutrients.
- Pathogenic heterotroph - They cause diseases in human (typhoid, cholera, tetanus, TB, etc), animals & plants (virus cancer, etc).

[Nishidha]

KINGDOM PROTISTA

- All single celled eukaryotes
- highly heterogeneous group b'coz the boundaries of this kingdom are not well defined
- Mostly aquatic.
- Reproduction: Asexual & Sexual (cell fusion & zygote formation is involved).

EUGLENIDS

- Euglena like unicellular flagellates which possess a protein layer called pellicle, instead of cell wall.
- Pellicle makes their body flexible
- mostly fresh water organisms found in stagnant water. • have 2 flagella - a short & a long. Flagellum of Euglena or Astasia is stichonemate - Flagella having small hair like structures (mastigonemes). They have chl-a, chl-b & carotenoids (carotene & xanthophylls). • mode of nutrition: photosynthetic. They can predate on smaller organisms in absence of light (heterotroph). • connecting link b/w plants & animals. • In Euglena reserve food is paramylum bodies or paramylon.

SLIME MOULDS (Myxomycetes)

- Saprophytic protists without cell wall.
- Spores possess true walls. • Habitat: Decaying twigs & leaves. • During favourable conditions, they form an aggregation called plasmodium which may grow & spread over several feet.
- Thalloid multinucleate body of slime mould is called plasmodium. • During unfavourable condition it differentiates & forms fruiting bodies bearing spores at their tips. • Spore producing body of slime mould is called sporangium or fruiting body. They are extremely resistant & survive for many years.

CHRYSTOPHYTES: Belong to division bacillariophyta & class bacillariophyceae

- It includes diatoms & desmids (golden algae). • Cosmarium is unicellular non-motile desmid.
- Habitat: Aquatic (Fresh water or marine) & plankton (Passively floating). • lack flagella except in the reproductive stages. • microscopic. • Diatoms stay float on water surface due to light weight, stored lipids. • Phytoplankton acts as direct or indirect food for all marine creatures.

DINOFLAGELLATES

- Class: dinophyceae • appear yellow green, brown, blue or red depending on the main pigment present in their cells. They are mostly marine & photosynthetic. • contain chl-a, chl-c & unique xanthophyll pigment. • As the name indicates most of the dino flagellates have 2 flagella. One lies longitudinally & other transversely (heterokonts) in furrow b/w the wall plates. • very often, red dinoflagellates (Gonyaulax) undergo such rapid multiplication that they make the sea appear red, called red tides. • Toxins (saxitoxin) released by such large numbers may even kill other marine animals such as fishes.

DIATOMS: cell wall (siliceous) form two thin overlapping shells which fit together as in soap box. The walls are embedded with silica & thus the walls are indestructible. The diatoms are left behind large amount of cell wall deposits in their habitat. This accumulation over billions of years is called diatomaceous earth or diatomite or kieselguhr. • Diatoms are chief producers in oceans • commercial use: Polishing and filtration of oils and syrups. • Reserve food is leucosin (Polysaccharide) & oil.

Amoeboid protozoans: Locomotory organ is pseudopodia. Features: Present in fresh water or in a water or moist soil. Marine forms may have silica shells. Eg: Amoeba (Free living) Entamoeba (Parasitic)

Flagellated protozoans: Flagella, Free living (aquatic) or parasitic. Eg: Trypanosoma (Disease - African sleeping sickness)

Ciliated protozoans: Cilia, Aquatic - numerous cilia are present over the body - food is drawn by steering action of cilia present in gullet of cell. Eg: Paramecium.

Sporozoans: Locomotory organ is absent. • These possess spore like infectious stage. Eg: Plasmodium (Malaria parasite)

PROTOZOANS

- actually acellular
- All heterotrophs & live as predators on parasites. BGA live endosymbiotically inside protozoan, called cyanella.
- They are believed to be primitive relatives of animals.
- Protozoans are classified on the basis of locomotory organs.

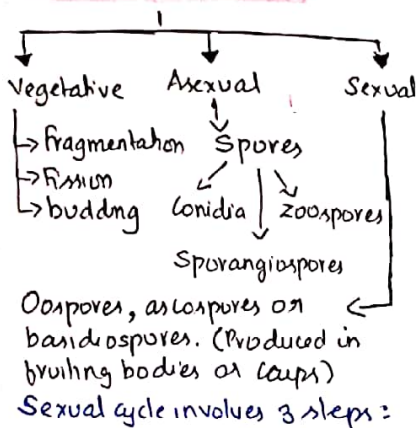
KINGDOM FUNGI

- Study of fungi - mycology
- Father of mycology - Micheli
- Father of Indian mycology - Butler
- Fungi are cosmopolitan & prefer to grow on warm & humid places.

General Information about Kingdom Fungi

- Members are filamentous & multicellular (except yeast) • All heterotrophic (mostly saprotrophic). Few may be parasitic. • Their bodies consist of long, slender thread-like structures called **hyphae**. The network of hyphae is known as **mycelium**.
- Some hyphae are continuous tubes filled with multinucleated cytoplasm, these are called **coenocytic hyphae**. • Others have septae or cross walls in their hyphae.
- The cell walls of fungi are composed of chitin ($C_{22}H_{34}N_4O_{21}$)_n and polysaccharides. • Cell wall of both bacteria & fungi have **N-acetylglucosamine**.
- In fungi food is stored in the form of glycogen & oil. • Fungi may live as symbiont - **In lichens** (with algae) or as **mycorrhiza** (with roots of higher plants)

REPRODUCTION



NUTRITION

- Fungi don't have chlorophyll hence cannot manufacture their food. They show 3 types of heterotrophic nutrition:
- Fungi which absorb soluble organic matter from dead substrata → **Saprophytes**
 - **Obligate saprophyte**: obtain food only from dead & decaying organic matter. eg: *Rhizopus nigricans*
 - **Facultative parasite**: They are normally saprophytic but in the absence of dead organic matter they become parasitic. eg: *Rhizopus stolonifer*.
 - Those that depend on living plants & animals are called **parasites**
 - **Obligate parasite**: They fail to survive in absence of host. eg: *Albugo candida*
 - **Facultative saprophyte**: They are normally parasitic but in the absence of host they become saprophytic. eg: *Helmintosporium oryzae*.

- The parasitic fungi take their nutrition from the host with the help of **haustoria**.

CLASSIFICATION OF FUNGI

Features	Phycomyces	Ascomyces	Basidiomycetes	Deuteromycetes
Common name	Algal fungi	Sac fungi	Mushrooms / Puffballs / bracket fungi	Fungi imperfecti
Mycelium	Aseptate & coenocytic	Branched & septate	Branched & septate	Branched & septate
Asexual reproduction	zoospores / aplanospores (Endogenously produced in sporangium)	Conidia (Exogenously produced)	Usually absent	Conidia (Exogenously produced)
Sexual reproduction	Oospores	Ascospores (Endogenously produced)	Basidiospores (Exogenously produced)	—
Dikaryotic stage (n+n) in sexual cycle	Absent	Present	Present	Absent
Other feature	Aquatic / decaying logs / obligate parasites on plants	Saprophytic / decomposers / coprophiles (dung) / Parasitic	In soil / decaying logs / Parasitic on plants as rusts & smuts. commonly reproduced by fragmentation. Sex organs absent.	only asexual vegetative stage known. Sexual stage is absent. saprophytic / Parasitic
Examples:	<i>Rhizopus</i> (bread mould), <i>Albugo</i> (Parasitic fungus mustard), <i>Mucor</i>	<i>Neurospora</i> (used in genetics), <i>Claviceps</i> , <i>Aspergillus</i> , Yeast, <i>Penicillium</i> . Edible → Morels & truffles	<i>Agaricus</i> (mushroom), <i>Puccinia</i> (rust fungus), <i>Ustilago</i> (smut fungus)	<i>Colletotrichum</i> , <i>Alternaria</i> , <i>Trichoderma</i>

VIRUS

- Term coined by **Louis Pasteur** (father of microbiology) • Acellular organisms obligate parasites. • No place in 5 kingdom classification. • Connecting link b/w living & non living.
- Virus means poison or venom - **D.J. Ivanowsky**: Virus are causative agents of tobacco mosaic disease (discovery of virus). - **M.W. Beijerinck (1898)**: Demonstration of infectious nature of plant sap obtained from infected part of tobacco plant. He also gave the term: **Contagium vivum fluidum** (living infectious fluid) to it. **W.M. Stanley (1935)**: Crystallization of virus. Also showed that these crystals were made of proteins. • They destroy the host.
- **Genetic material**: Either double stranded DNA or double stranded RNA or single stranded DNA or single stranded RNA.
- **Chemical nature**: nucleoprotein. Genetic material - nucleic acid & the protein coat is capsid.
- **Human viral diseases**: Flu, Influenza, AIDS, Mumps, small pox, herpes, etc.
- Plants are also infected by virus & produce symptoms like mosaic pattern formation, leaf curling, leaf rolling, yellowing & vein curling, dwarfing & stunted growth, etc.

VIROIDS

- Term by T.O. Diener → discovered potato spindle disease is caused by a new infectious agent which was smaller than virus. It was found to be free RNA like & given the term viroid.
- Low molecular weight.

PRIONS

- Discovered by Prusiner.
- They are infectious protein causes - Animal diseases
- Mainly attack on nervous system. • also known as 'slow virus' Prions causes:
 - Scrapie disease of sheep / goat
 - MAD cow disease
 - Alzheimer disease in man
 - Creutzfeldt-Jakob disease in mad.
 - Kuru (causing death in humans)

LICHENS

- It is a symbiotic association (mutualism) b/w algae & fungi.
- Dual hypothesis for lichens was given by **Schwendener**
- Algal component or **phycobiont** - It is autotrophic & provides food for fungi.
- Fungal component or **mycobiont** - It is heterotrophic. It provides shelter & also absorb water & minerals for algae.
- **Ecological importance**: Lichens also act as good pollution indicator (*Cladonia*, *Usnea*). They do not grow in polluted areas