# Biological classification



✡ kingdom of classification →

1) Two kingdom classification → By Linnaeus
→ All organism grouped into two kingdom - Basis - cell wall.

Animalia
- → Protozoa
- → Mollusca
- → Arthopoda
- → Fishes
- → Reptiles
- → Mammals

Plantae
- → Algae, Bryophytes, Pteridophytes, Gymnosperm & Angiosperm.
- → Bacteria, Cyanobacteria, Archaebacteria
- → Fungi
- → Diatoms, Dinoflagellates, Euglenoids.

• Drawback →
i) Prokaryotic is kept with eukaryotic cell.
ii) Autotrophic is kept with heterotrophic
iii) Less differentiated was kept with more differentiated.
iv) Unicellular is kept with multicellular.

Note → As our understanding change, criteria for classification also changed.

2) Three kingdom classification - By Ernst Haeckal

Animalia

Plantae

~~Prostisa~~
3rd Protista
- → protozoa
- → Bacteria, Cyanobacteria & Archaebacteria
- → Fungi
- → Diatom, Dinoflagellate

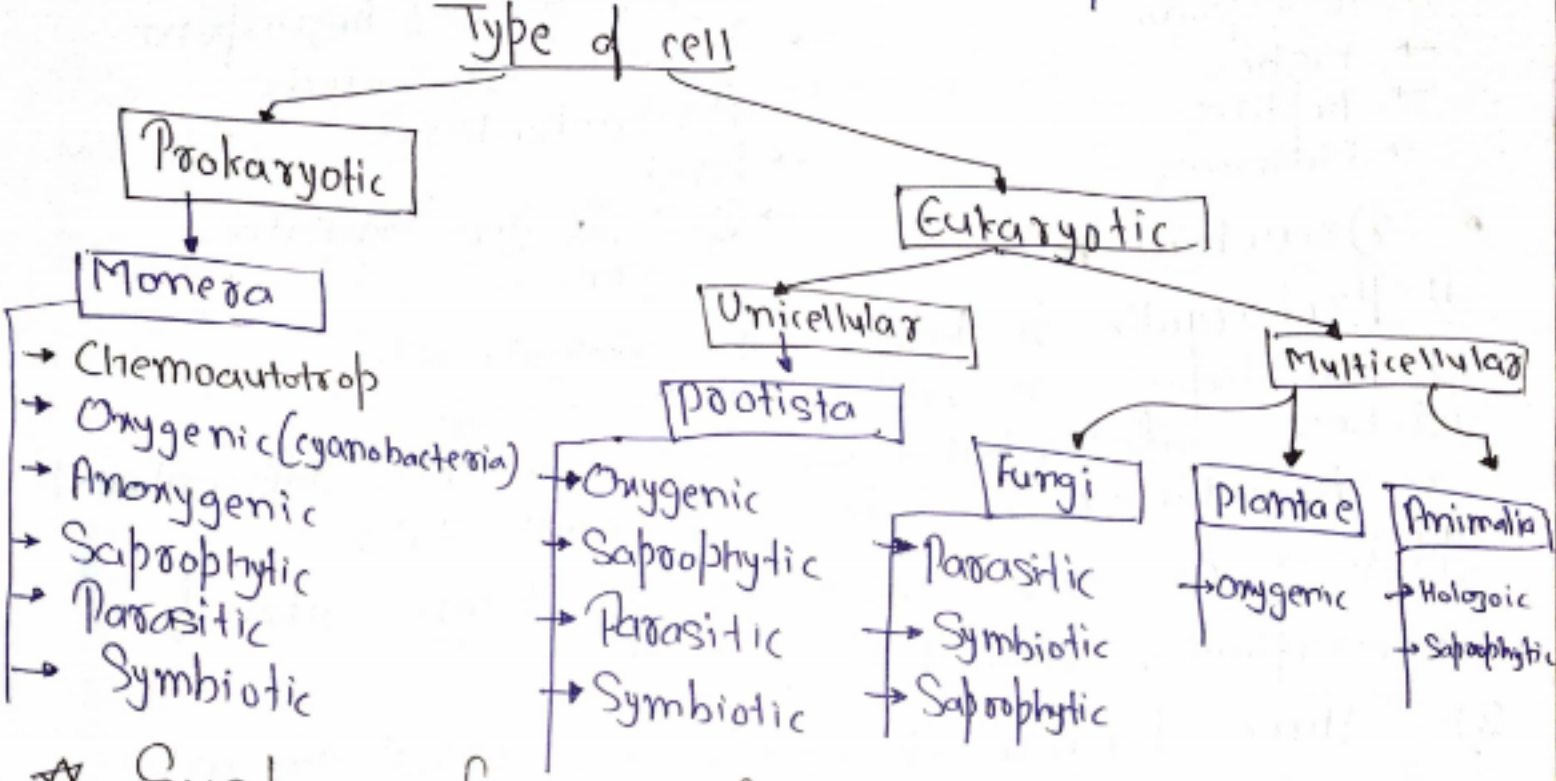
3) Four kingdom classification - By copeland

| Plantae | Animalia | Protista | Monera (4th) |
|---|---|---|---|
| Algae | | protozoa | Bacteria |
| Bryophytes | | Dinoflagellate | Cyanobacteria |
| Pteridophytes | | Diatom | Archabacteria |
| Gymnosperm | | | |

Drawback → Fungi not placed properly.

## Five kingdom classification - By R.H. Whittaker [1969]

Basic - 1) Cell structure
2) Thallus organisation
3) Nutrition
4) Reproduction
5) Phylogenetic relationship




## ✡ System of Classification :→

Various taxonomic work is classified 3-categories.

1) Artificial system → It is based on external morphology.
→ Its unrelated come together group appear to be artificial.

Example of artificial system

(a) Aristotle → Classify animal → Anaima (without RBC)
→ Enaima (with RBC)
Classify plant → Herb, Shrub & Tree.

(b) Linnaeus → Classify flowering plant on the basis of no. of stamen/Androecium

Drawback of artificial system
→ It only considered morphological features.

* Natural system :→ It is based on many features like morphology, anatomy, cell structure, embryology, biochemistry
→ After considering so many feature, group appear to be natural, as only related organism come closer in one group.
→ Bentham & Hooker System

III Phylogenetic classification system →
Based on evolutionary relationship between the various organism.

IV Numerical Taxonomy → Given by E. Anderson
Large number of feature is considered and each feature is given equal ~~weitage~~ weightage in form of code & a computer based program is designed which compare two organism.

V Cytotaxonomy →
Based on cytological information like chromosomes number, structure, behavior.

VI Chemotaxonomy →
Based on chemical constituents of the plant to resolve confusions.

# kingdom Monera :→

- Bacteria are the sole members of the kingdom monera.
- They are most abudant micro-organism.
- Rigid cell wall of murein or peptidoglycan
- Histone are absent. Ribosomes are of 70S type.
- Bacteria occur almost everywhere. Hundreds of bacteria are present in a handful of soil.

- They also live in extreme habitats such as hot springs, deserts, snow and deep oceans where very few other life forms can survive.
- Many of them live in or on other organism as parasites.

On the basis of shape bacteria are grouped under 4 - Categories

1) Spherical ⁘ Coccus (pl.... cocci)
2) Rod shape Bacillus (pl... bacilli)
3) Comma-shaped Vibrium (pl. vibrio)
4) Spiral Spirillum (pl... spirilla)

- They are very complex in behavior. Show the most extensive metabolic diversity.
- Some bacteria synthesize their own food from inorganic substrates.

## Archaebacteria

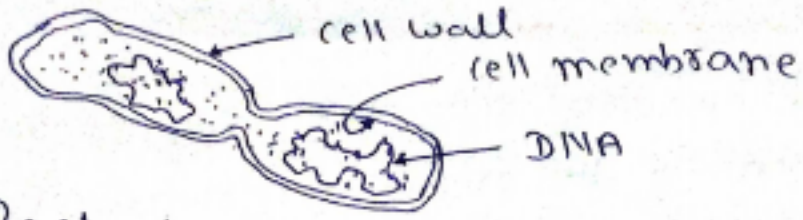
- They live in some of the most harsh habitats.
- Halophiles (salty areas) Strictly Anaerobes.
- Thermoacidophiles (hot spring) Aerobic in nature.
- Methanogens (marshy areas): Anaerobic in nature.
- Archaebacteria differ from other bacteria in having a different cell wall structure & this features is responsible for their survival in extreme conditions.
- Methanogens are present in the gut of several ruminant animals such as cows & buffaloes and they are responsible for the production of (methan) (biogas) from the dung of these animals & also help in digestion of cellulose.

## Eubacteria

- There are thousands of different eubacteria or true bacteria.
- They are characterised by the presence of a rigid cell coat (polysaccharide and amino acid), & if mortile, a flagellum.

### Types of flagellation:

- Monotrichous: Flagella at one end.
- Lophotrichus: Group of flagella at one end.
- Amphitrichus: Group of flagella at both ends.
- Peritrichus: Flagella all over the body.
- Cyanobacteria (also referred to as blue-green algae/ myxobacteria) have chlorophyll a similar to green plant and are photosynthetic autotrops.
- Cyanobacteria are unicellular, colonial or filamentous, fresh water/marine or terrestrial body algae.
- Colonies are generally surrounded by gelatinous sheath.
- They often form algal blooms in polluted water bodies.
- Some of these organism can fix atmospheric nitrogen in a specialised cells called Heterocysts e.g. Nostoc & Anabaena.
- Chemosynthetic autotrophic
- Obtained food by oxidation of inorganic substance.
- They play a great role in recycling nutrients like nitrogen, phosphorous, iron and sulphur.
- Heterotrophic bacteria.
- They play a great role in recycling nutrients like nitrogen, phosphorous, iron & sulphur.
- Heterotrophic bacteria
- They are the most abundant in nature. The majority are important decomposers.
- They are helpful in making curd from milk, production of antibiotics nitrogen in legume roots etc.
- Cholera, typhoid, tetanus, citrus canker are well known diseases caused by bacteria. etc.




- Bacteria reproduce mainly by fission.
- Sometimes, under unfavorable conditions, they produce spores.

## Plasmids

- Plasmid term given by Lederberg.
- Plasmids are extra-chromosomal small, circular double stranded DNA molecules.
- R-factor is type of plasmid which contains genes for antibiotic resistance.

Episomes:→ When plasmids are integrating into the bacterial DNA chromosomes

## Sexual Reproduction in Bacteria →

- Conjugation: ① Direct contact between two cells, ② Discovered by Lederberg & Tatum
- Transformation: → Transformation was first demonstrated in 1928 by British bacteriologist Frederick Griffith.
- Transduction: → Transfer of bacterial DNA with the help of bacteriophage / virus.
  → was discovered by Zinder & Lederberg.

Gram positive vs Gram negative Bacteria

| Gram positive bacteria | Gram negative bacteria |
|---|---|
| | |

## Mycoplasma: Joker of plant kingdom

- They are organisms that completely lack a cell wall.
- They are the smallest living cells known and can survive without oxygen.
- Many mycoplasmas are pathogenic in animal & plants.
- Mycoplasma is insensitive to penicillin but sensitive to tetracycline

## • kingdom Protista :→

→ All single celled eukaryotes placed under Prostista.
→ It include Chrysophytes, Dinoflagellates, Euglenoids, Slime moulds & protozoans.
→ Member of prostista are ~~primaly~~ primarily aquatic.
→ This kingdom forms a link with the others dealing with plants, animals & fungi.
→ Being eukaryotes, the protistan cell body contains a well defined nucleus & other membrane-bound organelles.
→ Protists reproduce asexually & sexually by a process involving cell fusion & zygote formation.

**Chrysophytes →** This group includes diatoms and golden algae (desmids).

→ They are found in fresh water as well as in marine environments.
→ They are microscopic and float passively in water currents (plankton)
→ Most of them are photosynthesis.
→ In diatoms, the cell wall form two thin overlapping shells, which fit together as in a soap box. The wall are embedded with silica and thus the wall are indestructible
→ Diatoms have left behind large amount of cell wall deposits in their habitat: this accumulation over millions of years is referred to as 'diatomaceous earth'

- Being gritty, this soil is used in polishing, filtration of oils & syrups.
- Diatoms are the chief 'producers' in the oceans.

# Dinoflagellates (Fire algae)

- These organisms are mostly marine & photosynthetic
- They appear yellow, green, brown, blue or red depending on the main pigments present in their cells.
- The cell wall has stiff cellulose plates on the outer surface.
- Most of them have two flagella; one lies longitudinally & the other transversely in a furrow between the wall plates.
- Red dinoflagellate Gonyaulax make the sea appear red (red tides).
- Toxins release by such large number may even kill other marine animals such as fishes.

# Euglenoids

- Majority of them are fresh water organism found in stagnant water.
- Instead of cell wall, they have a protein rich layer called pellicle which make their body flexible.
- They have two flagella, a short and a long one.
- They are photosynthetic in the presence of sunlight. When deprived of sunlight they behave like heterotrophs by predating on other smaller organisms.
- They pigments of euglenoids are identical to those present in higher plants. e.g., Euglena.

# Slime Moulds (Slime Fungi) →

→ Slime moulds are saprophytic protists.
→ The body moves along decaying twigs & leaves engulfing organic material.
→ Under suitable conditions, they form an aggregation called plasmodium which may grow & spread over several feet.

- During unfavourable conditions, the plasmodium differentiates and form fruiting bodies bearing spores at their tips.
- The spore posses true wall.
- They are extremly resistance & survive for many years, even under adverse conditions. The spore are dispersed by air currents.

Example: Physarum & Physarella are unicellular slime moulds.

# Protozoans

- All protozoans are heterotrophs and live as predators or parasites.
- They are belived to be primitive relative of animals. There are four major group of protozoans
- Amoeboid protozoan → They move and capture their prey by putting out pseudopodia (false feet) as in Amoeba (fresh water).
- Marine forms have silica shells on their surface.
- Entamoeba histolytica are endo-parasites
- Contractile vacuoles are present in Entamoeba but absent in Amoeba.
- Flagellated protozoan → The member of this group are either free-living or parasitic
- They have flagella
- Sleeping sickness caused by Trypanosoma gambiense. Parasite is transmitted by Tse Tse fly (Glossira)
- kala-azar or black fever or Dumdum fever caused by leishmania
- Giardiasis/Diarrhoea also known as Back packer disease caused by Giardia intestinalis.
- Ciliated protozoan → These are aquatic, actively moving organism because of the presence of thousands of cilia.
- They have a cavity that opens to the outside of the cell surface.

- The coordinated movement of rows of cilia causes the water laden with food to be steered into the gullet.

Example: Paramoecium

- Paramoecium respond to electric current. This property of paramoecium is known as galvanotaxis.
- Sporozoans → This include diverse organisms that have an infectious spore-like stage in their life cycle.
- The most notorious is plasmodium (malarial parasite) which causes malaria, a disease which has a staggering effect on human population.
- Plasmodium is digenetic means required two host: primary host is Man and secondary host is female Anopheles.
- Final host of malarial parasite is female Anopheles mosquito and man is intermediate host.
- Plasmodium is intracellular parasite in man.

# kingdom fungi → Study of fungi called "Mycology"

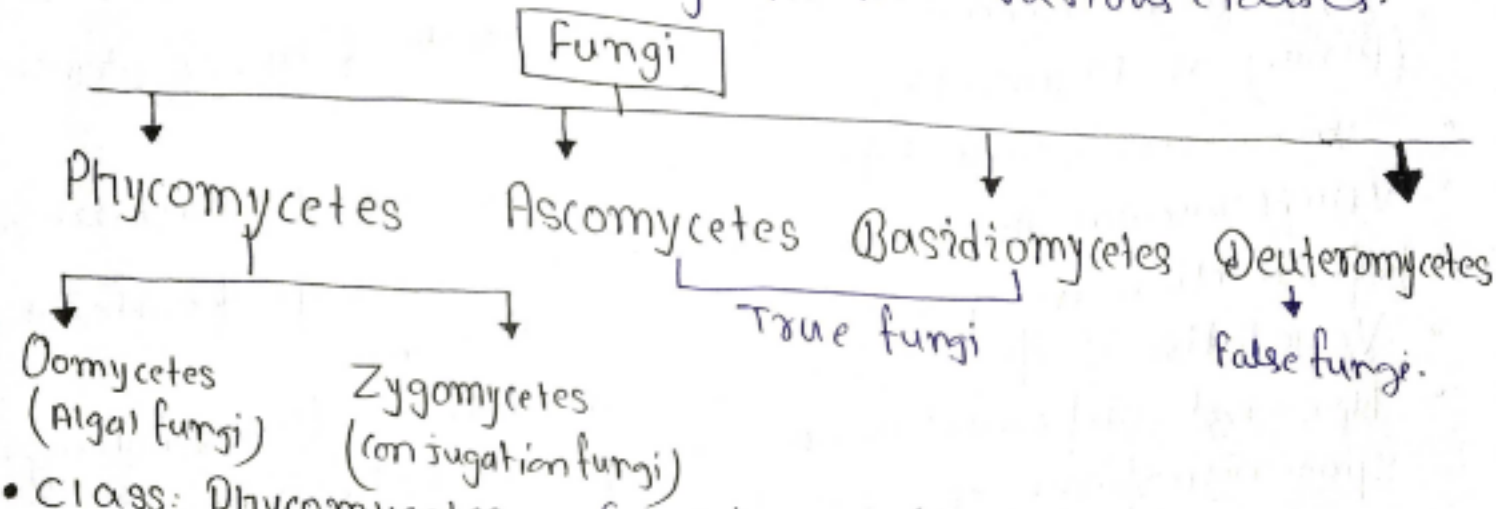
- A unique kingdom of heterotrophic organisms.
- Bread develops a mould or orange rots because of fungi.
- The common mushroom & toadstools are also fungi
- White spots seen on mustard leaves are due to a parasitic fungus.
- Unicellular fungi eg:- yeast are used to make bread & beer.
- Wheat rust causing fungi is puccinia
- Source of antibiotics: Penicillium
- fungi are cosmopolitan and occur in air, water, soil and on animal & plants.
- They prefer to grow in warm & humid places.
- In very cold area like freeze, fungi do not grow it helps to prevent food from going bad due to bacterial or fungal infections.

- With the exception of yeast which are unicellular, fungi are filamentous.
- Their body consists 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.**
- The cell wall of fungi are composed of Chitin & polysaccharide
- Most fungi are heterotrophic and absorb soluble organic matter from dead substrates and hence are called saprophytes.
- Symbiotic association of fungi with roots called lichens.
- Symbiotic association of fungi with roots of higher plants (pinus) as Mycorrhiza
- There are two types of mycorrhiza. Endo & ectomycorrhiza
- VAM (Vascular Arbuscular Mycorrhiza) is an example of endomycorrhiza

**Reproduction in fungi can take place by**

- Vegetative reproduction → fragmentation, fission & Budding.
- Asexual reproduction → is by spores called conidia or sporangiospores or zoospores
- **Sexual reproduction**
- By zygospore (2n) oospores, ascospores (n) & basidiospores (n) (OOA)
- The various spores are produced in distinct structure called fruiting bodies.
- Sexual cycle involves the following three steps:
- **Plasmogamy** :→ fusion of protoplasm between two motile or non-motile gametes.
- **karyogamy** :→ fusion of two nuclei
- **Meiosis** → in zygote resulting in haploid spores.

- In fungi (Ascomycetes and Basidiomycetes) an intervening dikaryotic stage (n+n, i.e two nuclei per cell) occurs; such a condition is called a dikaryon and the phase is called dikaryophase of fungus.
- Later, the parental nuclei fuse and the cells become diploid. The fungi form fruiting bodies in which reduction division occurs, leading to the formation of haploid spores.
- Classification of fungi:→ The morphology of mycelium, mode of spore formation and fruiting bodies form the basis for the division of the kingdom into various classes.




- Class: Phycomycetes → found in aquatic habitats, decaying wood in moist and damp places or as obligate parasite on plants.

Important features →

Common name → Algal fungi
Mycelium → coenocytic & branched
Cell wall → Cellulosic in Oomycetes & chitinous in Zygomycetes
Asexual spores → Zoospores (motile) & aplanospores (non-motile); Spores are endogenous.

Sexual reproduction: Occurs by fusion of similar gametes (isogamous) or dissimilar gametes (anisogamous or oogamous). Plasmogamy is immediately followed by karyogamy, without dikaryophase.

Sexual spore: Oospore in Oomycetes; Zygospore in Zygomycetes.

Example

saprophyte { Rhizopus (Black mould/Bread mould)
Mucor

parasite { Albugo candida - white rust of cruciferae (mustard)

Class: Ascomycetes → They are saprophytic, decomposers, Parasitic or coprophilous.

common name → Sac fungi

Plant body → a) unicellular/non-mycelial eg - Yeast.
b) Mostly mycelial eg., Penicillium, Aspergillus.

Mycelium → Branched, septate

Asexual spores → conidia: Thin walled, non-motile, exogenous spores.

Sexual reproduction → Conjugation, eg., Yeast
Gametangial contact, eg., penicillium
karyogamy, meiosis and ascospore formation occurs inside the ascus. Shorter dikaryophase (n+n) is present in between plasmogamy & karyogamy.

Fruiting bodies: are called ascocarp, formed in sexual life cycle and contain asci

## Examples

- Saccharomyces :→ Budding yeast.
- Aspergillus flavus :→ Guinea pig of the plant kingdom/weed of laboratory.
- Neurospora crassa :→ Drosophila of plant kingdom; pink bread mould, used extensively in biochemical and genetic work.
- Claviceps purpurea :→ Ergot of rye; source of LSD (Lysergic acid diethylamide) Hallucinogenic drug.
- Morels :→ an edible ascocarp
- Truffles ↗

## Class: Basidiomycetes

They include bracket fungi, mushrooms, puffballs, rust and smut fungi. They are most common and advanced fungi.

Common name→ Club fungi, because they produce club-shaped basidia for the formation of basidiospores in sexual life cycle.

Mycelial structure: Secondary mycelium (n+n), dikaryotic dominant and long lived phase. Primary mycelium (n) is monokaryotic and short lived phase and develops from germination of basidiospore.

(a) They are decomposer of wood, they decompose cellulose and lignin and grow in soil, on tree stumps, logs and also as parasites on plants eg→ rusts and smuts

(b) Septa Possess dolipore (central pore with barrel shaped outgrowth) Dolipore septa absent in rust & smut - causing fungi.

(c) Asexual spore are generally absent, vegetative reproduction by fragmentation is common.

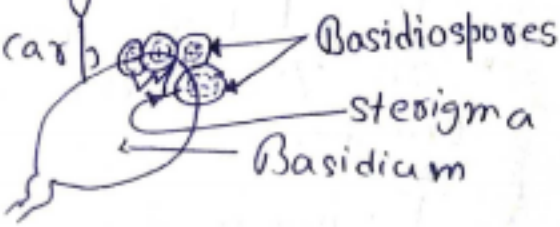
Sex-organ are absent but plasmogamy is brought about by fusion of two vegetative or somatic cells of different genotypes.

(e) Clamp connections are present. They are meant for proper distribution of dikaryon at the time of cell division.

(f) Basidium is the place of karyogamy, meiosis, formation of basidiospores and is produced from secondary mycelium.

(g) Basidiospores are 4 in number and produced exogenously at the tip of sterigmata

(h) Fruiting body is called basidiocarp




Examples

Agaricus → Edible mushroom

Ustilago → Loose smut of wheat.

Puccinia → Black rust disease of wheat.

## Class: Deuteromycetes →

→ They are saprophytic or parasitic and many members help in mineral cycling by decomposing litter.

→ Commonly known as imperfect fungi.

→ Sexual reproduction is not known.

→ Reproduce by conidia

→ Once the perfect stage or sexual stage was discovered, they are shifted to ascomycetes or basidiomycetes.

Ex. Alternaria → Early blight of potato.

Colletotrichum → Red rot of sugarcane

Trichoderma

# LICHENS, VIRUSES, VIROIDS AND PRIONS

- They are not included in the five kingdom system of classification. as they are non-cellular.

## LICHENS

→ They are symbiotic association i.e mutually useful association which are formed by a fungus partner (mycobiont) and an algal partner (Phycobiont). Algae prepare food for fungi and fungi provide shelter and absorb mineral nutrients & water for its partner.

→ Mycobiont is dominant forming 95% of total thallus. It belongs mostly to ascomycetes and sometimes to basidiomycetes.

→ In 75% lichens, Phycobiont is mostly chlorophyceae

Economic importance of lichens →

a) Pioneers of vegetation:→ They initiate weathering of rocks into soil particles during primary succession.

b) As a food & fodder → Reindeer moss of the arctic region is eaten by reindeer & cattle. Iceland moss is used as food by man in Iceland.

c) Dye orchil is obtained from species of Rocella & Lecanora Litmus is derived from Rocella.

d) Indicators of air pollution:→ Lichens are very sensitive to $SO_2$ and die at heigher level of $SO_2$.

VIRUS → These are obligate parasite which are inert outside specific host cell.

Pasteur: Coined the term virus denoting venom or poisonous fluid

D. J. Iwanowsky: Recognised the causal agent of Tobacco mosaic disease.

M.W. Beijerinck - contagium vivum fluidum or infectious living fluid from infected plants of tobacco.

W.M. Stanley: Crystallised viruses and found that these crystals largely consists of proteins.

A virus has following part →

i) Envelope:→ It has smaller subunits, known as peplomeres and is found in some viruses e.g., Herpes virus, HIV etc

ii) Capsid: Protein coat made up of subunit called capsomeres. It protect the nucleic acid in all the viruses.

iii) Genetic material:→ Viruses contains either DNA or RNA. Genetic material is infectious in viruses. In general, virus that infect plants have (single standard RNA) SSRNA & viruses that infect animals have either SS or ds RNA or dsDNA. Bacterial viruses are generally ds-DNA viruses

→ No virus contains both DNA & RNA.

On the basis of type of genetic material, virus are classify under

a) Deoxyviruses

i) contain double standard DNA (dsDNA) eg:- Pox virus, Cauliflower mosaic virus.

ii) contain single strand DNA (SSDNA): eg $\phi \times 174$

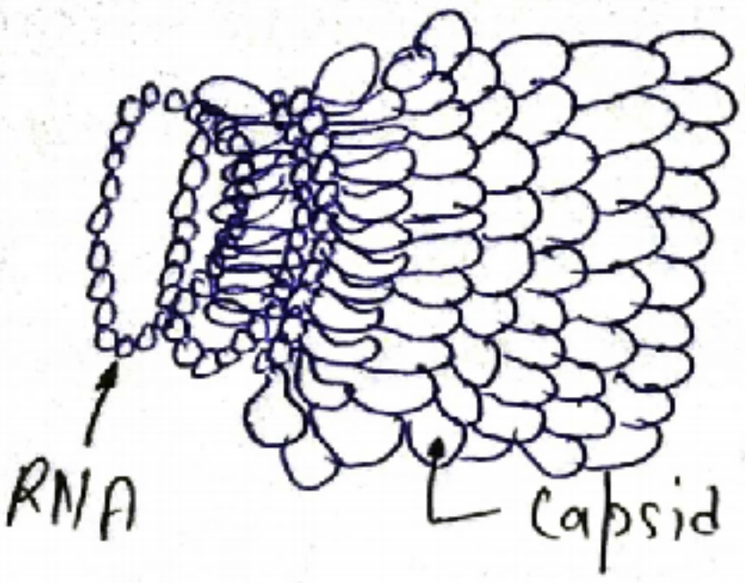
b) Riboviruses:

i) Contain DS RNA: eg Reovirus, wound tumour virus.

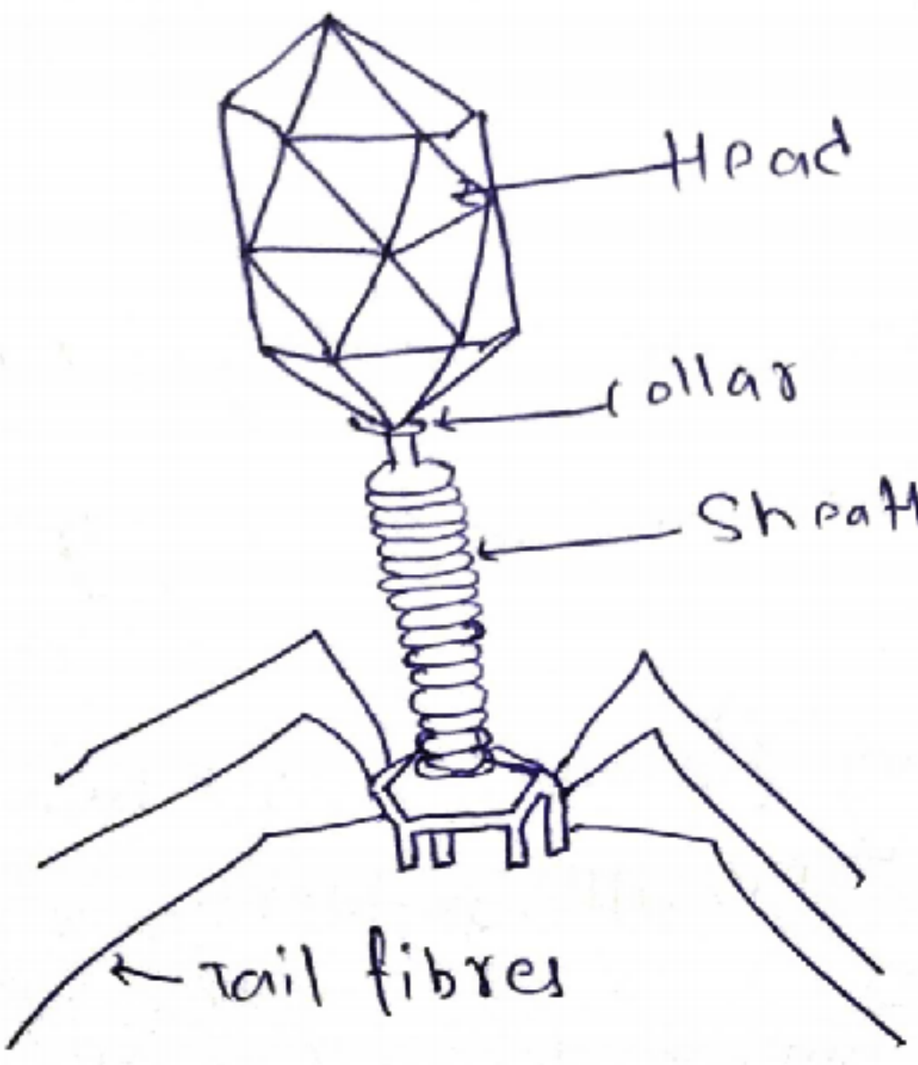
ii) contain SS RNA: eg, TMV, HIV, Influenza virus.

Structure of some viruses

i) Tobacco Mosaic Virus (TMV) is elongated rod like, 3000Å long. 180Å in diameter, 2130 capsomeres are arranged helically to form the capsid.




(ii) T4 Bacteriophage has a tadpole like structure with polyhedral head connected to a helical tail. The head consists of nucleic acid surrounded by a protein coat or capsid. Nucleic acid is double standard DNA. Tail is proteinious, tube like, core surrounded by sheath. At one end, tube is joined to the head by thin collar. At the other end, it has a hexagonal base plate with six small tail pins & six tail fibres which help in attachment of the phage to the host cell.



## Disease cause by virus in man

| Name of the disease | Causal virus |
|---|---|
| i) Common cold | Rhinoviruses |
| ii) Influenza | Influenza virus |
| iii) Measles | Measles virus |
| iv) Poliomyelitis (Polio) | Polio virus |
| v) Small pox | Variola virus |

- In plants, virus causes development of symptoms like mosaic formation, yellowing and vein clearing, leaf rolling & curling, dwarfing & stunted growth.
- Viroids →

Were discovered by T.O. Diener in 1971. It has RNA without protein coat thus, called viroid. RNA of the viroid has low molecular weight. Viroids cause potato spindle tuber disease (PSTD), Chrysanthemum stunt disease.

| | |
|---|---|
| Appear in purple color under the microscope | Appear in pink color under the microscope |
| Outer membrane is present | Outer membrane is absent |
| Peptidoglycan layer is thick and multilayered | Peptidoglycan layer is thin and single-layered |
| Periplasmic space is absent | Periplasmic space is present |
| Cell wall is around 20-80 nm | Cell wall is around 5-10 nm |
| Cell wall is smooth | Cell wall is wavy |
| Cell wall contains virtually non lipopolysaccharide content | Cell wall high lipopolysaccharide content |
| Lipid and lipoprotein content is low in the cell wall | Lipid and lipoprotein content is high in the cell wall |
| More susceptible to anionic detergents | Less susceptible to anionic detergents |
| Examples include actobacillus, Actinomyces, Bacillus, Streptococci, Clostridium & Corynebacterium | Examples include Acetobacter, Chlamydia, Borrelia, Bortadella, Burkholderia, and Enterobacter |