

02

Biological Classification

01. INTRODUCTION

- There have been many attempts to classify living organisms. It was done instinctively not using criteria that were scientific but borne out of a need to use organisms for our own use for food, shelter and clothing.
- Classification systems for living organisms have hence undergone several changes over time.
- Though plant and animal kingdoms have been a constant under all different systems of classifications.
- The understanding of what groups/organisms be included under these kingdoms have been changing.
- The numbers and nature of other kingdoms have also been understood differently by different scientists.

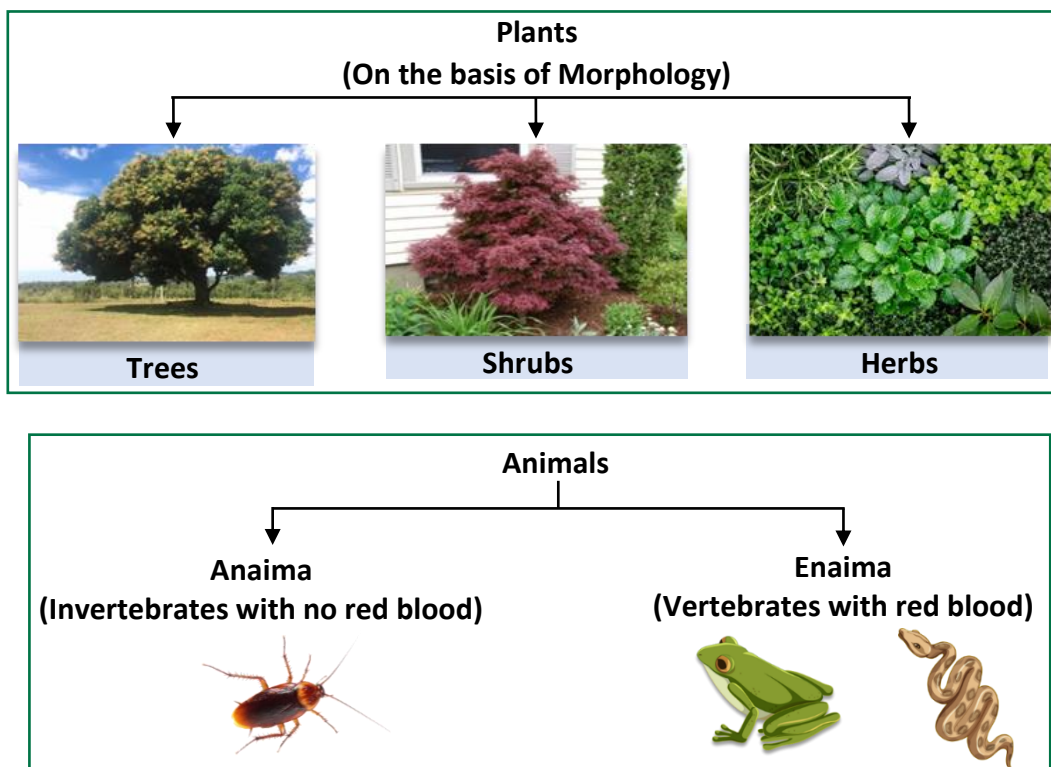
NCERT Question :

Discuss how classification systems have undergone several changes over a period of time?

02. HISTORY OF TAXONOMY

(A) ARISTOTLE :

- **Aristotle** was the earliest to attempt a more scientific basis for classification. He used simple morphological characters to classify plants into **trees, shrubs** and **herbs**.
- Aristotle also divided animals into two groups, those which had red blood and those that did not.

**(B) THEOPHRASTUS :**

- He wrote first book of Botany i.e. '*Historia Plantarum*'. He is known as father of botany and father of ancient plant taxonomy also. Theophrastus classified plants into four groups on the basis of growth forms.
 - (i) Herbs (ii) Shrubs (iii) Undershrub (iv) Trees

(C) CAROLUS LINNAEUS (TWO KINGDOM CLASSIFICATION) :

- He is known as father of taxonomy, father of plant taxonomy and father of animal taxonomy.
- Linnaeus gave the two-kingdom system classification.** He grouped plants and animals into kingdom Plantae and kingdom Animalia respectively on the basis of **cell wall** only.

Life forms

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graph TD
    LifeForms[Life forms] --> Plantae[Plantae]
    LifeForms --> Animalia[Animalia]
    Plantae --> CellWallPresent["cell wall present"]
    Animalia --> CellWallAbsent["cell wall absent"]
  
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The diagram shows the two-kingdom classification of Linnaeus. Life forms are divided into Plantae and Animalia. Plantae has a cell wall present, while Animalia has a cell wall absent. Examples of a tree and a tiger are provided for each kingdom.
- He gave plant nomenclature in his book '*Species Plantarum*' and plant classification in '*Genera Plantarum*'.
- He used mainly the character of male reproductive organ i.e. stamen (androecium) and made 24 classes of plant.

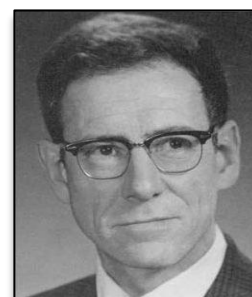
Demerits of two kingdom classification :

- In two kingdom classification prokaryotes (bacteria, blue green algae) and eukaryotes (fungi, mosses/bryophytes, fern/pteridophytes, gymnosperm and angiosperm) are placed in same kingdom.
- In two kingdom system unicellular organism (*Chlamydomonas* and *Chlorella*) and multicellular organism (*Spirogyra*) are placed together under algae in plant kingdom, because they have cell wall.
- This classification did not differentiate between the heterotrophic fungi and autotrophic green plants, though they also showed a characteristic difference in their cell wall composition - the fungi had **chitin** in their walls while the green plants had a **cellulosic cell wall**.
- Hence the two kingdom classification used for a long time was found inadequate. Besides, gross morphology a need was also felt for including other characteristics like cell structure, nature of wall, mode of nutrition, habitat, methods of reproduction, evolutionary relationships, etc. Classification systems for the living organisms have hence, undergone several changes over the time.
- Though plant and animal kingdoms have been a constant under all different systems, the understanding of what groups/organisms be included under these kingdoms have been changing; the number and nature of other kingdoms have also been understood differently by different scientists over the time. Therefor three kingdom classification (**Haeckel**), four kingdom classification (**Copeland**) also came into existence.

(D) R. H. WHITTAKER :

R.H. Whittaker (1969) proposed a five-kingdom classification. The kingdoms defined by him were named as **Monera, Protista, Fungi, Plantae and Animalia**. The main criteria used by him for making classification are :-

- Cell structure (Complexity of cell)
- Thallus organisation (complexity of organism)/Body organization
- Mode of nutrition
- Reproduction/Life style
- Phylogenetic relationship



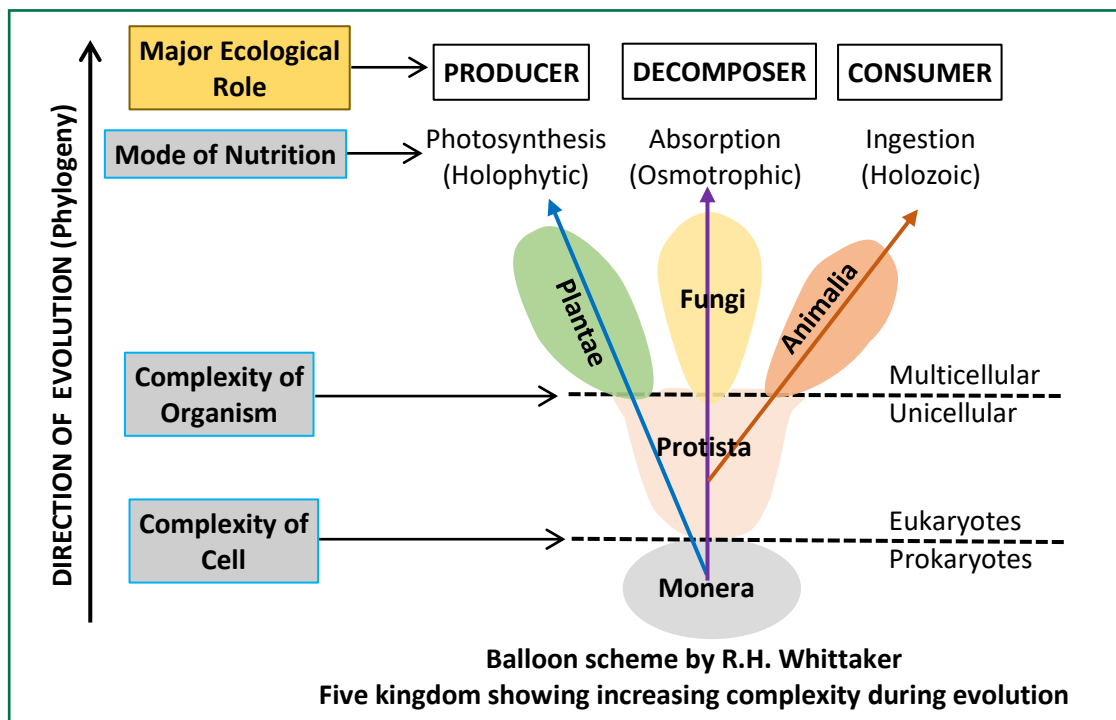


TABLE 2.1 Characteristics of the Five Kingdoms

Characters	Five Kingdoms				
	Monera	Protista	Fungi	Plantae	Animalia
Cell type	Prokaryotic	Eukaryotic	Eukaryotic	Eukaryotic	Eukaryotic
Cell wall	No cellulosic (Polysaccharide + amino acid)	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 (chemosynthetic and photosynthetic) and Heterotrophic (saprophyte/parasite)	Autotrophic (Photosynthetic) and Heterotrophic	Heterotrophic (Saprophytic /Parasitic)	Autotrophic Photosynthetic	Heterotrophic (Holozoic/ Saprophytic etc.)

FIVE KINGDOM :

- (i) **Monera** : All the prokaryotes (Eubacteria, Rickettsia, Actinomycetes, BGA, Archaeobacteria, *Mycoplasma*)
- (ii) **Protista** : All the Unicellular eukaryotes (Dinoflagellates, Diatoms, Euglenoids, Slime moulds (false fungi) and Protozoans)
- (iii) **Fungi** : True fungi
- (iv) **Plantae** : All the multicellular plants – Algae, Bryophyta, Pteridophyta, Gymnosperms, Angiosperms.
- (v) **Animalia** : All the multicellular animals

Note : (a) In five kingdom classification **virus**, **viroids**, **prions** and **lichens** are not mentioned.

(b) According to five kingdom classification. *Chlamydomonas* and *Chlorella* are placed in kingdom Protista.



BEGINNER'S BOX-1

TAXONOMIC CATEGORIES TO CARL WOESE

1. Chemosynthesis is mode of nutrition is found in kingdom :
 (1) Monera (2) Protista (3) Fungi (4) Plantae
BBC403
2. Which of the following is not mention in five kingdom classification :
 (1) Bacteria (2) Virus (3) Amoeba (4) Fungi
BBC404
3. According to five kingdom classification, multicellular heterotrophs are included in :
 (1) Three kingdom (2) One kingdom
 (3) Two kingdom (4) Three domain
BBC405
4. According to five kingdom classification, archaeobacteria belong to :
 (1) Archaea (2) Protista (3) Plantae (4) Monera
BBC406
5. According to R.H. Whittaker which kingdom includes producer, decomposer and consumer is :
 (1) Plantae (2) Fungi (3) Protista (4) Animalia
BBC407
6. Basis of two kingdom system was :
 (1) Cell wall (2) Nucleus (3) Cell membrane (4) Pigments
BBC408

7. Two kingdom classification was given by :

- (1) Linnaeus (2) Bentham and Hooker
(3) Theophrastus (4) Carl Woese

BBC409

8. Consider the following statements with respect to characteristic features of the kingdom.

- (i) In Animalia, the mode of nutrition is autotrophic.
(ii) In Monera, the nuclear membrane is present.
(iii) In Protista, the cell type is prokaryotic.
(iv) In Plantae, the cell wall is present.

Of the above statements, which one is correct ?

- (1) (i) only (2) (ii) only (3) (iii) only (4) (iv) only

BBC410

9. Analyse the following statements and identify the correct options given below:

- (I) Two kingdom system of classification did not distinguish between the eukaryotes and prokaryotes, unicellular and multicellular organism and green algae and fungi.
(II) The two kingdom classification used for a long time was found inadequate.

- (1) I a true, but II is false (2) I is false, II is true
(3) I and II are true (4) I and II are false

BBC411

10. Match the kingdom listed under column I with the characteristics give under column II choose the answer which give the correct combination.

Column-I Kingdom		Column-II Characteristics	
(A)	Animalia	(P)	Unicellular prokaryote
(B)	Plantae	(Q)	Multicellular heterotroph
(C)	Protista	(R)	Multicellular autotroph
(D)	Monera	(S)	Unicellular eukaryote

- (1) A-S, B-Q, C-R, D-P
(2) A-Q, B-R, C-S, D-P
(3) A-S, B-R, C-Q, D-P
(4) A-R, B-Q, C-S, D-P

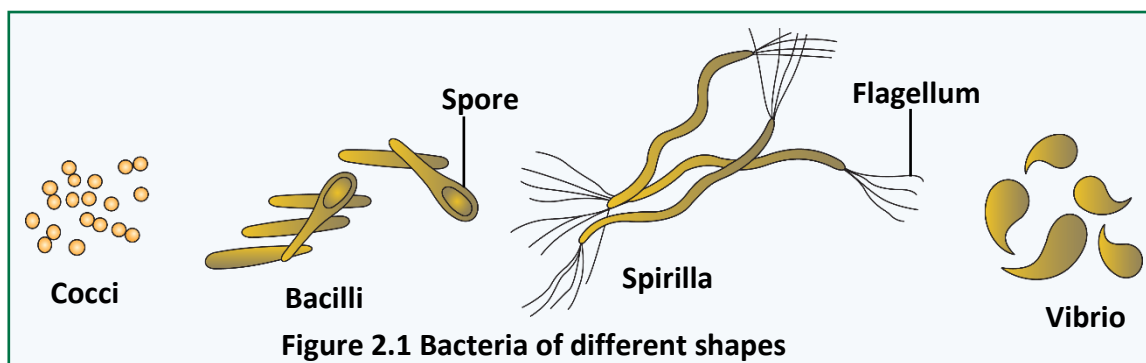
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03. KINGDOM – MONERA

- Bacteria are the sole members of the Kingdom Monera.
- They are the most abundant micro-organisms.
- 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 organisms as parasites.

(A) EUBACTERIA :**(i) Shape of Bacteria :**

- Bacteria are grouped under four categories based on their shape:
 - (a) The spherical Coccus (pl.: cocci) **e.g. *Streptococcus***
 - (b) The rod-shaped Bacillus (pl.: bacilli) **e.g. *Escherichia coli***
 - (c) The comma-shaped Vibrium (pl.: vibrio) **e.g. *Vibrio cholerae***
 - (d) The spiral Spirillum (pl.: spirilla) **e.g. *Spirillum***

**(ii) Motility in Bacteria :**

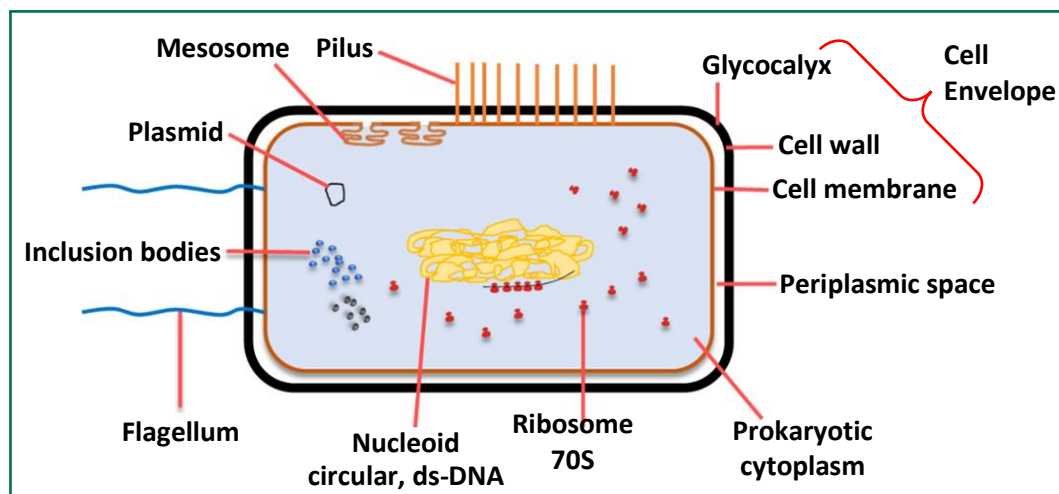
- Bacteria are motile as well as non-motile. Movement in bacteria takes place by means of flagella.
- Number and arrangement of flagella is called flagellation.
- Peritrichous – When flagella are found on the whole body of bacterium
e.g. *E.coli.*, *Salmonella typhi*

(iii) Pili (Sing. Pilus) :

- Bacterial cell wall is covered by numerous hair like structures called pili.
- **Pili are smaller than the flagella.**
- They are of two types (A) Longer pili, (B) Shorter pili.

- Longer pili are also known as '**F**' pili or '**sex**' pili. Longer pili occur in only donor (F^+ or male) bacteria and help in conjugation. These are absent in recipient bacteria or female.
- The shorter pili take part in attachment to rocks in streams and to the host tissue. These are also known as 'infective' pili or **Fimbriae**. These are found only in pathogenic bacteria.

(iv) **Structure of prokaryotic cell or a typical bacterial cell :**



- Though the bacterial structure is very simple, they are very complex in behaviour
- Bacterial cell has a chemically complex cell envelope. The cell envelope consists of a tightly bound three
- layered structure.

(a) Glycocalyx

(b) Cell wall

(c) Cell membrane

Although each layer of the envelope performs distinct function they act together as a single protective unit.

(a) Glycocalyx –

Capsule – Capsule protect bacteria from host immune system. Thick, non sticky, regular and tough layer.

Slime layer – Thin, sticky, irregular layer.

When bacteria are surrounded by capsule, called capsulated bacteria. Formation of capsule is performed by cell membrane. **Capsulated bacteria are mostly pathogenic.**

Capsule is made up of polysaccharides and polypeptides.

When the molecules of polysaccharides are very loosely arranged they form a thin and sticky layer, known as slime layer.

Glycocalyx protects the bacteria from W.B.C. and also helps in colony formation.

(b) Cell Wall –

Bacterial cell wall is rigid and made up of mainly **peptidoglycan or murein which is a type of muco-peptide**.

Gram (+) and Gram (–) bacteria:

In Gram (+) bacteria cell wall is single layered and thick. It is made up of peptidoglycan. Lipids are also present but in less quantity.

While in Gram (–) bacteria cell wall is double layered. Inner layer is thin and composed of peptidoglycan while outer layer is thick and made up of **lipopolysaccharide**. Some quantity of lipoproteins and phospholipids are also present in outer layer.

(c) Cell membrane or Plasmalemma or Plasma membrane –

This is the inner most layer.

Bacterial cell membrane is made up of **lipoprotein** like the eukaryotic membrane.

(d) Cytoplasm –

In bacterial cytoplasm membrane bound cell organelles viz. Mitochondria, Chloroplast

E.R., Lysosome, Golgi body, Microbodies are absent.

Bacterial cytoplasm does not show streaming or cyclosis.

(e) Cytoplasmic Structures –

• **Mesosomes –**

- Mesosome was discovered by F. James. Mesosome is a special membranous structure formed by the extension or infoldings or invaginations of plasma membrane into the cell. These extensions are in the form of **vesicles, tubules and lamellae**.
- These are functionally mitochondria like structures. Oxidative enzyme are found in mesosome.

Functions -

- They help in **cell respiration** and **cell wall secretion** processes by increasing surface area of the plasma membrane and enzymatic content.
- Help in **DNA replication and distribution** to daughter cells during cell division.

• **Storage granules/Inclusion bodies –**

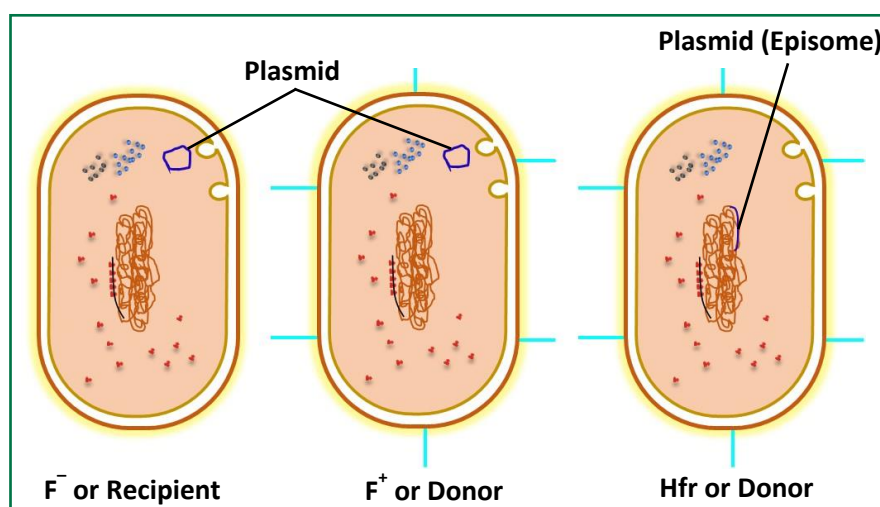
- **Glycogen granules** – They store carbohydrate
- **Volutin granules** – These are also known as metachromatic granules or phosphate granule.

- **Bacterial Chromatin material (Nucleoid) –**

- Nucleus of bacterial cell is called **Nucleoid or Genophore** or Incipient nucleus or fibrillar nucleus. Nuclear membrane and nucleolus are absent.
- True chromosomes are also absent in bacterial cells. Instead of true chromosome they contain a single false chromosome or prochromosome. It consists of a **double stranded circular naked DNA** (without histone) + Non-histone proteins. Non-histone proteins are polyamines. Nucleoid is connected to mesosome.
- Beside this DNA another small and circular DNA is also present in bacterial cell, which is called Plasmid. It is also known as **extra chromosomal or extranuclear or extra genomic genetic material**.

(The term 'plasmid' was given by **Lederberg**).

- Plasmids have the ability to replicate independently.
- Plasmids are of many types on the basis of their function or phenotypic character
- **F-plasmid (fertility factor) –** On the basis of presence or absence of 'F' plasmid, there are two types of bacteria.
 - (a) F^+ – Cells, carrying 'F' plasmid, act as donor and are called F^+ .
 - (b) F^- – Cells, lacking 'F' plasmid, act as recipient and are called F^- .
- When 'F' plasmid is attached with main DNA, it is designated as Episome and this type of cell is known as HFR cell. (HFR – Highly frequent recombinant cell)

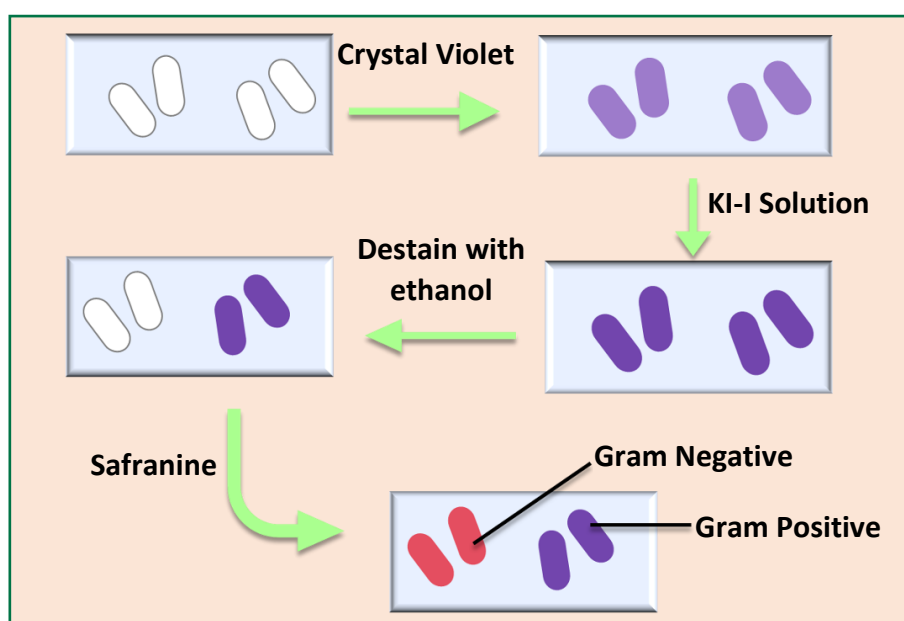


R-factor - Resistance to certain antibiotics.

(v) Staining of Bacteria :

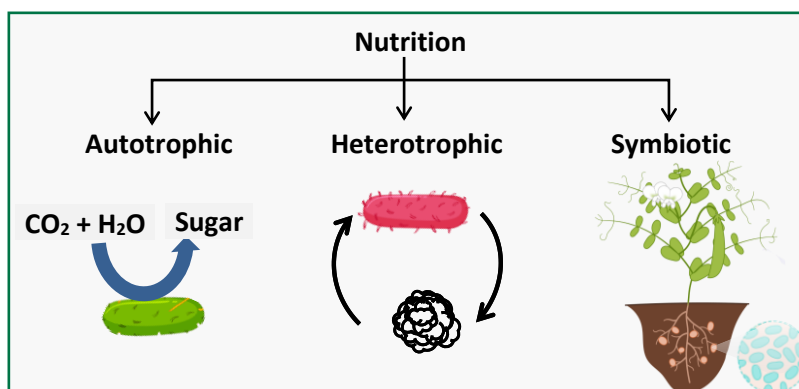
Gram Staining technique :

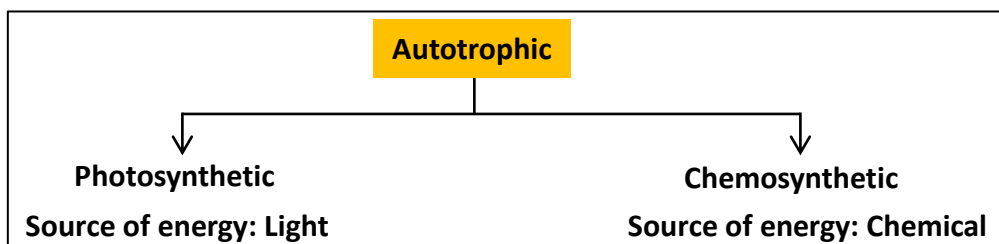
- First of all **H.C. Gram** differentiated bacteria on the basis of staining.
- In the first step of this method bacteria are stained with **Crystal violet** or gentian violet and then added KI solution.
- After staining, bacteria are washed with Acetone or **Ethyl alcohol**. After washing some bacteria retain the stain and some bacteria are decolourised.
- Bacteria which retain stain (violet or purple) are called **Gram(+)** and bacteria which decolourise are known as Gram(–). Gram(–) bacteria are counter stained by **safranine**.



(vi) Bacterial Nutrition :

- Bacteria as a group show the most extensive metabolic diversity. Most of the bacteria are heterotrophic but some are autotrophic. On the basis of nutrition bacteria are classified into following three categories.





(a) **Autotrophs :**

These bacteria use **light** or **chemical energy** for their own food synthesis. On the basis of source of energy autotrophs are of following two types

(i) **Photosynthetic autotrophs = Photoautotrophs = Phototrophs**

- These bacteria use light energy for food synthesis.
- In bacterial photosynthesis **H-donor is not water**, so they do not release oxygen during photosynthesis hence this is called **Non-oxygenic photosynthesis** *e.g.- Rhodospirillum*, purple bacteria and green sulphur bacteria.
- In bacterial cytoplasm many photosynthetic pigments are scattered.

Pigments –

- In purple bacteria (sulphur and non-sulphur) – **Bacteriochlorophyll 'a' & 'b'**.
- In green sulphur bacteria – **Bacteriochlorophyll 'a', Chlorobium chlorophyll** or **Bacterioviridin**.

(ii) **Chemosynthetic autotrophs = Chemoautotrophs = Chemotrophs**

- These are non-photosynthetic autotrophs i.e.; photosynthetic pigments are absent.
- They use chemical energy instead of light energy for food synthesis.
- These bacteria oxidise some **chemical compounds** and release energy which is used for food synthesis.

e.g. **Nitrifying bacteria** – They oxidise nitrogenous compounds and obtain energy.

Nitrite bacteria – Convert ammonia into Nitrite (*Nitrosomonas* & *Nitrococcus*)

Nitrate bacteria – Convert nitrite into nitrates (*Nitrobacter*)

Note : **Chemosynthetic bacteria play a great role in recycling nutrients like nitrogen, phosphorus, iron and sulphur.**

NCERT Question :

State two economically important uses of heterotrophic bacteria

(b) Heterotrophs :

Most of the bacteria are heterotrophic *i.e.*, they cannot manufacture their food.

They receive their own food from dead organic matter or living organism.

These are of following types

(i) Saprotrophic bacteria –

These bacteria obtain food from dead and decaying organic matter.

e.g. Bacillus vulgaris, Clostridium botulinum, Pseudomonas

(ii) Parasitic bacteria –

They obtain their food from living organism.

e.g. Mycobacterium leprae, Mycobacterium tuberculosis.

(c) Symbiotic Bacteria :

They form symbiotic relation with other organisms.

These bacteria convert atmospheric nitrogen into ammonia and then into nitrogenous compounds like Amino acids, NO_3 or salts of ammonia.

e.g. Rhizobium

(vii) Respiration :

On the basis of respiration bacteria are of two types

(1) Aerobic bacteria: They use oxygen in respiration. *e.g. Azotobacter*

(2) Anaerobic bacteria: They do not use oxygen in respiration. *e.g. Clostridium*

(viii) Reproduction :

- Reproduction leads to increase in number of individuals.
- Bacteria reproduce only by asexual reproduction but they also perform a primitive type of gene transfer from one bacterial cell to the other which is called **genetic recombination**.

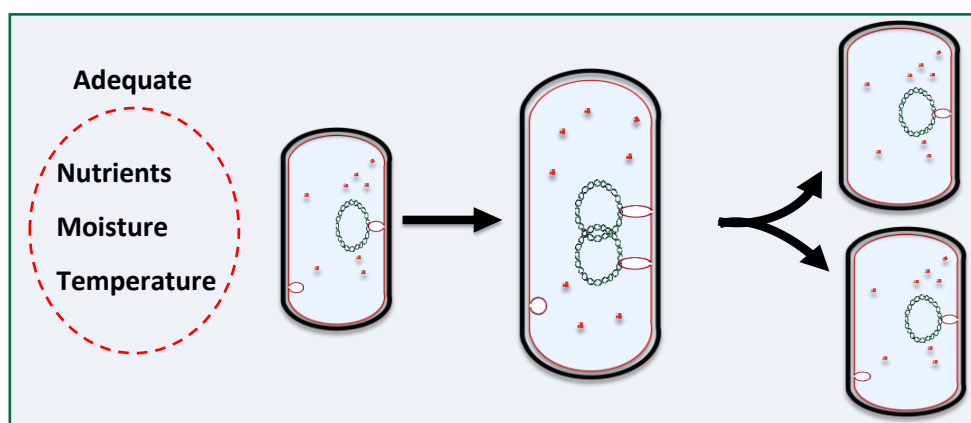
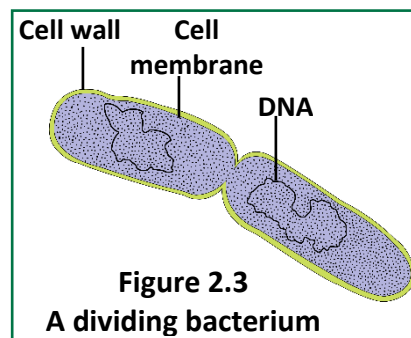
(a) Asexual Reproduction :

Following methods of asexual reproduction are found in bacteria.

(i) Binary fission :

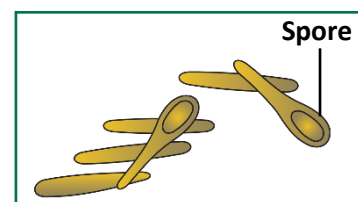
- This is the **most common method** of bacterial reproduction.
- First of all, DNA replication takes place in bacterial cell.

- Under favourable conditions bacterial cell divides into two cells due to formation of a septum (partition) in the centre of the cell.
- Each daughter cell grows into a new bacterium.
- Thus, the bacterial cell divides by amitosis which is a faster process than mitosis or meiosis.



(ii) By Endospore:

- Endospore formation occurs under unfavourable conditions.
- Only one endospore is formed in a bacterial cell.
- It is a highly resistant structure. **It is resistant to high temperature, radiations, antibiotics and chemicals.**
- Endospore have maximum resistant power due to presence of **Ca-dipicolinate** in wall.



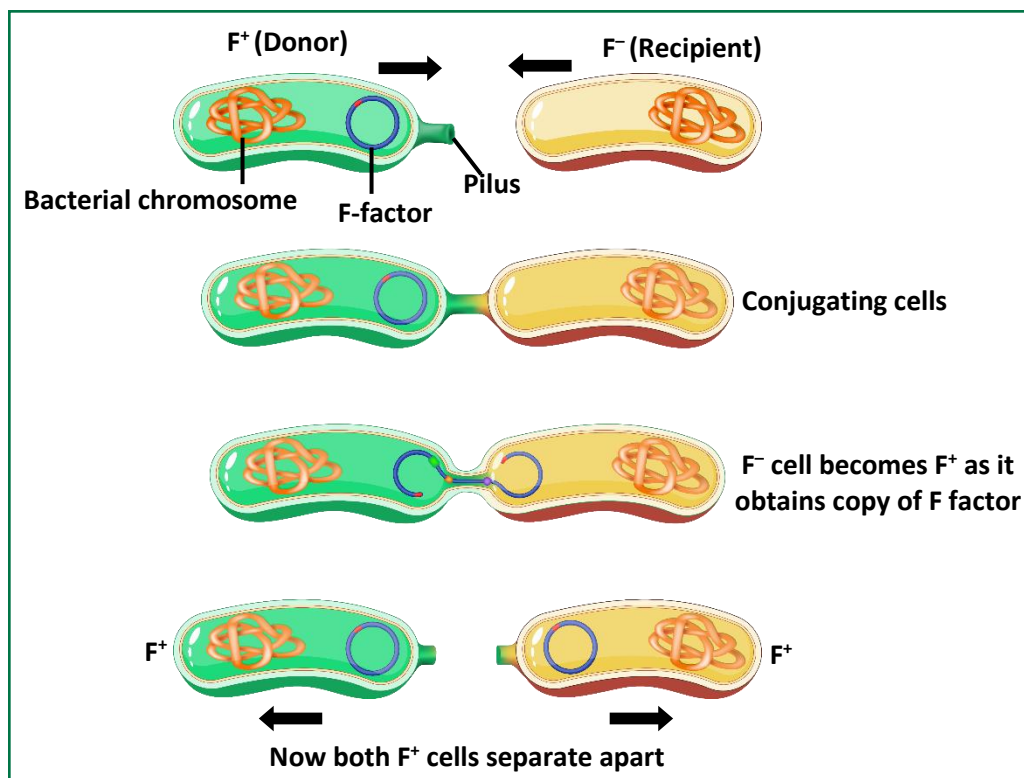
(b) Genetic Recombination :

(i) Conjugation:

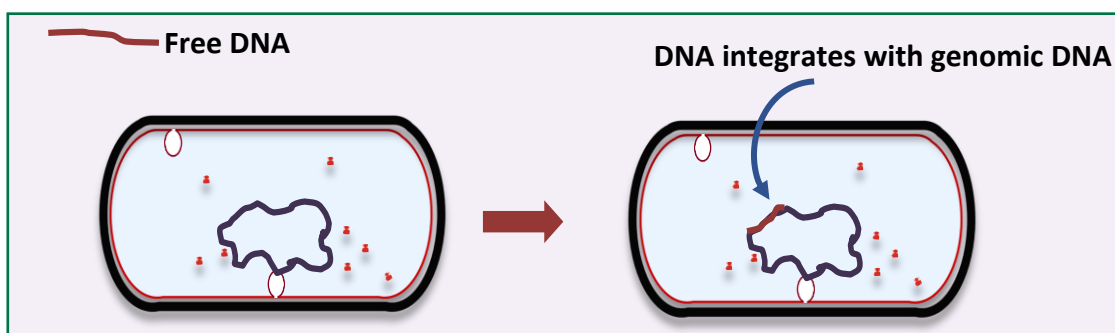
Gene transfer by physical contact between two bacterial cells.

Conjugation between F^+ and F^-

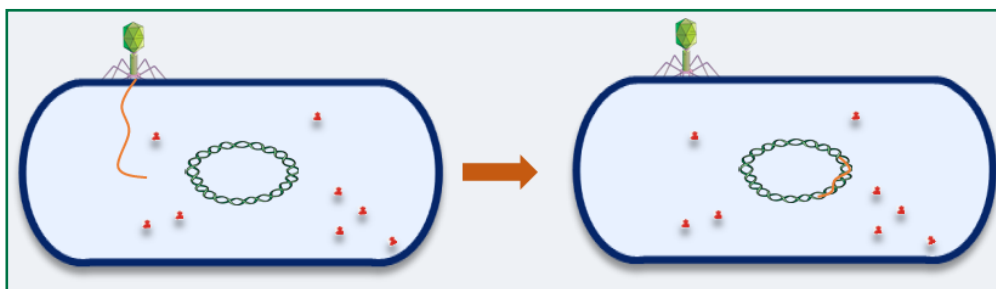
- First of all, donor cell is attached to recipient cell with the help of sex pili. Sex pili help in formation of conjugation tube.
- The 'F' factor now replicates and the replica moves to F^- , through conjugation tube.
- Both the cells are then separated. Due to transfer of 'F' factor F^- cell now becomes F^+ cell.

**(ii) Transformation:**

Transfer of genetic material from one bacterium to another bacterium through surrounding is called transformation.

**(iii) Transduction:**

When the gene transfer process between two different bacteria is carried out by virus (bacteriophage) called transduction.



(B) ECONOMIC IMPORTANCE OF BACTERIA :

Harmful Activities :

(i) Disease in Human beings :

Disease		Bacterium
Tuberculosis (T.B.)	–	<i>Mycobacterium tuberculosis</i>
Leprosy	–	<i>Mycobacterium leprae</i>
Tetanus	–	<i>Clostridium tetani</i>
Typhoid	–	<i>Salmonella typhi</i>
Cholera	–	<i>Vibrio cholerae</i>

(ii) Disease in Animals –

Anthrax	–	<i>Bacillus anthracis</i>
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(iii) Disease in plants

Citrus canker	–	<i>Xanthomonas citri</i>
Crown gall in many plants	–	<i>Agrobacterium tumefaciens</i>

Note : Plant pathogenic bacteria are mostly gram negative and non-spore forming bacteria.

(iv) Food poisoning –

Botulism – *Clostridium botulinum* – It is most lethal type of **food poisoning**. These bacteria survive in absence of O₂. These bacteria multiply in canned food. Their toxins damage the parasympathetic nervous system. It leads to paralysis of both smooth and striped muscles, resulting in immediate death.

Useful Activities :

(i) Dairy products -

Dairy products are formed with the help of bacterial fermentation.

Milk $\xrightarrow{\text{Lactobacillus (LAB)}}$ Curd

Note : *Lactobacillus lactis* (LAB/Lactic acid bacteria) increase **vitamin B₁₂ in curd**. LAB also help in checking the disease causing microbes in stomach.

(ii) Antibiotics -

Many antibiotic medicines are obtained from the bacteria.

For example, **streptomycin** is obtained from *Streptomyces griseus* (It is an actinomycetes)

(iii) Pollution indicating bacteria -

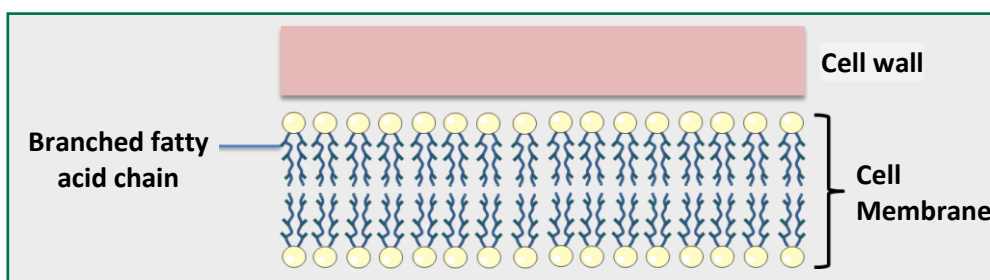
Water in which *E. coli* bacteria are present known as polluted water. Quality of water depends on number of *E. coli*. If *E. coli* are very much in no. the water will be highly polluted. So, the *E. coli* is known as pollution indicating bacteria.

(iv) Bacteria for genetic engineering -

e.g. *E. coli* and *Agrobacterium* → These are Gram (–) bacteria

(v) N₂ fixing bacteria - (a) Free living (b) Symbiotic**(C) ARCHAEBACTERIA (GROUP OF ANCIENT BACTERIA) :**

- Evolutionary they are primitive. They were the first to be born on our planet and they are present now days with their primitive characters. They are the "Oldest living fossils".
- **Mostly archaeobacteria are anaerobes.**
- Their cell wall is not made up of peptidoglycan like that of eubacteria. Their cell wall is made up of complex polysaccharides and complex polypeptide.
- Cell membrane of archaeobacteria is highly complex because of branched lipid chain.
- Due to complex cell wall and cell membrane **archaebacteria can survive in harsh habitat.**

**NCERT Question :**

State two economically important uses of archaeobacteria.

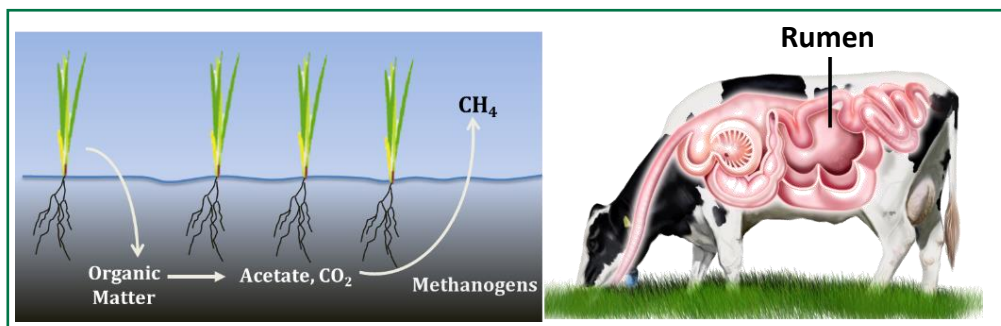
Archaeobacteria includes following bacteria :**(i) Methanogens :**

‘Methane producing bacteria’

(a) Methanogens are found in marshy area, gobar gas fermenter and produce methane.

e.g. *Methanobacterium*, *Methanococcus*, *Methanomicrobium*

- (b) Methanogens are found in the rumen of cattle and responsible for the production of methane (biogas).



(ii) Halophiles (“Halo”- Salt and “Philos”- like) :

- These archaeobacteria are found in **extreme salty areas**.
- Some halophiles have bacteriorhodopsin in their cell membrane, which absorbs suitable light radiations and produces ATP e.g. *Halobacterium*. Found in extreme **salty areas (20% w/v salt concentration)**.

(iii) Thermoacidophiles :

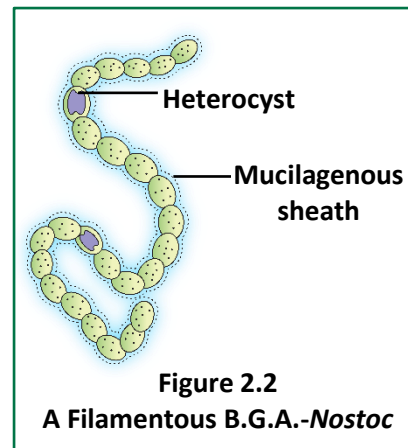
- These archaeobacteria are found at those places where temperature is **approx 80°C to 100°C** and medium is acidic. [pH = 2]
- They are found in **hot sulphur springs**. Hot water sulphur springs are found in the Himalayan region. e.g. *Thermophilus*, *Sulfolobus*

(D) CYANOBACTERIA (BLUE GREEN ALGAE) :

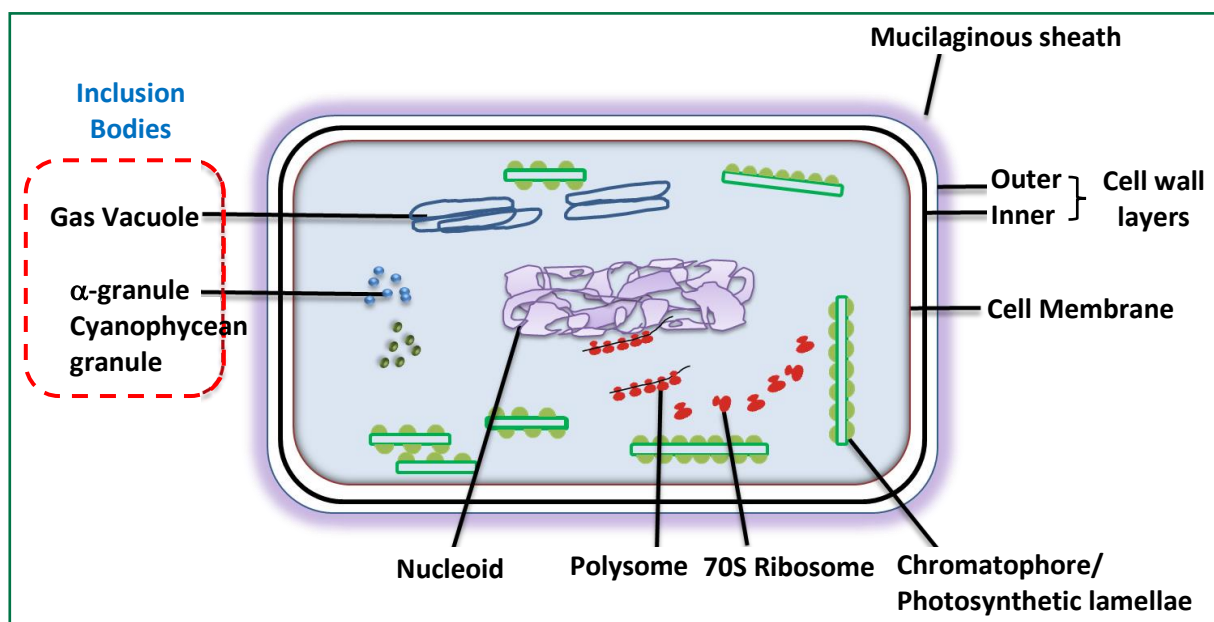
- They are included in Kingdom Monera, because blue green algae (B.G.A) are prokaryote.
- The name cyanobacteria was suggested by ICNB [International Code of Nomenclature for Bacteria] Cyanobacteria were the **first organism that produced O₂ on our earth**.
- Cyanobacteria are photosynthetic prokaryotes; however, they are also found as symbiont with some plants. e.g. *Cycas*
- In cyanobacteria membranous extensions into the cytoplasm are found called **chromatophores**.
- They have pigments for photosynthesis:
Chlorophyll 'a' – green, Carotenoids – yellow, C - phycocyanin – blue, C - phycoerythrin – red

Different forms of BGA or Cyanobacteria :

- (a) **Unicellular:** Some B.G.A. are unicellular *e.g.* *Spirulina* (*Spirulina* is an edible B.G.A. because it has large amount of proteins). It can be grown artificially in water tanks. It is a fodder for cattle.
- (b) **Colonial:** Some B.G.A. are found in colony *i.e.* cell colonies.
e.g. *Anabaena*, *Microcystis*
- (c) **Filamentous:** Some B.G.A. are filamentous. There are many cells arranged in a row to form a filamentous body. The filament of B.G.A. is known as trichome.
e.g. *Oscillatoria*, *Nostoc*



Structure of Cyanobacteria :



- (a) The structure of **B.G.A. is similar to Gram (–ve) eubacteria**. Because the cell wall of B.G.A. is bilayered. Outer layer is made up of lipopolysaccharides and the inner layer is made up of peptidoglycan.
- (b) B.G.A. are surrounded by a **mucilaginous membrane or gelatinous sheath** or envelope. This envelope is made up of mucopolysaccharides.
- (c) They do not produce flagellated structures in their life cycle.
- (d) **Inclusion bodies** : α-granules and gas vacuoules.

- (e) They have cyanophycean granules which store reserve food and nitrogen compounds.
- (f) **Gas vacuoles** are found in B.G.A. and purple and green photosynthetic eubacteria.
- (g) Special type of cells are found for nitrogen fixation in *Nostoc* and *Anabaena* known as Heterocyst. **Heterocyst is a thick walled, non-green cell.**

Note : Inclusion bodies are non-membranous structures.

- Nucleoid – ds circular naked DNA
- Ribosomes – 70s type

Nitrogen fixation :

- (a) Some of the B.G.A., can perform nitrogen fixation. They convert atmospheric nitrogen in to ammonia and then nitrogenous compounds like amino acids, nitrates. These nitrates increase the fertility of soil. Hence B.G.A. improves the fertility of soil by nitrogen fixation.
- (b) B.G.A. fix nitrogen in **two forms** :-

Symbiotic form and Asymbiotic or free living form

Symbiotic form	Free living form
e.g. <i>Anabaena</i> & <i>Nostoc</i> These B.G.A. form symbiotic association with many plants and performs nitrogen fixation. e.g. :- * In the leaves of <i>Azolla</i> * In the coralloid roots of <i>Cycas</i> <i>Azolla</i> → If <i>Azolla</i> is grown with rice, than the production increases up to 50% [because <i>Anabaena</i> are found in the leaves of <i>Azolla</i>]	e.g. <i>Anabaena</i>, <i>Nostoc</i> Some B.G.A. are found free living in water and soil and perform nitrogen fixation. <i>Aulosira</i> → This.B.G.A. is found in plenty in paddy fields. This B.G.A. performs nitrogen fixation due to which the production of rice is increased. <i>Oscillatoria</i> = also fix N₂ in paddy fields.

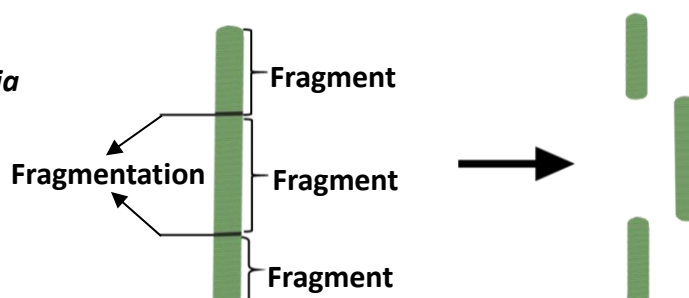
Note : Special type of cells are found for nitrogen fixation in ***Nostoc* and *Anabaena*** known as **Heterocyst**. Heterocyst is a thick walled, non-green cell.

Heterocyst does not perform photosynthesis like other vegetative cells.

Reproduction :

BGA reproduce by two methods:

- (1) Binary fission *e.g. Spirulina*
- (2) Fragmentation: *e.g. Oscillatoria*



Useful activities:

- They provide fertility to soil by nitrogen fixation.
- *Spirulina* is a very good source of protein.
- Some **BGA are used as green manure**.
- Some species of *Oscillatoria* secrete toxins, which inhibits the growth of mosquito larva in water

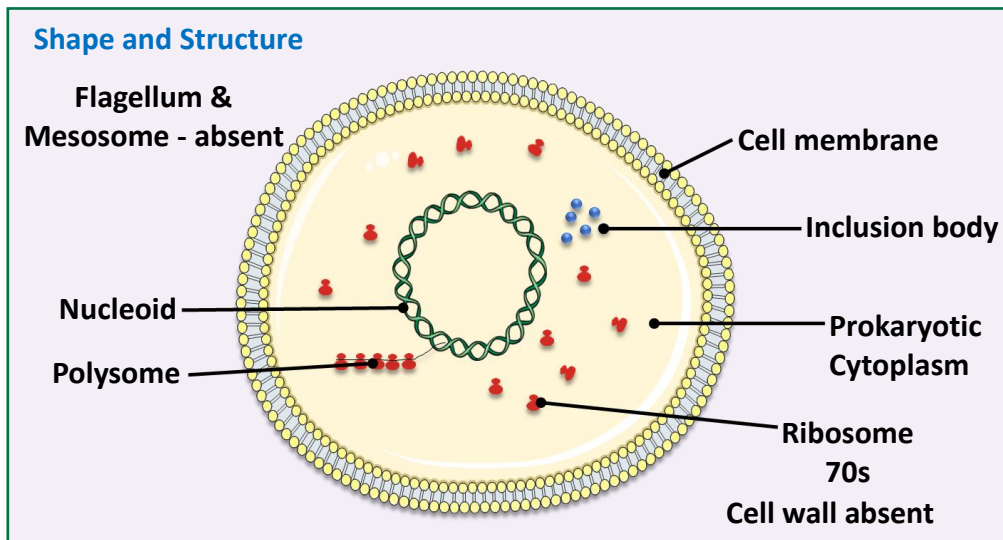
Harmful activities:

- Water bloom
- BGA which grow in water tanks, they damage them also.



(E) MYCOPLASMA :

- Discovered by E. Nocard and R. Roux and were designated as **PPLO (i.e. Pleuropneumonia like organism)**.
- Mycoplasmas are unicellular, smallest prokaryotic organisms. The diameter of cell varies from $0.1\mu\text{m}$ to $0.3\mu\text{m}$.
- Cell membrane is made up of lipoprotein. Both DNA (double stranded DNA, mainly circular) and RNA (ssRNA) are present.
- They are cell wall less hence, they exhibit pleomorphism and thus called '**Joker of microbiology**'.
- Osmotrophic mode of nutrition (absorption of nutrients by osmosis) is found in Mycoplasma.
- They are **resistant to penicillin antibiotics**, as penicillin acts on cell wall.
- They are sensitive to tetracycline & chloramphenicol that act on metabolic activities.
- **Most of the species of Mycoplasma can survive without oxygen.**
- Species of Mycoplasma are saprophyte or parasite.



Reproduction in mycoplasma:

- Most common method of reproduction in Mycoplasma is Binary fission.

Diseases :

Plant disease: Aster yellow disease of sunflower.

Animal disease: Bovine pleuropneumonia



Aster yellow of sunflower

★ Golden Key Points ★

- The cytoplasm of prokaryotes lack membrane bounded cell organelles.
- Cyanobacteria are gram –ve, photosynthetic, oxygenic monera (prokaryotes).
- Though the bacterial structure is very simple, they are very complex in behaviour, because they are both autotroph (Phototroph and Chemotrophs) and heterotrophs. (Parasites, Saprophytes and Symbionts).
- As a group bacteria show most extensive metabolic diversity.
- Cell membrane of archaebacteria has branched lipid chain.
- In some bacteria their body is filament or fungi like (mycelium), so they are also called filamentous **bacteria** or **actinomycetes** or **mycobacteria**. These bacteria are very important for us, as they are used in making antibiotics. The cell wall of actinomycetes contains mycolic acid.
e.g. Streptomyces, Mycobacterium, Beggiatoa, Frankia.
- **Barophilic prokaryotes** – Prokaryotes which grow and multiply in very deep marine sediments.
- The richest source of bacteria is soil. Hundreds of bacteria are present in a handful of soil.
- Teichoic acid is an organic acid present in cell wall of Gram (+ve) bacteria.



BEGINNER'S BOX-2

KINGDOM MONERA

1. The bacteria which are associated with some plant roots and fix atmospheric nitrogen are :
 (1) *Azotobacter* (2) *E. coli* (3) *Rhizobium* (4) *Pseudomonas*
BBC413
2. In paddy field blue green algae are grown :
 (1) For medicinal use (2) To increase soil fertility
 (3) To serve as food for fishes (4) To conserve water
BBC414
3. The digestive tracts of ruminants contain :
 (1) Halophilic bacteria (2) Methanogens
 (3) Thermoacidophile bacteria (4) *Mycoplasma*
BBC415
4. Archaeobacteria differ from eubacteria in one of the following aspects :
 (1) Their cell wall lack peptidoglycan
 (2) They tolerate extreme environment
 (3) They have unique cell membrane with branched lipid chain
 (4) All of these
BBC416
5. Crown galls in plants is caused by a bacterium which is most widely used in genetic engineering is:
 (1) *E. coli* (2) *Agrobacterium*
 (3) *Pseudomonas* (4) *Nitrosomonas*
BBC417
6. Which of the following may be used in the reclamation of soil :
 (1) *Mycoplasma* (2) Methanogen (3) *Nostoc* (4) *E. coli*
BBC418
7. Murein is found in the cell wall of :-
 (1) Diatoms (2) Cyanobacteria (3) Archaea (4) *Mycoplasma*
BBC419
8. Which of the following is first oxygenic photosynthetic organism :
 (1) Green algae (2) Red algae
 (3) Blue-green algae (4) Golden algae
BBC420
9. Teichoic acid is present in :
 (1) Gram +ve bacteria (2) Gram -ve bacteria
 (3) *Mycoplasma* (4) Blue green algae
BBC421
10. Blue green algae can photosynthesize due to presence of :-
 (1) Heterocyst (2) Chloroplast
 (3) Chromatophore (4) Leghaemoglobin
BBC422

11. Which of the following group consists of only ingestive organisms ?

- (1) Monera (2) Protista (3) Fungi (4) Animalia

BBC423

12. How many kingdoms were included in Domain Eukarya?

- (1) Two (2) One (3) Four (4) Six

BBC424

13. **Assertion :** Mycoplasma show resistance against some antibiotics such as penicillin.

Reason : Cell membrane of mycoplasma is made up of lipoprotein.

In the light of the above statements, choose the correct answer from the options given below:

- (1) Both Assertion and Reason are correct but Reason is not the correct explanation of Assertion.
 (2) Assertion is correct but Reason is not correct.
 (3) Assertion is not correct but Reason is correct.
 (4) Both Assertion and Reason are correct and (R) is the correct explanation of Assertion.

BBC425

14. Which of the following statements regarding Blue green algae are correct ?

- (i) Cyanobacteria have chlorophyll-a similar to green plants
 (ii) All BGA have heterocysts and can fix atmospheric nitrogen
 (iii) They form blooms in polluted water bodies
 (iv) *Nostoc* and *Anabena* are photoautotrophs

- (1) (i), (ii) & (iii) (2) Only (ii) (3) (i), (iii) & (iv) (4) (ii), (iii) & (iv)

BBC426

15. Match the following column correctly :

Column-I		Column-II	
(a)	Mesosome	(i)	Protect the bacteria from WBC
(b)	Glycocalyx	(ii)	DNA replication & cell division
(c)	Nucleoid	(iii)	False chromosomal coiled region
(d)	Phosphate granules	(iv)	Storage reservoir for phosphate

(1) a–ii, b–i, c–iii, d–iv

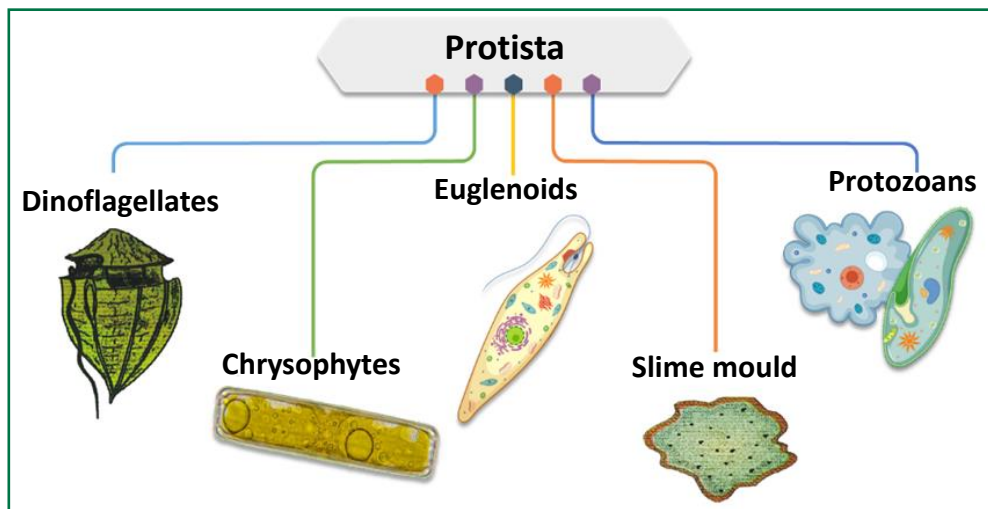
(2) a–i, b–ii, c–iii, d–iv

(3) a–ii, b–iii, c–iv, d–i

(4) a–iv, b–i, c–iii, d–ii

BBC427

04. KINGDOM – PROTISTA



- All the organism included in Protista are **unicellular eukaryotes**. *i.e.* the structure of all protists is similar to eukaryotic cell.
- Members of Protista are primarily aquatic.
- Being eukaryotes, the protistan cell body contains a well-defined nucleus and other membrane-bound organelles. Some have flagella or cilia.
- The members of Protista have characters of plants, animals and fungi, hence **the boundary lines of this kingdom are not well defined**.
- Some protists have cell wall around them, which is **made up of cellulose**. Beneath cell wall, cell membrane is present. Cell membrane is made up of lipoprotein.
e.g. Dinoflagellates, Diatoms
- Some protists do not have cell wall, they are surrounded by cell membrane, which surrounds all the cell organelles. **e.g.** Euglenoids, Slime moulds, Protozoa

Nutrition :

- Mode of nutrition in protists is of different types
- Holophytic or Photosynthetic:** They prepare their own food by photosynthesis.
 - Holozoic:** Some protists have holozoic mode of nutrition, which is similar to animals *i.e.* food is first ingested (intaken) and then digested.
 - Osmotrophic or Absorptive:** Food is first digested and then ingested in this mode of nutrition. Some protists obtain their food from dead organic substances. These protists secrete some extracellular enzymes.

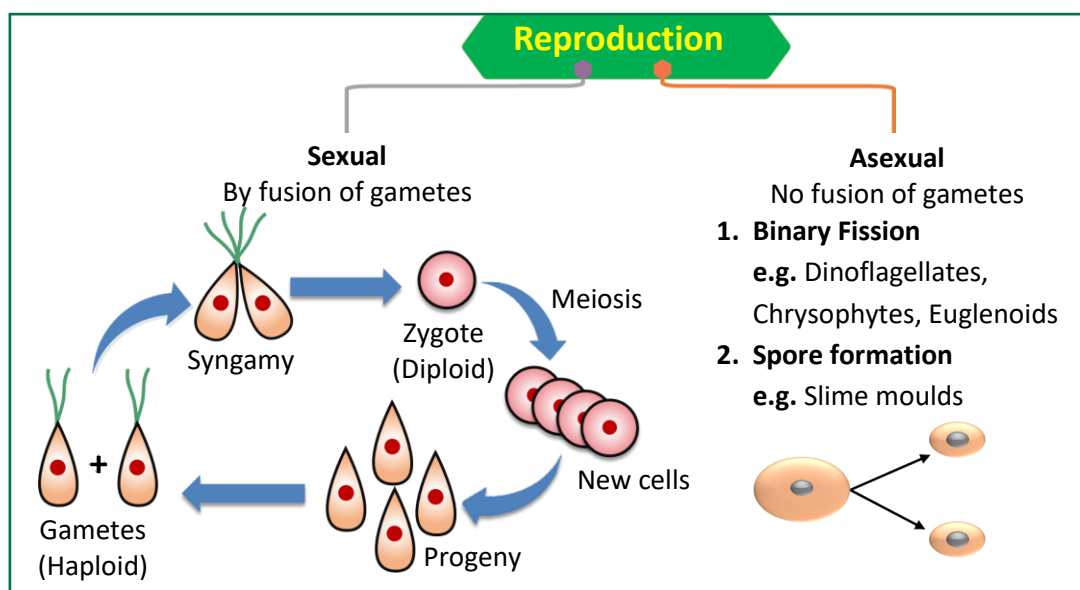
These enzymes convert the complex organic substances into simpler substances.

Now these simple substances can be easily absorbed through the body surface. If food is absorbed from livings, it is parasitic and if from dead organic matter it is saprophytic mode of nutrition.

(d) **Mixotrophic:** Some Protists have more than one type of nutrition *e.g.* *Euglena*.

Reproduction :

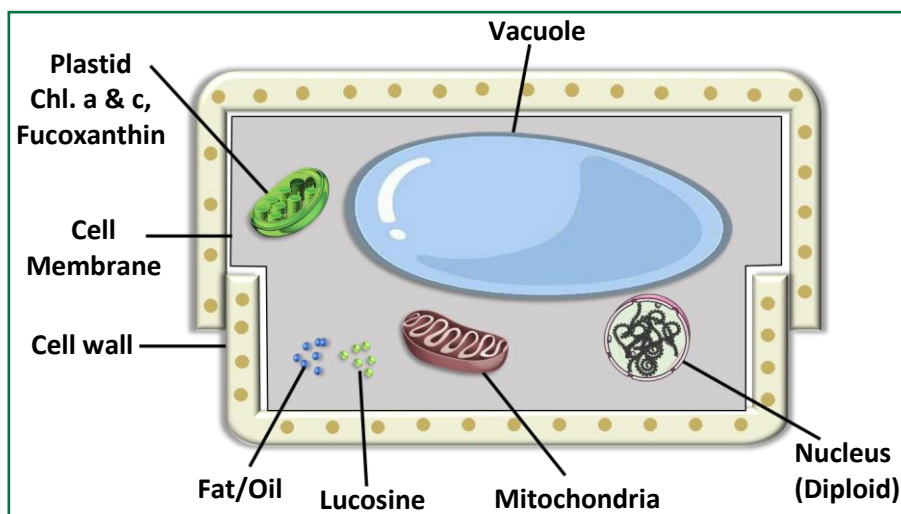
- Protists reproduce asexually and sexually by a process involving cell fusion and zygote formation.



(A) CHRYSOPHYTES :

- This group includes **diatoms and golden algae (desmids)**. They are found in fresh water as well as in marine environment. **Diatoms are also known as pearls of oceans.** *e.g.* *Navicula*

Structure :



- They are found in different shapes such as circular, rectangular, triangular, elongated and boat shaped.

NCERT Question :

What is the nature of cell-walls in diatoms?

- The cell wall(shell) of diatoms is made up of cellulose in which **silica particles** are embedded in at many places. Due to which the cell wall appears to be made up of silica. This silicated cell wall is called "**shell**" or "**frustule**".
- Their cell wall is made up of two halves, which are arranged like the lids of soap box.
- Their cell wall have silica in very large quantity. Due to this reason their cell wall is hard. The cell wall does not get destroyed after their death so at the bottom of sea, very huge rocks of dead diatoms are formed which are known as "**diatomite**" or "**diatomaceous earth**" or "**keiselgurh**".
- Diploid nucleus is present in Diatom.
- Diatoms have pigments **Chlorophyll 'a', Chl 'c', and xanthophyll (fucoxanthin)**. Due to these pigments they appear golden coloured.
- They are **chief, producers in the ocean** due to very high number of them in oceans.
 - (i) **Stored food** – Leucosin (Chrysolaminarin) & fats (Oil).
 - (ii) **Movement** – They are immotile, because flagella are absent in them. They float passively on the surface of water (Plankton) due to low molecular weight stored fats.

Reproduction :

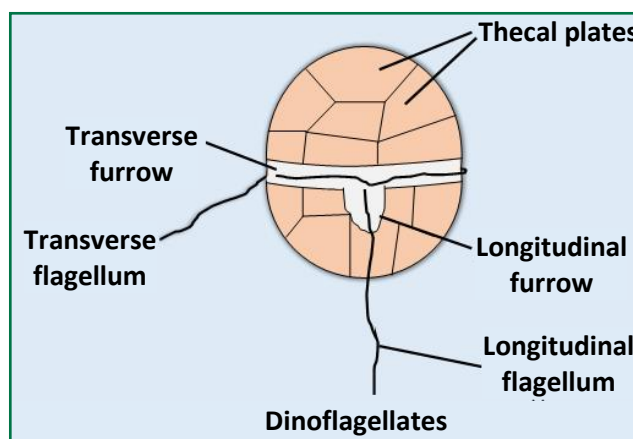
- (a) **Mainly asexual** – Binary fission.
- (b) **Sexual reproduction** – Very rare - by gametic meiosis.

(B) DINOFLAGELLATES :**Division – Pyrophyta :**

- Dinoflagellates are mainly marine.
- Dinoflagellates are haploid
- They are found on the surface of water.
- They appear yellow, green, brown blue or red depending on the main pigments present in their cells.
- In Dinoflagellates, the nutrition is mainly photosynthetic. *e.g. Noctiluca, Gonyaulax*

Structure :

- Their cell wall is divided into plates, which is made up of cellulose.
- **Dinoflagellates have two flagella - one is transverse and other is longitudinal.**
- Dinoflagellates show a special type of movement which is like whirling whips, therefore they are called 'whirling whips'.
- Dinoflagellates are yellow-brown or golden brown in colour. These colours of Dinoflagellates are due to the pigments present in them - Chlorophyll 'a', Chl. 'c' and Xanthophylls.
- They have **starch as stored food**.

**Reproduction :**

- (a) Mainly Asexual – Binary fission.
- (b) Sexual reproduction is very rare in them.

NCERT Question :

Find out what do the terms 'algal bloom' and 'red-tides' signify.

Some facts:

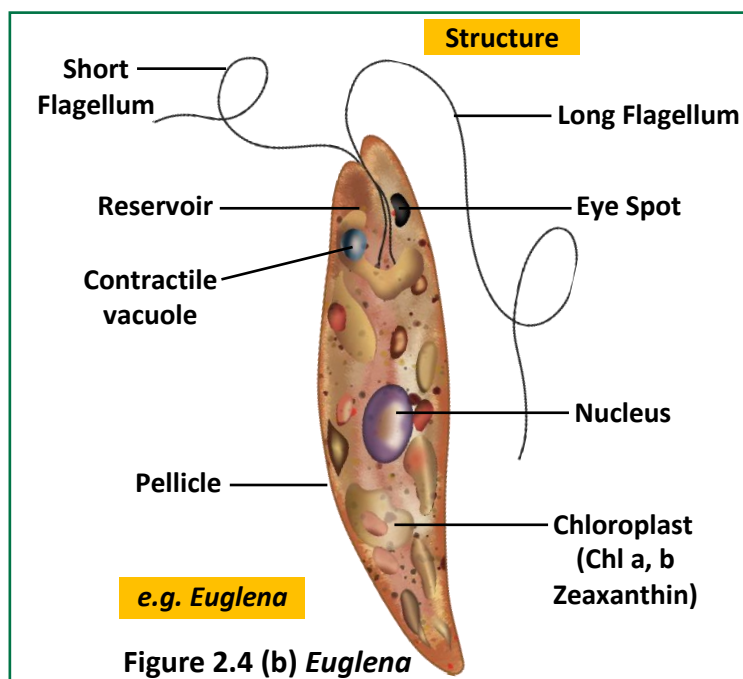
- (a) **Dinoflagellates** (e.g. - *Noctiluca*, *Gonyaulax* show '**bioluminescence**' due to presence of photogenic granules in cytoplasm, so these dinoflagellates are also known as 'night light'. Also, knowns "fire algae" because they appear as glowing light due to bioluminescence.
- (b) ***Gonyaulax*** spreads on the surface of sea water, through rapid multiplication due to which the sea water appears red. It is called **red tide**. It is also responsible for water bloom.
- (c) Both *Gymnodinium* & *Gonyaulax* **secrete toxins, which can cause paralysis in human beings**. Humans acquire these toxins through food chain. These toxins also affect the marine animals.

NCERT Question :

What are the characteristic features of Euglenoids?

(C) EUGLENOIDS :**Division – Euglenophyta :**

- Previously euglenoids were placed in plant kingdom due to their photosynthetic ability. But due to the absence of cell wall and animals like nutrition some scientists placed them in animal kingdom. But now according to five kingdom classification they are included in Protista.



- They are found as free-living organisms in fresh water lakes, ponds, etc. But sometimes they are also found in damp soil and brackish water.
- Though they are **photosynthetic in presence of sun light**, when deprived of sunlight they behave like heterotrophs by preying on other smaller organisms. **e.g. Euglena**

Structure :

- They are unicellular, cell wall is absent around them. They are surrounded by a cell membrane which is made up of lipoprotein and this cell membrane is covered with pellicle. **Pellicle is mainly made up of protein and it is elastic in nature.**
- At the anterior end of Euglenoids, a cavity is present, which is known as reservoir. Flagellum is originated from the base of reservoir. Euglenoids have **only one functional flagellum and one non-functional flagellum**. One eye spot is present at anterior position.
- They have a contractile vacuole. These contractile vacuoles help in osmoregulation.
- Euglenoids have a haploid nucleus and chloroplast.

Chloroplast has following pigments :

Chl. 'a' , Chl. 'b' and Xanthophyll - These pigments are identical to higher plant

Stored food - Paramylum and fat.

Reproduction - Asexual reproduction by longitudinal binary fission.

(D) SLIME MOULDS :

- These organisms develop a **slimy mass at the time of their vegetative phase** therefore they are called slime moulds. They are also called false fungi.

- Slime moulds are saprophytic found on decaying twigs and leaves engulfing organic material, so they also show phagotrophic mode of nutrition.

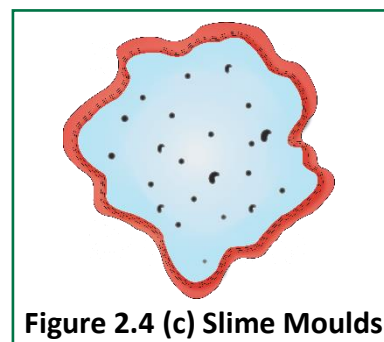
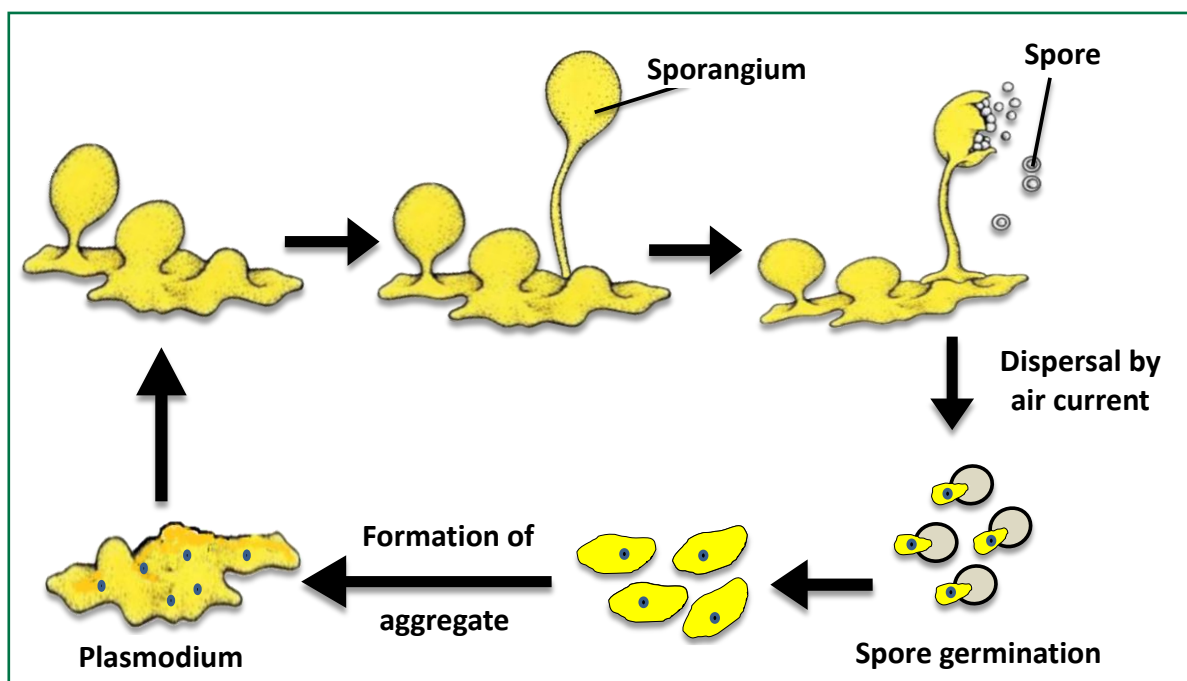


Figure 2.4 (c) Slime Moulds

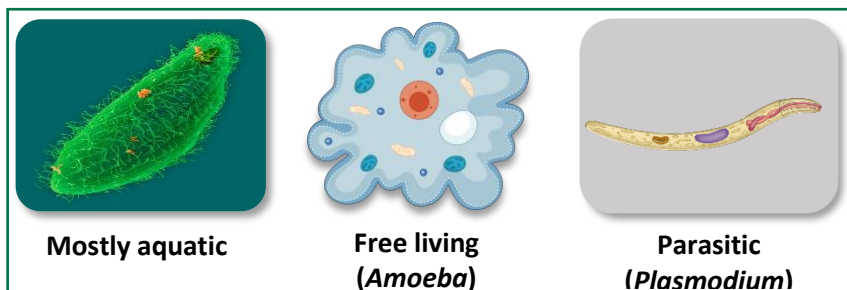
- Under suitable conditions they form an aggregation which may grow and spread over several feet called **plasmodium**. During unfavourable conditions plasmodium forms fruiting bodies, which bear spores at their tip. The **spores possess true walls**. They are extremely resistant and survive for many years, even under adverse conditions. The spores are **dispersed by air current**. e.g. *Physarum*



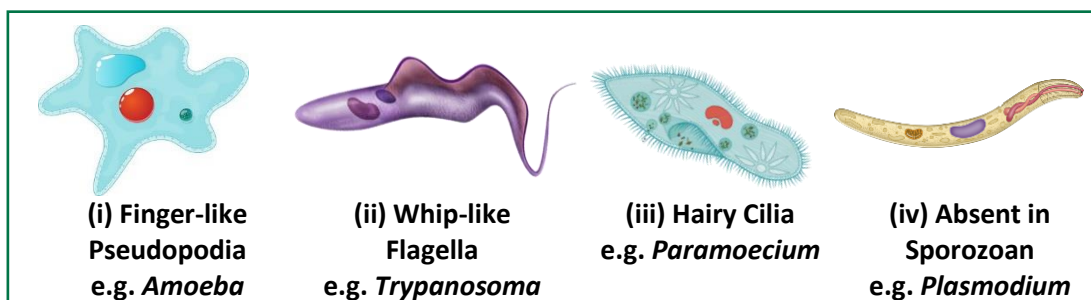
(E) PROTOZOANS :

- Includes unicellular eukaryotes
- One celled body performs all the biological activities like multicellular animals.

Microscopic :



- Body level of organisation is protoplasmic level. Few show nuclear dimorphism.
e.g. *Paramoecium*.
- Locomotory structures.



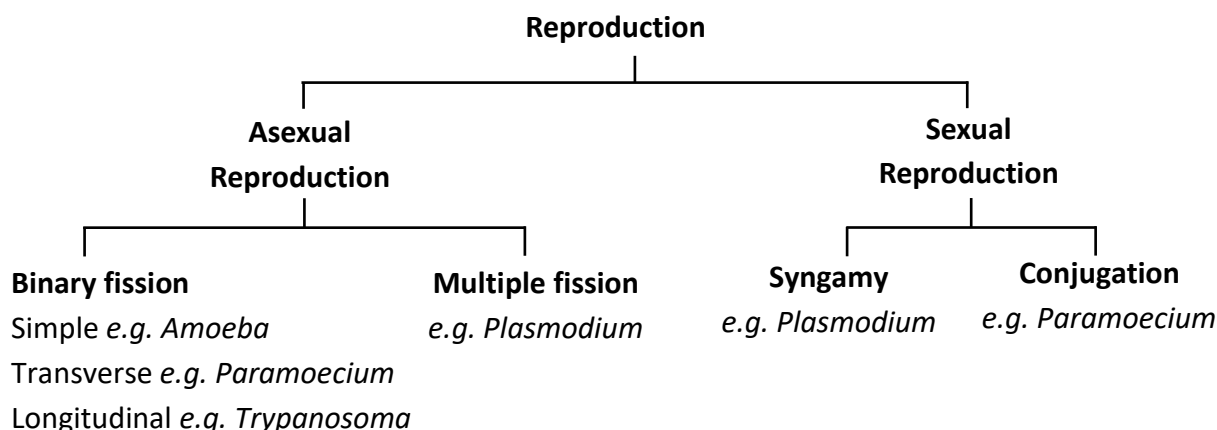
- **Digestion** : Nutrition in Protozoans is mainly holozoic (*Amoeba*) and Parasitic (*Plasmodium*). Digestion is intra cellular takes place in food vacuole.
- Holozoic nutrition is the process of **nutrition** that takes place in organisms that take solid or liquid food inside their body. *Amoeba* follows holozoic nutrition.

Steps of holozoic nutrition

- | | |
|------------------|-------------------|
| (i) Ingestion | (ii) Digestion |
| (iii) Absorption | (iv) Assimilation |
| (v) Egestion | |

- Respiration and excretion take place by general body surface.
- Some excretion may occur through contractile vacuole. Nitrogenous waste is Ammonia.
- Some fresh water protozoans get rid of excess water through contractile vacuole by the process known as Osmoregulation.

Reproduction :



Amoeboid protozoans :

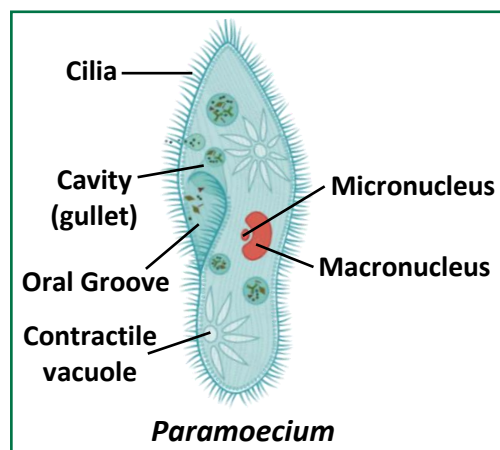
- Live in fresh water , sea water or moist soil.
- Move and capture their prey by putting out pseudopodia (false feet) as in *Amoeba*.
- Marine forms have silica shells on their surface.
- Some of them such as *Entamoeba* are parasites.

Flagellated protozoans :

- The members of this group are either free-living or parasitic.
- They have flagella.
- Example: *Trypanosoma*.
- The parasitic forms cause diseases like sleeping sickness.

Ciliated protozoans :

- These are aquatic, actively moving organisms because of the presence of thousands of cilia.
- They have a cavity (gullet) 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.
e.g. *Paramecium*

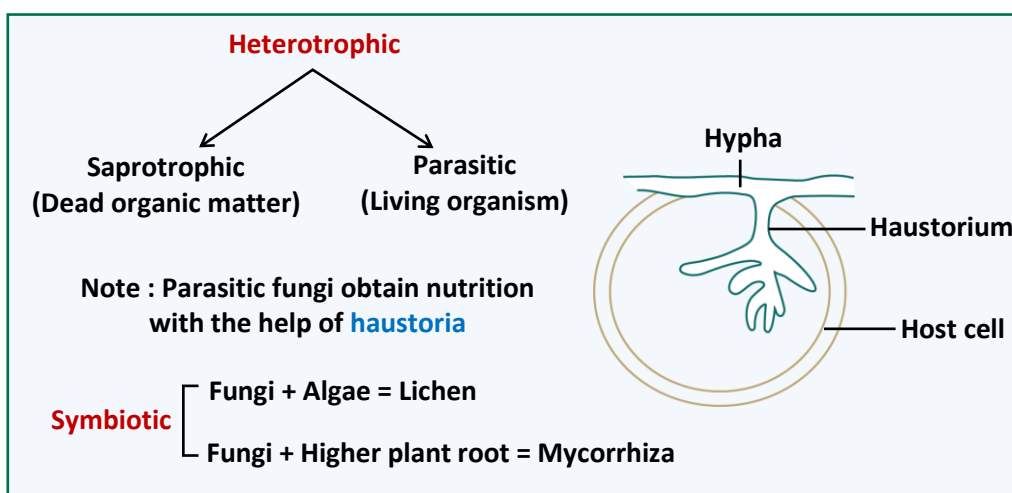


Sporozoans :

- This includes 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.

05. KINGDOM – FUNGI

- The fungi or mycota is a unique kingdom of heterotrophic organisms.
- Members of this kingdom are also called fungi.
- They show a **great diversity in morphology and habitat**.
- They can be seen in form of moulds on bread, butter, leather, pickle, rotten fruits (orange rotting) and vegetables or as parasites in plants (white spot on mustard leaves) and animals.



- Fungi prefer to grow in warm and humid places so we keep food in refrigerator, which prevent food from going bad due to bacterial or fungal infections. Fungi do not have chlorophyll and chloroplast.

NCERT Question :

Give a comparative account of the classes of Kingdom Fungi under the following :
Mode of nutrition

On the basis of source of food fungi are of two types :

- Saprotrophic:** These fungi obtain their food from dead organic matter such as bread, rotting fruit, vegetable and dung.
- Parasitic:** They obtain their food from living organism, such as plants, animals and human beings. Nutrition is absorptive in fungi.
- Symbiotic**– in association with algae as lichens and with roots of higher plants as mycorrhiza.
 - A very few fungi are unicellular or non-mycelial **e.g.** Yeasts and most of the fungi are mycelial i.e. their body is made of mycelium. Which is composed of hyphae or filaments.

- Cell wall of fungi is mainly made of **chitin which is also called fungal cellulose** but actually it is not cellulose.
- Cell wall also have some quantity of polysaccharides, proteins, lipid and cellulose.
 - Cell wall of the members of class-oomycetes is mainly made up of cellulose.
 - In fungi the **stored food is in the form of glycogen and oil.**

NCERT Question :

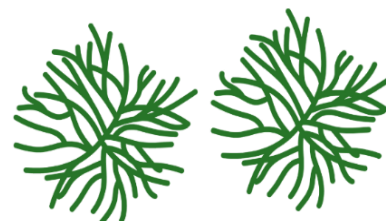
Give a comparative account of the classes of Kingdom Fungi under the following:

Mode of reproduction

Reproduction :

(a) Vegetative reproduction : It occurs by different processes.

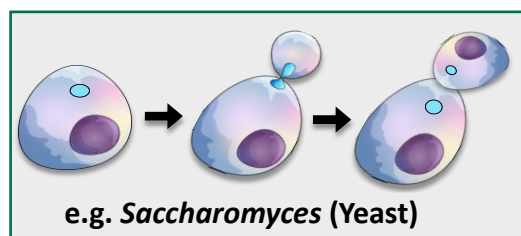
- Fragmentation** - Sometimes the fungal filament (mycelium) breaks into small pieces due to any reason. Now these pieces form a new fungal filament and start working like normal filament.



- Budding** – Some times a bud is formed in non-mycelial fungi. Now this bud, separates from the mother cell and functions as young fungi.

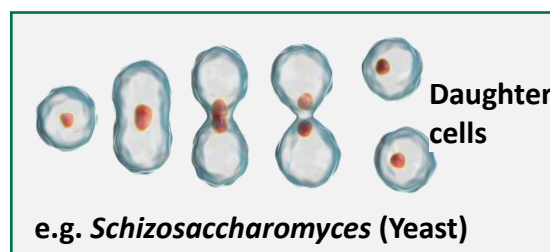
At the time of separation of bud from its mother cell or fungi, the nucleus of mother cell divides mitotically into two parts. Out of these two nuclei, one remains with in the mother cell while the other migrates to the bud.

e.g. Saccharomyces (Yeast)



- Fission** - Sometimes the fungal cell divides into two parts. Its nucleus also divides into two parts. Each cell receives a nucleus and starts working as a new cell.

e.g. Schizosaccharomyces (Yeast)



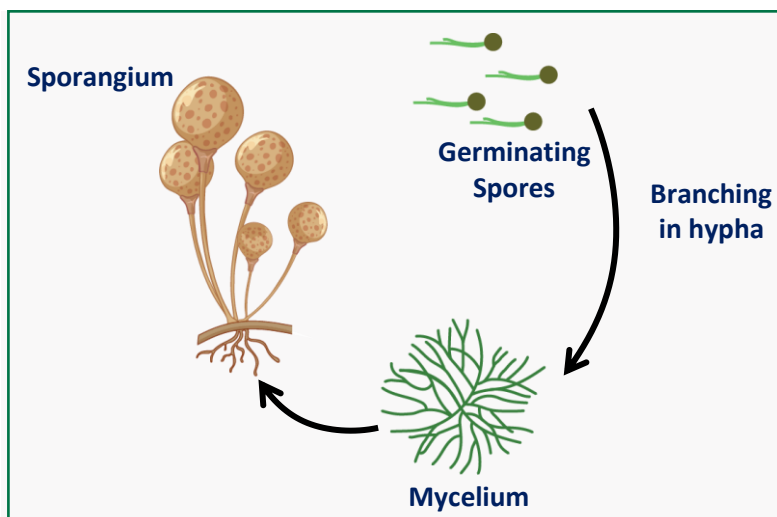
(b) Asexual reproduction :

Asexual reproduction takes place by the formation of different types of spores.

Spores are of following types

- (i) **Sporangiospores** - They are formed in sporangia. Sporangium is formed at the tip of fungal filament.

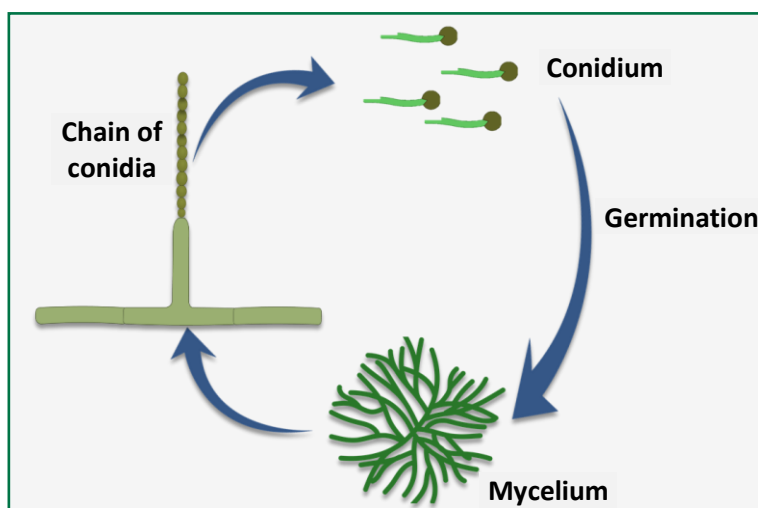
The fungal filament on which sporangium is formed is called as sporangiophore. Numerous spores (sporangiospores) are present in the sporangium, they come out by rupturing of sporangia and germinate to form fungal filaments. These spores are **endogenously** produced in sporangium.



Sporangiospores are of Two types :

1. **Zoospore** : When the sporangiospores formed in sporangia are **flagellated and motile**, then they are called as zoospores. In this condition the sporangia are called zoosporangia.
2. **Aplanospore** : When sporangiospores are **non-flagellated and non-motile** then they are called aplanospores.

- (ii) **Conidia** - The formation of conidia takes place **exogenously**. These conidia are formed at the tip of Mycelium.

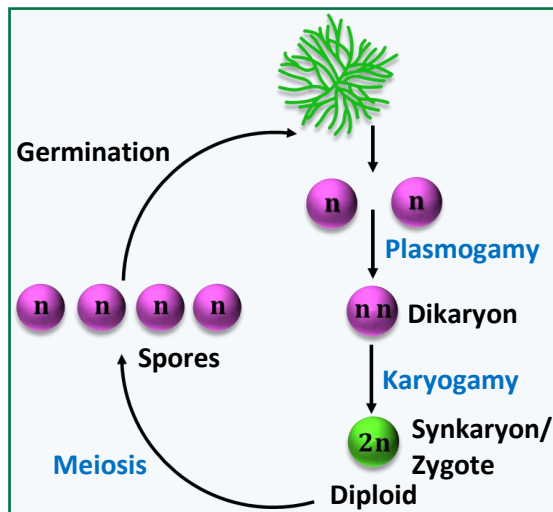


Sexual Reproduction :

- The cell in which gametes are formed is called gametangium.
- Sexual reproduction in fungi completes in three steps

(i) **Plasmogamy** - This is the first stage of sexual reproduction. In this stage two sex cells fuse with each other but their nuclei do not fuse due to which a single cell has two nuclei.

In phycomycetes two different sex organs came close to each other (Anisogamy or Oogamy) or two identical sex organ directly fuse perform plasmogamy (Isogamy). Fusion of two haploid cells immediately result in diploid cells ($2n$). However, in other fungi



(**Ascomycetes and Basidiomycetes**), Plasmogamy is brought about by fusion of two vegetative or somatic cells of different strains or genotypes, the resultant structure is an intervening **dikaryotic stage ($n + n$, i.e., two nuclei per cell)**. Such a condition is called a dikaryon and phase is called **dikaryophase of fungus**.

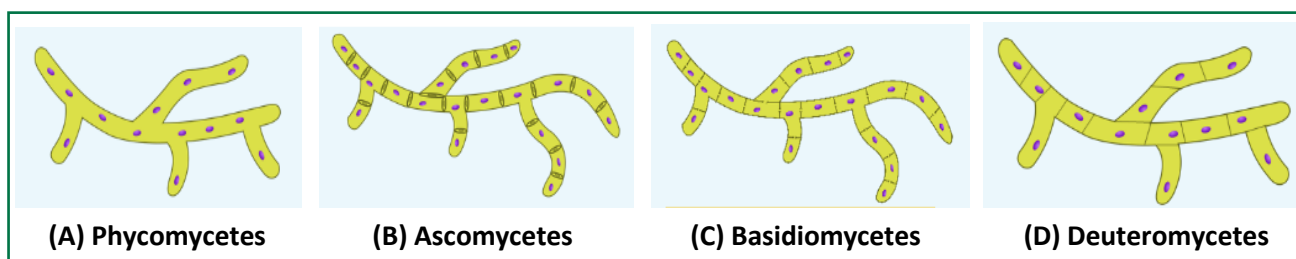
(ii) **Karyogamy** - In this stage the nuclei present in the cell fuse with each other to form a diploid nucleus which is known as **synkaryon**.

(iii) **Meiosis** (Reduction division) - In this stage, meiosis takes place in the diploid nucleus due to which again haploid nuclei or haploid cells are formed.

- In some fungi sex organ are not formed during sexual reproduction and directly the somatic/vegetative cells get fused, known as somatogamy.

Classification :

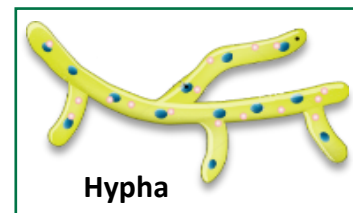
- True fungi are divided into following classes on the basis of morphology of mycelium, mode of spore formation and fruiting bodies during sexual reproduction –



(A) PHYCOMYCETES :

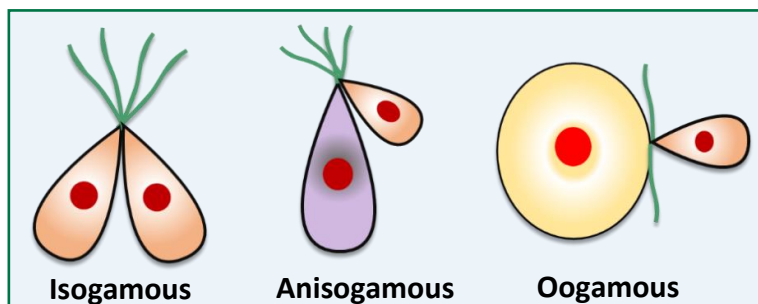
Habitat :

- All the fungi included in this class are called as lower fungi. Members of phycomycetes are found in aquatic habitat (members of this class known as algal fungi) and on **decaying wood in moist and damp place or as obligate parasites on plants.**



Mycelium :

- The fungal filament (mycelium) of the fungi included in this class are coenocytic, aseptate and branched.
- Asexual reproduction = by **zoospores, aplanospores and conidia.**
- Sexual reproduction = may be isogamous, anisogamous and oogamous.
- Phycomycetes includes further groups like oomycetes, zygomycetes



Note : The mycelium of both oomycetes and zygomycetes is same in structure i.e. **coenocytic & aseptate**. But they are dissimilar in their method of sexual reproduction.

(a) Oomycetes :

Asexual reproduction :-

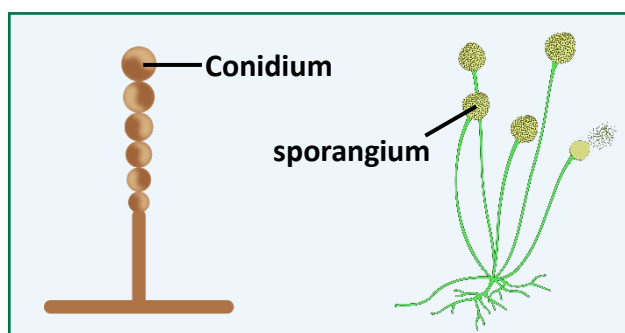
By the formation of zoospores and conidia.

Type of sexual reproduction

Oogamous - All the members

e.g.: -

- Phytophthora infestans***: - Causes late blight of potato. This disease is known as "**Famine of Ireland**" - 1845
- Pythium species***: - Causes "**Damping off**" disease in tobacco & "**vegetable crops**".

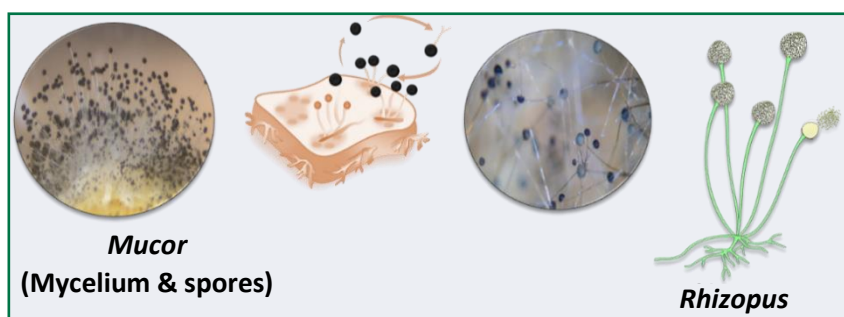


- (iii) *Albugo candida* or *Cystopus candidus*: - It causes "**White rust or white spots disease**" in the members of cruciferae family.



(b) Zygomycetes :

- **Asexual reproduction**: - By the formation of aplanospores.



Types of sexual reproduction :

Isogamous: - All the members

e.g.: (i) *Pilobolus* : Commonly grows on herbivore dung.

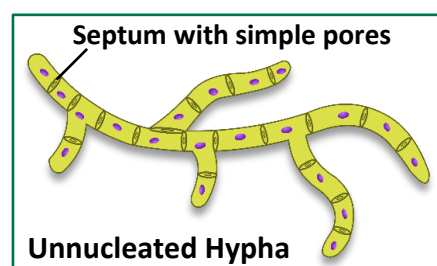
(ii) *Rhizopus* : They prefer to grow on bread, so known as bread mould.

(iii) *Mucor* : Pin mould

(B) **ASCOMYCETES :**

"The sac fungi"

Members of this class are mostly multicellular rarely unicellular (e.g. yeast).



Habitat : Members of Ascomycetes are **saprophytic decomposers, parasitic** or **coprophilous** (growing on dung)

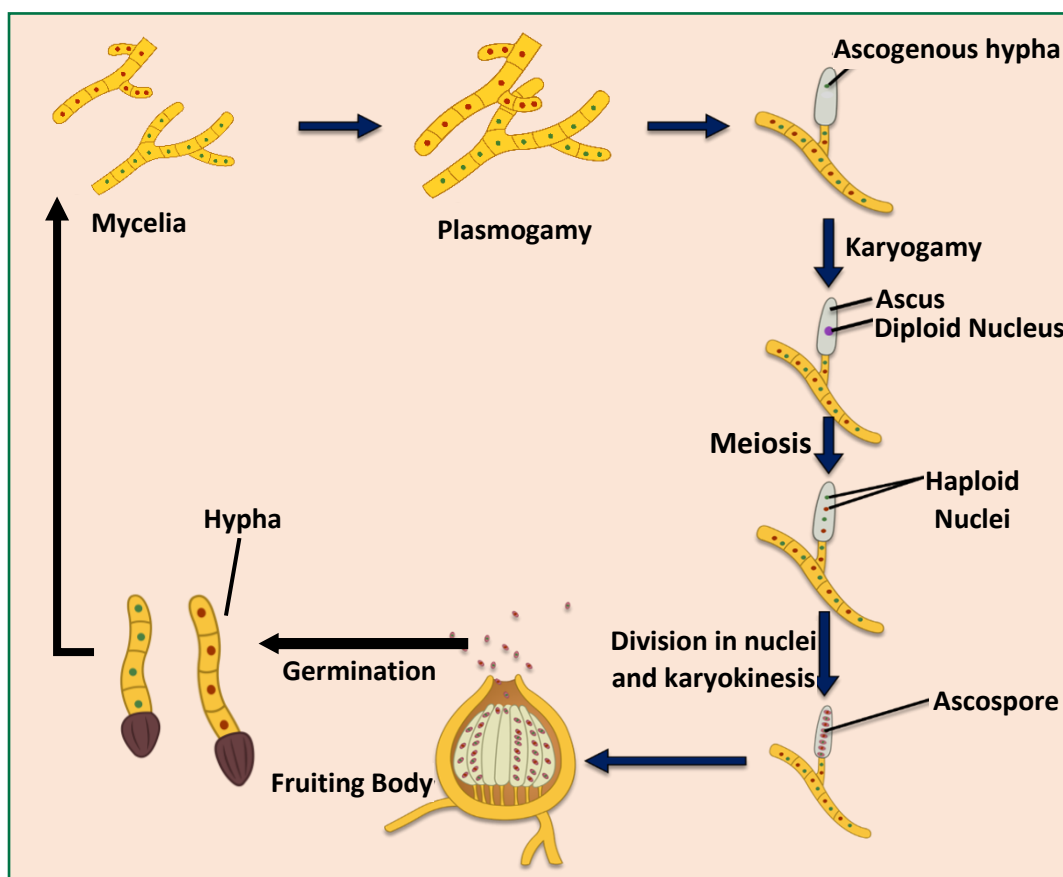
Mycelium : Septate and branched. Septa are found in mycelium of ascomycetes. Pores are present in septa. These pores allow cytoplasm to pass from one cell to other cell. Pores do not allow passing of nucleus.

Asexual reproduction : By Conidia

Sexual Reproduction :

Somatogamy :

- Ascospores are formed during sexual reproduction. On this basis they are named as Ascomycetes.
- (a) There are three stages in sexual reproduction of **Ascomycetes** **Plasmogamy** → **Karyogamy** → **Meiosis**.
- (b) In it two fungal hypha of mycelium come close to each other and their cells fuse to form dikaryon.
- (c) After this an outgrowth originates from dikaryon which is called ascogenous hypha. Ascogenous hypha develops and form a sac like structure which is called ascus (Plural - Asci). Due to this sac like ascus, ascomycetes are called as **sac fungi**.



- (d) Now both the nuclei reach in ascus and fuse to form diploid nucleus. Now ascus is protected by some fungal filaments to form a fruiting body, called as ascocarp in which reductional division occurs leading to formation of haploid ascospores.

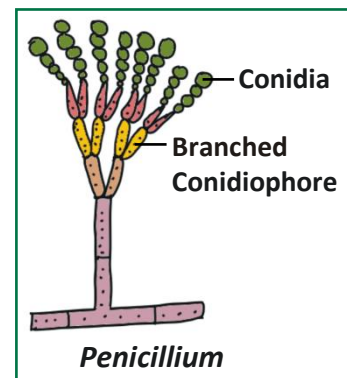
Note : Minimum four ascospores are formed in one ascus but generally '8' ascospores are formed in one Ascus.

- (e) By the rupturing of ascocarp & ascus, ascospores become free and each ascospore forms a new mycelium.

e.g.

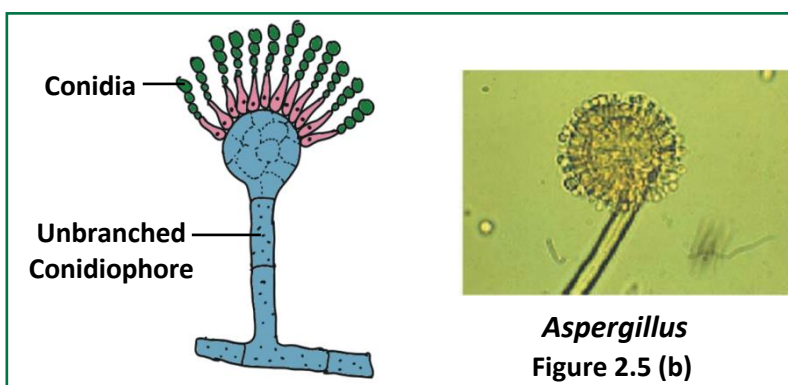
(i) **Penicillium** : -

- Penicillin antibiotic was obtained from **Penicillium notatum**.
- Alexander Fleming discovered **penicillin** while working on **Staphylococcus** bacteria.



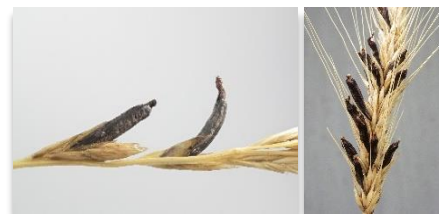
(ii) **Aspergillus** : -

- Different species of **Aspergillus** are related to "**aspergillosis**" disease and secretion of "**aflatoxins**" (carcinogenic) substance.
- **Aspergillus niger** – Known as weed of laboratory and produce citric acid.



(iii) **Claviceps** : -

- **Claviceps purpurea** – It causes "**Ergot disease**" of Bajra and Rye.
- "**Ergotin**" (drug) is obtained from it.
- Narcotic drug (LSD) is also obtained from it.
- LSD (**Lysergic acid diethylamide**) is a hallucinogenic drug.



(iv) **Morchella** : -

- The edible species of **Morchella** are commonly called as **morels**.



(v) **Neurospora** : -

- **Red or Pink mold "Drosophila of Plant Kingdom"**.
- It is used for the study of genetics and biochemical studies in Plant kingdom.
- Beadle and Tatum proposed "**One gene - one enzyme theory**" in Genetics by experimenting on **Neurospora**.

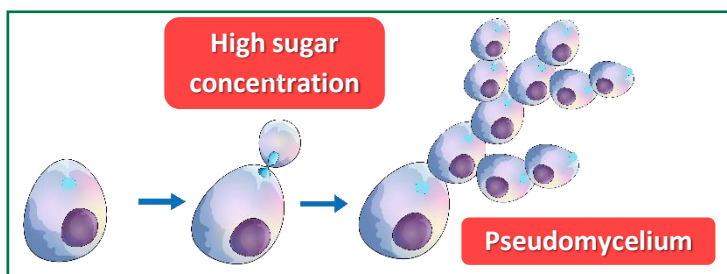
(vi) Truffles: -

- Some members of ascomycetes are known as **Truffles**. They are also edible.



(vii) Yeast e.g. *Saccharomyces*, *Schizosaccharomyces*.

- Yeasts are **unicellular fungi**.
- Yeasts grow on ripened fruits like grapes, sugarcane, date palm and flowers.
- Mycelium is absent in yeasts.

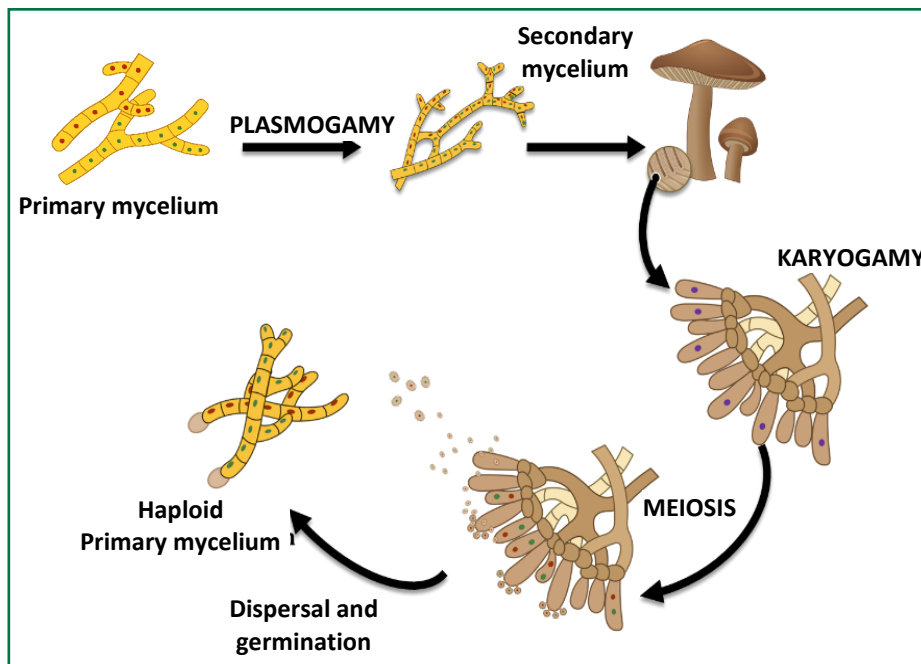


(C) **BASIDIOMYCETES (CLUB FUNGI) :**

- Mycelium** - Branched, Septate and uni or binucleate
- They grow in soil, on logs (thick wooden pieces), and tree stumps (thin wooden branches) and in living plant bodies as parasites.
- Main mycelium of basidiomycetes is dikaryotic and septate. In these fungi the monokaryotic mycelium (Primary mycelium) is also found which is short living and soon converts into long living dikaryotic mycelium (Secondary mycelium).
- The conversion of monokaryotic mycelium into dikaryotic mycelium is **Dikaryotisation**.
- Asexual spores are generally not found in basidiomycetes but vegetative reproduction by fragmentation.
- The sex organs are absent because they perform sexual reproduction by two methods i.e. Somatogamy and Spermatiation.
- Most of the members are heterothallic so fusion is found between different strains or genotypes.

Sexual Reproduction :

Somatogamy :



- First of all, the two-mycelium come close to each other.
- Now their apical ends fuse with each other (Plasmogamy), as a result of which dikaryon is formed. (Dikaryon - The cell in which two nuclei are present)
- Now a club shaped structure is formed on every cell, which is known as **basidium**.
- Now both the nuclei of each cell fuse with each other (karyogamy) in basidium. Due to which each becomes diploid.
- After that diploid nucleus of the basidium divides by meiosis, as a result of which four haploid spores are formed on basidium, which are known as **basidiospores**.
- Now the Basidiospores become free from basidium and produce a new monokaryotic mycelium on germination.

Examples:

- Bracket or Shelf fungi** :-
- Puff balls** – *e.g. Clavatia*



Bracket or Shelf fungi



Puff balls



Figure 2.5 (c) *Agaricus*

- Mushrooms** - It is a fleshy, spore bearing fruiting body of basidiomycetes fungi.
Most delicious, **edible mushroom** - *Agaricus bisporus*
World's most **poisonous mushroom** - *Amanita muscaria* (It is also hallucinogenic) (Poisonous mushrooms are known as Toad - stool).



Note : *Agaricus* – It is called gill fungi.

(d) **Rust Fungi** : - *Puccinia graminis* (black rust of wheat)

(e) **Smut fungi** - They cause smut disease and produce **black spores**, which are known as smut spores. *e.g.* *Ustilago nuda* or *Ustilago tritici* - Loose smut of wheat.

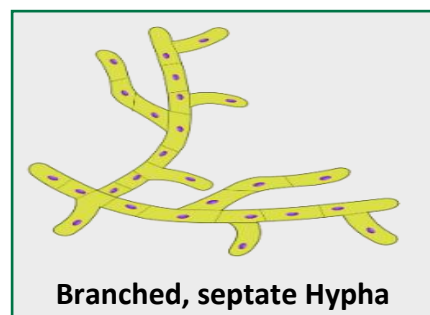
Smut fungi



Note : Basidiomycetes - Also known as "**Club fungi**" because a club shaped basidium is formed in them. Fungi completing its type cycle in/on one host is called Autoecious fungi. Fungi completing its type cycle in/on more than one host is called Heteroecious fungi.

(D) DEUTEROMYCETES :

- It is also called "**fungi Imperfecti**", because perfect stage or sexual reproduction is absent in this class of fungi. Those fungi are included in this class in which sexual reproduction is absent or is not discovered at yet. When the sexual forms of this class of fungi were discovered they were moved into right class ascomycetes or basidiomycetes from deuteromycetes.



Mycelium : Septate and branched

Asexual reproduction : Takes place with the help of conidia.

Some members are saprophytic or parasitic.

A large number of members of this class are decomposers of litter and help in mineral cycling.

e.g. *Trichoderma*

The fungi included in this class cause many diseases.

Example :

Alternaria solani : Early blight of Potato

Colletotrichum falcatum : Red rot of sugarcane

Trichoderma : It produces "**Ringworm**" in humans





BEGINNER'S BOX-3

KINGDOM PROTISTA & FUNGI

1. Dinoflagellates can be considered as connecting link between monera and protista because :
 (1) They spin while they move
 (2) They have flagella in grooves
 (3) They show bioluminescence
 (4) They have condense chromosome lacking histone protein
BBC428
2. Kingdom protista includes organisms like :
 (1) *Amoeba*, *Euglena* and Diatoms
 (2) *Amoeba*, *Euglena* and *Penicillium*
 (3) *Amoeba*, *Spirogyra* and *Penicillium*
 (4) *Euglena*, *Spirogyra* and *Albugo*
BBC429
3. In *Gonyaulax* meiosis occurs in :
 (1) Gamete (2) Zygote (3) Sporangium (4) Zoospores
BBC430
4. The famous Irish (Ireland) famine is related to a disease of potato known as :
 (1) Late blight (2) Early blight (3) Smut disease (4) Red rot
BBC431
5. Cellulose is the major component of cell wall of :
 (1) *Albugo* (2) *Puccinia*
 (3) *Morchella* (4) *Saccharomyces*
BBC432
6. Among rust, smut and mushroom all the three :
 (1) are pathogen (2) are saprobes
 (3) bear ascocarp (4) are basidiomycetes
BBC433
7. Ethanol is commercially produced through a particular species of :
 (1) *Aspergillus* (2) *Saccharomyces*
 (3) *Clostridium* (4) *Trichoderma*
BBC434
8. The dominant part in the life cycle of protista and fungi is mostly :
 (1) Haplontic (2) Diploid
 (3) Haplodiplontic (4) Diplohaplontic
BBC435
9. Taxonomy of fungi is mainly based on :
 (1) Sexual reproduction (2) Nutrition
 (3) Shape of fruiting body (4) Cell wall
BBC436

- 10.** Which of the following fungus can cause disease in Human ?
 (1) *Aspergillus* (2) *Ustilago* (3) Mushroom (4) *Puccinia* **BBC437**
- 11.** Which of the following pair belongs to basidiomycetes :
 (1) Puff ball and *Claviceps* (2) *Morchella* and mushroom
 (3) *Morchella* and *Aspergillus* (4) Shelf fungi and puffball **BBC438**
- 12.** Asexual reproduction in fungi occurs by :
 (1) Aeciospores (2) Basidiospores
 (3) Conidia (4) Oospores **BBC439**
- 13.** Which of the following is a harmful event performed by bacteria?
 (1) Nitrogen fixation (2) Ammonification
 (3) Nitrification (4) Denitrification **BBC440**
- 14.** Which of the following statement is not true for Methanogens?
 (1) They are methane producers
 (2) They are symbiont in cattle
 (3) They all are aerobic
 (4) They all are anaerobic **BBC441**
- 15.** Archaeobacteria differ from eubacteria in?
 (1) Cell wall
 (2) Cell membrane
 (3) Type of genetic material
 (4) Both cell wall and cell membrane **BBC442**
- 16.** Select the correct matching :
 (A) Fungi depend on dead substrate – Saprophytic
 (B) Fungi depend on living plants and animals – Parasite
 (C) Fungi as symbiont with algae – Lichens
 (D) Fungi as symbiont with root of higher plant – Mycorrhiza
 (1) A and B only (2) B and C only
 (3) C and D only (4) All of these **BBC443**
- 17.** Which of the following is not the property of amoeboid protozoan?
 (1) Live in fresh water, sea water or moist soil.
 (2) Move and capture their prey by putting out pseudopodia (false feet) as in *Amoeba*.
 (3) Marine forms have silica shells on their surface.
 (4) Some of them such as *Entamoeba* are free living. **BBC444**

18. Which of the following is not the property of ciliated protozoan?

- (1) These are aquatic, actively moving organisms because of the presence of thousands of cilia.
- (2) They have a cavity (gullet) that opens to the outside of the cell surface.
- (3) The coordinated movement of rows of cilia causes the water laden with food to be steered into the gullet.
- (4) The parasitic forms cause diseases like sleeping sickness.

BBC445

19. Match the group with their usual site of occurrence and examples correctly :

Group		Occurrence		Example	
(a)	Chrysophyta	(i)	Fresh and Marine water	(p)	<i>Physarum</i>
(b)	Dinoflagellate	(ii)	Decaying twigs and leaves	(q)	Diatoms
(c)	Euglenoids	(iii)	Marine water	(r)	<i>Euglena</i>
(d)	Slime mold	(iv)	Stagnant fresh water	(s)	<i>Gonyaulax</i>

- (1) a-iii-q, b-i-s, c-iv-r, d-ii-p
- (2) a-iii-q, b-ii-s, c-iv-p, d-i-s
- (3) a-i-q, b-iii-s, c-iv-r, d-ii-p
- (4) a-i-p, b-iii-q, c-iv-s, d-ii-r

BBC446

20. **Assertion** : Fungi show great diversity in habitat and morphology.

Reason : Fungi prefer to grow in warm and moist environment.

- (1) Both Assertion & Reason are True & the Reason is a correct explanation of the Assertion.
- (2) Both Assertion & Reason are True but Reason is not a correct explanation of the Assertion.
- (3) Assertion is True but the Reason is False.
- (4) Both Assertion & Reason are False.

BBC447

21. **Statement-I** : Slime moulds are saprophytic protists.

Statement-II : All protozoan are heterotrophic and live as predator or parasite.

- (1) Statement-I and Statement-II both are correct.
- (2) Statement-I and Statement-II both are incorrect.
- (3) Only Statement-I is correct.
- (4) Only Statement-II is correct.

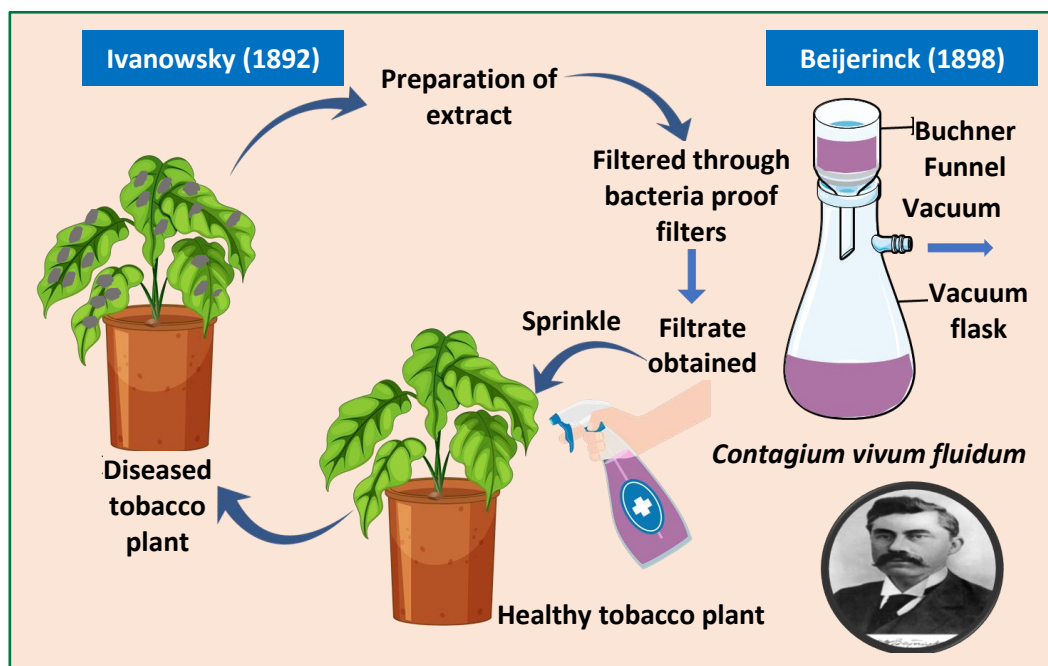
BBC448

NCERT Question :

Give a brief account of viruses with respect to their structure and nature of genetic material. Also name four common viral diseases.

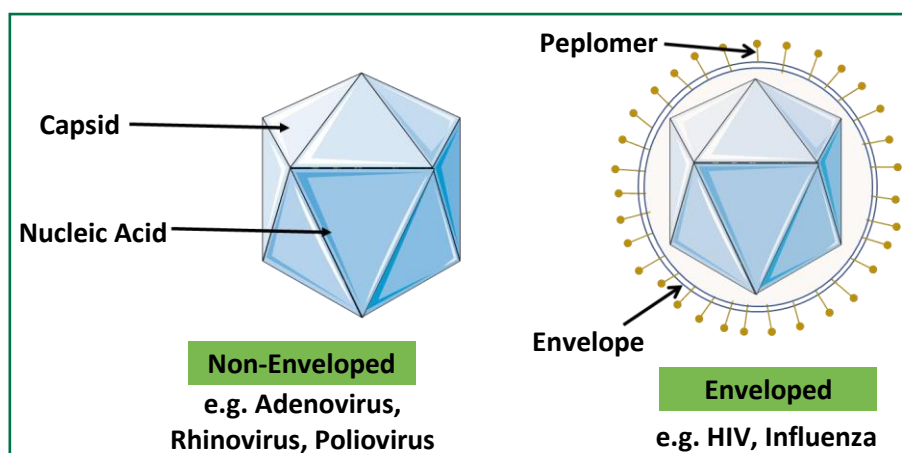
06. VIRUSES, VIROIDS, PRIONS, LICHENS AND MYCORRHIZA**(A) VIRUS :**

- Latin word, which means '**poisonous fluid**' or '**venom**' or '**secretion**' (According to Pasture).
- Ivanowsky separated a microorganism from the sap of infected tobacco plant and named "TMV". He reported that viruses are smaller than bacteria and they can pass through the bacterial proof filters.
- **Beijerinck** demonstrated that the extract of the infected plants of tobacco could cause infection in healthy plants and called the fluid as '**contagium vivum fluidum** (Infectious living fluid)'.
- Stanley crystallized TMV first time and Nobel prize was awarded to him.

**NCERT Question :**

Organise a discussion in your class on the topic – Are viruses living or nonliving?

Characteristic features of viruses :



- These are sub microscopic & non-cellular organisms.
- They are obligate intracellular parasites.
- They have either RNA or DNA. No virus contains both DNA and RNA.
- They are inert outside their specific host cell in crystalline form.
- They contain nucleic acid so they are capable of protein synthesis by the help of ribosomes of host cell.

Living or Biotic characters (within host cell)	Non-living or Biotic characters (Outside the host cell)
Genetic material present	Protoplasm absent
Mutation occurs	Metabolism absent
Pathogenicity	No effect of antibiotics
Multiplication	Inert crystal
Reproduction	Cell, cell wall, cell membrane – absent

Morphology and structure of viruses :

Size of Viruses :

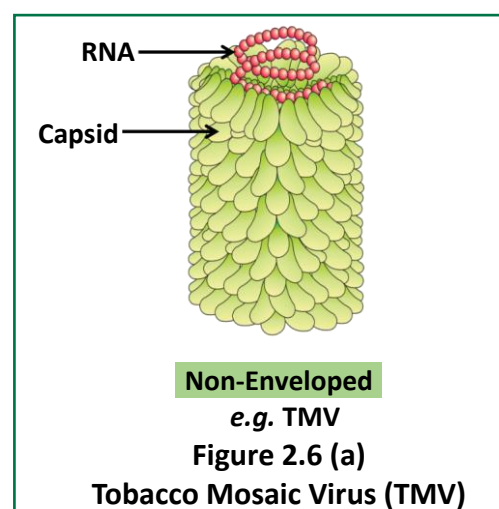
TMV - $300 \text{ m}\mu \times 20 \text{ m}\mu$ or $300 \text{ nm} \times 20 \text{ nm}$

SHAPE :

Spherical - Influenza virus, HIV

Rod shaped – TMV

Tadpole like – Bacteriophage



Chemical composition :

(a) Nucleic acid:

Either RNA or DNA

Generally, in plant viruses, ssRNA is present, but in Cauliflower mosaic virus dsDNA is present and in Gemini virus ss-DNA is present.

Generally, in animal viruses, double stranded DNA is present but in some animal viruses, RNA is present, which is single or double stranded.

(b) Protein coat:

It is known as capsid and made up of small sub unit called **capsomeres**.

Central core & Capsid are collectively known as **nucleocapsid**.

An additional covering is also present in some viruses around the capsid, called envelope. Such type of virus are called enveloped virus. Viral envelope is made of lipid and protein.

Symmetry of viruses:

(i) Helical symmetry: Capsomeres are arranged in helical manner in the capsid, e.g. TMV and Mumps virus etc.

(ii) Icosahedral: It is a type of polyhedral e.g. Herpes virus, Adeno virus, $\phi \times 174$ bacteriophage

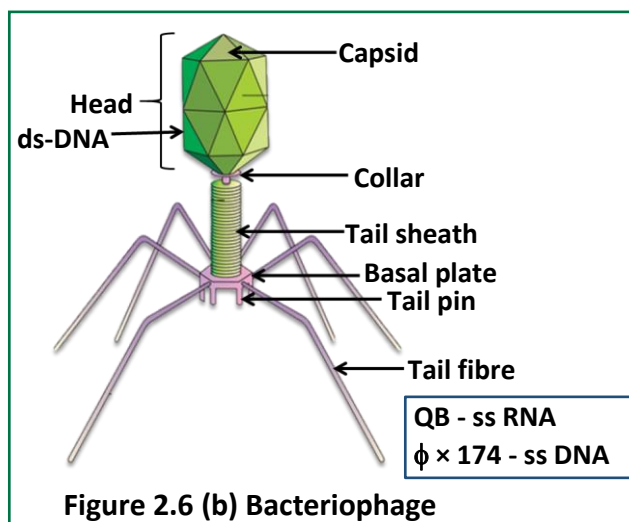


Figure 2.6 (b) Bacteriophage

TMV (Tobacco Mosaic Virus) :

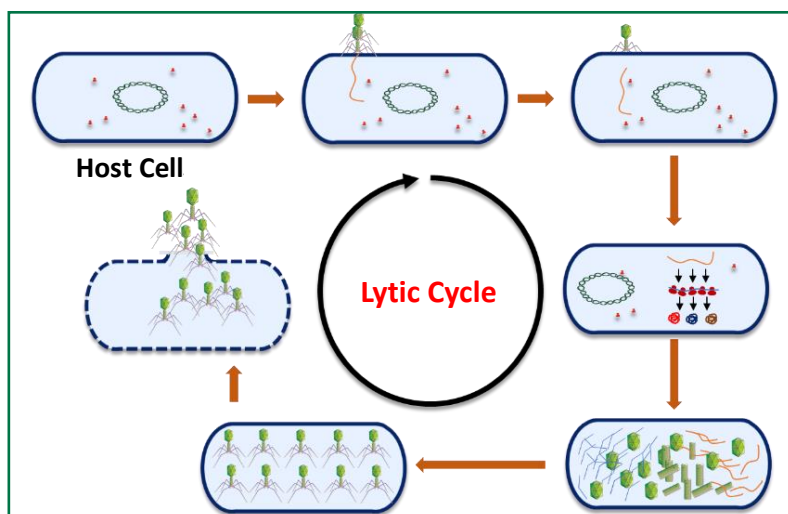
- It is the most thoroughly studied virus and was discovered by the Russian botanist **D. Ivanowsky (1892)**.
- It has helical symmetry.
- Having **single stranded RNA**
- In its capsid number of capsomeres is 2130.
- 5% RNA and 95% protein are present in TMV.

Bacteriophage Virus :

- The Virus which infect the bacteria are called bacteriophage.
- Bacteriophage was **discovered** by F.W. Twort and Named by Felix d' Herelle.
- Bacteriophages are generally double stranded DNA virus.
- In QB - bacteriophage - ss RNA is present.
- In $\phi \times 174$ bacteriophage - ss DNA is present.

Transduction :

- When a bacteriophage transfers genetic material from one bacterium (Donor cell) to another bacterium (receptor cell) called transduction.
- Discovered by - Zinder & Lederberg (1952) in *Salmonella typhimurium*.



Plant diseases/symptoms caused by viruses: -

- | | |
|----------------------------|-----------------------------------|
| 1. Tobacco mosaic disease. | 2. Leaf curl of papaya and tomato |
| 3. Vein clearing | 4. Potato leaf roll |
| 5. Bunchy top of banana. | 6. Dwarfing |
| 7. Stunting | 8. Chlorosis |
| | 9. Necrosis |

Human disease caused by virus: -

- | | | |
|-------------------|----------|--------------|
| 1. Influenza | 2. Mumps | 3. Small pox |
| 4. Herpes disease | 5. AIDS | |

(B) VIROIDS :

(Free infectious RNA)

- T.O. Diener (1971) discovered some new infectious agents, which are smaller than viruses, called viroids.
- Viroids contain only very low mol. wt. RNA (ss RNA) and not the protein coat.
- Viroids cause Potato spindle tuber disease.

(C) PRIONS :

(Slow viruses or Smallest Proteinaceous infectious agent)

- In modern medicine certain infections neurological diseases were found to be transmitted by an agent consisted of abnormally folded protein.
- The agent was similar in size to viruses. These agents were called prions.

- The most notable diseases caused by prions are bovine spongiform encephalopathy (BSE) commonly called mad cow disease in cattle and its analogous variant cause Cr-Jacob disease (CJD) in humans.

NCERT Question :

How are viroids different from viruses?

	Viruses	Viroid	Prion
Nucleic acid	DNA or RNA	ss-RNA	Absent
Presence of capsid	Present	Absent	Absent
Presence of protein	Present	Absent	Present
Host	Bacteria, Plants, Animals	Plants	Mammals

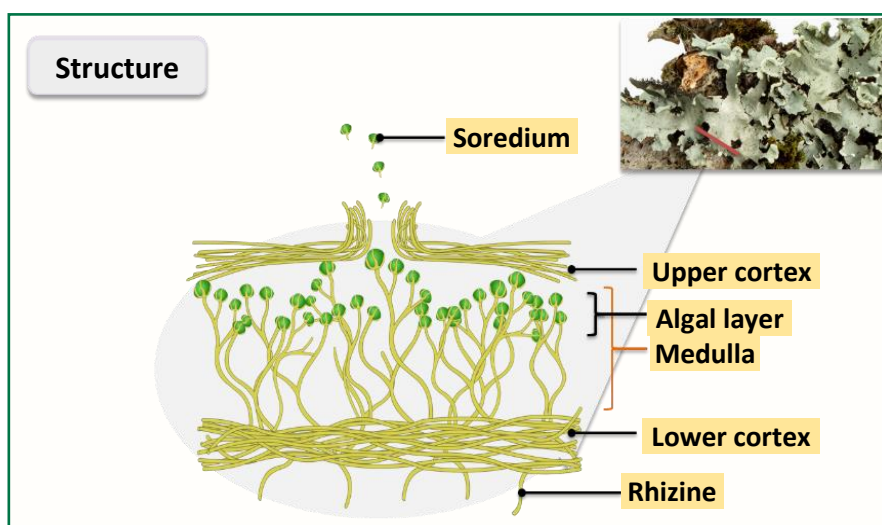
NCERT Question :

What do the terms phycobiont and mycobiont signify?

(D) LICHENS :

Nature :

- Lichen is composed of algae and fungi or Lichen is a composite thalloid structure of algae & fungi.
- The algal part of lichen is called phycobiont (photobiont) and the fungal part is called mycobiont.
- Both algae & fungi remain in symbiotic association i.e. they are beneficial for each other.
- The algal part makes carbohydrates through photosynthesis and provides nutrition to fungus & itself. The fungal partner absorbs water and minerals and provides them to algal partner also.



Habitat :

- Lichens are found at those places where normal plants do not grow such as on rocks, cold arctic regions, on walls etc. Lichens are also found on dead and decaying wooden pieces, leaves, soil etc.
- Lichens are not found in polluted areas.



Crustose Lichen
e.g. Graphis



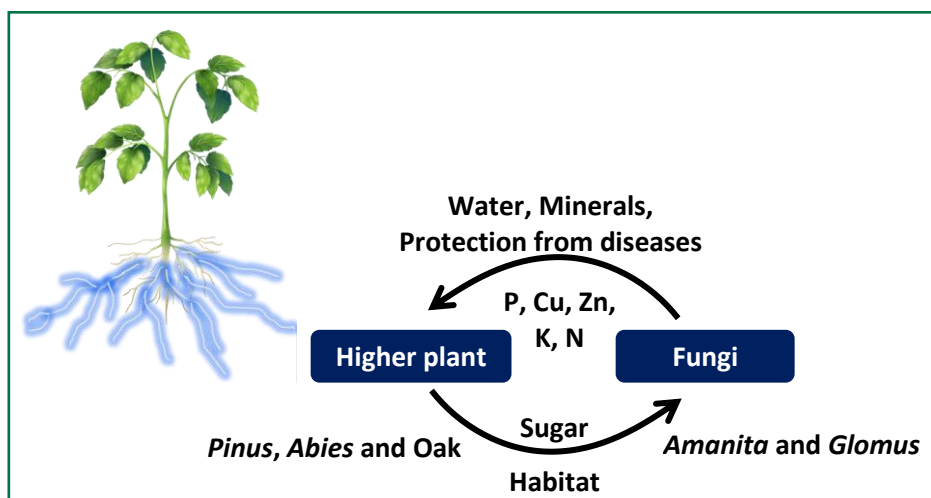
Foliose Lichen
e.g. Peltigera, Parmelia



Fruticose Lichen
e.g. Usnea

(E) MYCORRHIZA :

- The symbiotic association of fungus and the roots of higher plants is known as mycorrhiza.
- This symbiotic association is beneficial for both of them because fungus absorbs minerals like P, Cu, Zn, K, N and water from soil and provide them to higher plants while higher plants provide food and habitat to fungus. Fungus protects the roots from many diseases also.
- Mycorrhiza mainly perform phosphorus absorption.**
- Fungi which make mycorrhiza are *Amanita* and *Glomus*.



Mycorrhiza are of two types :

(a) Ectomycorrhiza - In this type the fungus forms a covering around the plant roots, so a thick layer of fungal mycelium is formed on the surface of the roots.

e.g. Plants → *Abies, Pinus* Fungi → *Amanita*

(b) Endomycorrhiza - In this type the fungi do not form thick layer on the roots of plant. They enter intracellularly in the roots.

e.g. Plants → *Orchid* Fungi → *Glomus*

★ **Golden Key Points** ★

- The viruses are non-cellular organisms that are characterised by having an inert crystalline structure outside the living cell.
- Viruses are obligate parasites.
- A virus is a nucleoprotein and the genetic material is infectious.
- The protein coat called capsid made of small subunits called capsomeres, protects the nucleic acid.
- In general, viruses that infect plants have single stranded RNA and viruses that infect animals have either single or double stranded RNA or double stranded DNA.
- Bacterial viruses or bacteriophages (viruses that infect the bacteria) are usually double stranded DNA viruses.
- T.O. Diener discovered a new infectious agent - Viroids that was smaller than viruses and caused potato spindle tuber disease.
- The most notable diseases caused by prions are mad cow disease in cattle and its analogous variant Cr–Jacob disease (CJD) in humans.
- Lichens are symbiotic associations i.e. mutually useful associations, between algae and fungi.
- Lichens are very good pollution indicators – they do not grow in polluted areas.
- Mycorrhiza is the symbiotic association between roots of higher plants and fungus.



BEGINNER'S BOX-4

VIRUS, LICHEN, MYCORRHIZA

1. Viruses are made up of :

- (1) Only nucleic acid (2) Only proteins
(3) Proteins and nucleic acid (4) Lipid and Proteins

BBC449

2. Lichens are association of :

- (1) Algae & Virus (2) Algae & Bryophytes
(3) Algae & Fungi (4) Fungi & Roots of plants

BBC450

3. Disease causing abnormally folded proteins are :

- (1) Viroids (2) Prions
(3) Viruses (4) Bacteriophages

BBC451

4. Which of the following virus is a rod shaped virus ?

- (1) $\phi \times 174$ (2) TMV (3) Adenovirus (4) HIV

BBC452

5. In which one of the following pairs of diseases both are caused by viruses?

- (1) Tetanus and typhoid
(2) Whooping cough and sleeping sickness
(3) Syphilis and AIDS
(4) Measles and Rabies

BBC453

6. Match the **column-I** with **column-II** and choose correct option.

Column-I		Column-II	
(A)	Prions	(i)	Free infectious RNA
(B)	Viroid	(ii)	Protein
(C)	Gemini viruses	(iii)	Single stranded RNA
(D)	Retro viruses	(iv)	Single stranded DNA

- (1) A-i, B-ii, C-iii, D-iv (2) A-ii, B-i, C-iv, D-iii
(3) A-iii, B-i, C-iv, D-ii (4) A-i, B-iv, C-iii, D-ii

BBC454

7. 'Mycorrhizae' are useful for plants mainly due to their following attribute :

- (1) Fixing atmospheric nitrogen
(2) Enhanced absorption of nutrients from soil
(3) Killing insects and pathogens
(4) Providing resistance against abiotic stresses

BBC455

8. In symbiotic association between algae and fungi which one is not correct about lichen :
- (1) Algae prepare food for fungi and itself also
 - (2) Fungi provide shelter and absorb mineral and water for its partner
 - (3) Lichens are very good pollution indicator because they grow in polluted areas only
 - (4) In lichens both partners are so close in their association that one would never imagine that they had two different organisms within them

BBC456

9. Which of the following is wrongly matched ?
- (1) T. O. Diener — Viroids are found to be a free DNA
 - (2) W. M. Stanley — Crystallised proteins
 - (3) M. W. Beijerinck — Contagium vivum fluidum
 - (4) D. J. Ivanowski — Microbes smaller than bacteria cause mosaic disease of tobacco

BBC457

10. **Statement-I** : Viruses are cellular organisms containing genetic material.

Statement-II : Viruses are obligate parasites.

- (1) Statement-I & Statement-II both are correct.
- (2) Statement-I is correct & Statement-II is incorrect.
- (3) Statement-I is incorrect & Statement-II is correct.
- (4) Both Statement-I & Statement-II is incorrect.

BBC458

11. **Assertion** : Lichen are good air pollution indicators.

Reason : Lichen do not grow in air polluted areas.

- (1) Both assertion & reason are true & the reason is a correct explanation of the assertion.
- (2) Both assertion & reason are true but reason is not a correct explanation of the assertion.
- (3) Assertion is true but the reason is false.
- (4) Both assertion & reason are false.

BBC459

12. Match the **column-I** with **column-II**.

Particles/Micro organisms		Diseases	
(i)	Viroid	(a)	CJD
(ii)	Virus	(b)	Citrus canker
(iii)	Bacteria	(c)	Potato spindle tuber disease
(iv)	Prion	(d)	Mumps

(1) i - a, ii - b, iii - d, iv - c

(2) i - c, ii - d, iii - a, iv - b

(3) i - c, ii - d, iii - b, iv - a

(4) i - a, ii - c, iii - b, iv - d

BBC460



BEGINNER'S BOX

ANSWERS KEY

BEGINNER'S BOX-1	Que.	1	2	3	4	5	6	7	8	9	10
	Ans.	1	2	3	4	3	1	1	4	3	2

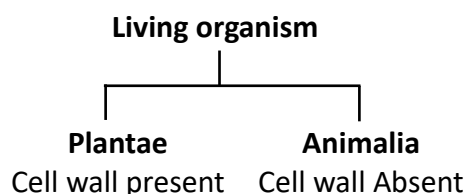
BEGINNER'S BOX-2	Que.	1	2	3	4	5	6	7	8	9	10
	Ans.	3	2	2	4	2	3	2	3	1	3
	Que.	11	12	13	14	15					
	Ans.	4	3	1	3	1					

BEGINNER'S BOX-3	Que.	1	2	3	4	5	6	7	8	9	10
	Ans.	4	1	2	1	1	4	2	1	1	1
	Que.	11	12	13	14	15	16	17	18	19	20
	Ans.	4	3	4	3	4	4	4	4	3	2
	Que.	21									
	Ans.	1									

BEGINNER'S BOX-4	Que.	1	2	3	4	5	6	7	8	9	10
	Ans.	3	3	2	2	4	2	2	3	1	3
	Que.	11	12								
	Ans.	1	3								



- **Two kingdom classification** : Carolus Linnaeus
(On the basis of cell wall)
- **Five kingdom classification**: R. H. Whittaker



Basis:

- | | |
|--|--|
| <ol style="list-style-type: none"> 1. Cell structure 2. Body organisation 3. Mode of nutrition 4. Reproduction 5. Phylogeny | <div style="display: flex; align-items: center;"> <div style="border-left: 1px solid black; height: 100px; margin-right: 5px;"></div> <div> <p>Monera: All prokaryotes</p> <p>Protista: Unicellular eukaryotes</p> <p>Fungi: Heterotrophic, cell walled multicellular eukaryotes</p> <p>Plantae: Autotrophic, cell walled multicellular eukaryotes</p> <p>Animalia: Heterotrophic, cell wall less multicellular eukaryotes</p> </div> </div> |
|--|--|

Monera : Eubacteria, Blue green algae, archaebacteria, *Mycoplasma* etc.

- All prokaryotes
- Non-cellulosic cell wall (Peptidoglycan)
- True nucleus absent
- Membrane bound cell organelle absent
- 70 s ribosome present
- Membrane less inclusion bodies present (Glycogen granules, phosphate granule)
- Autotrophic and heterotrophic (Mainly)
- Heterocyst is present in nitrogen fixing BGA
- Archaebacteria can survive in adverse environmental condition due to complex cell wall and cell membrane
- *Mycoplasma* are the smallest living cells, cell wall less prokaryotes can survive without oxygen.

Protista: Dinoflagellates, diatoms, euglenoids, slime mould, protozoa

- Unicellular eukaryotes
- Boundaries are not defined
- Mainly aquatic (Marine and fresh water)
- Producer, consumer and decomposers
- Cell walled and cell wall less both

	Characters	Chrysophytes	Dinoflagellates	Euglenoids	Slime Moulds
1.	Common name	Desmids- Golden algae Diatoms – pearls of sea	Fire algae, Bioluminescent algae.	Mixotrophs, Connecting link between plant & animals	Naked Fungi/false fungi, connecting link between fungi & animals
2.	Habitat	Fresh water & marine water	Marine water	Stagnant fresh water	Dark, cool, Moist conditions in forest on decaying organic matter
3.	Cell wall	Present, made of cellulose and silica, Soap box like	Present, made of Stiff cellulosic plats	Absent but pellicle present	Absent but Produced on spores
4.	Flagella	Absent in diatoms	Present, Two-longitudinal and transverse	Present, Two-one long and other is small	May present in Few members
5.	Movement	Passively float in water (Planktons)	Flagellar movement	Flagellar movement	Flagellar movement in motile cells only
6.	Nutrition	Holophytic (photosynthesis)	Holophytic (photosynthesis)	Light-Holophytic, Dark -Holozoic	Saprotrophic (Absorptive) and Holozoic (Engulfing)
7.	Photosynthetic pigment	Chlorophyll a+c fucoxanthin	Chlorophyll a+c	Chlorophyll a+b	Absent
8.	Life cycle	Diplontic	Haplontic	Haplontic	Diplontic Haplontic
9.	Special character	Chief producers of oceans. Cell wall forms two thin over lapping shells. Diatomaceous earth/Diatomite/ keiselgurh- used in filtration of oil and syrups.	Mostly release toxins in water. They appear yellow, green brown, blue or red depending on the main pigment present in them. Red tide - <i>Gonyaulax</i>	Mixotroph. Pigments like higher plants. Eye spot /Stigma present.	Members are both uninucleate & multinucleate. They form an aggregation known as plasmodium. During unfavourable condition they form fruiting bodies (Sporangia) & spores.
10.	Example	<i>Gonyaulax</i> , <i>Noctiluca</i>	<i>Navicula</i>	<i>Euglena</i>	<i>Physarum</i>

Fungi :

- Unique kingdom of heterotrophs (Osmotrophic or absorptive mode of nutrition)
- Chitinous and polysaccharide cell wall
- Mycelium branched, septate or aseptate
- Fungi can be parasites, saprophytes and symbiotic
- Fungi lives as symbionts – in association with algae as **lichens** and with roots of higher plants as **mycorrhiza**
- Asexual reproduction by zoospore, aplanospore or by conidia formation
- Sexual reproduction in three steps: Plasmogamy, Karyogamy and Meiosis
- Sexual reproduction by the formation of zygospore/oospore, ascospore and basidiospore

	Characters	Phycomycetes	Ascomycetes	Basidiomycetes	Deuteromycetes
1.	Common name	Lower Fungi Algal fungi	Sac fungi	Club fungi	Fungi Imperfecti (Imperfect fungi)
2.	Mycelium	Aseptate, branched coenocytic	Septate branched monokaryotic, some are cellular	Septate branched & dikaryotic	Septate, branched and mainly multikaryotic
3.	Habitat	In host as parasites and on dead organic matter as saprophytes	Parasites, saprophytes Some are coprophilous	Parasites, saprophytes also on logs and tree stumps	Parasites, saprophytes They are important decomposers of litter and help in mineral recycling
4.	Vegetative Reproduction	By fragmentation	By fragmentation	By fragmentation	By fragmentation
5.	Asexual Reproduction	By conidia (exogenous) & zoospores and aplanospores (endogenous)	By conidia	Generally asexual spores are absent	By conidia
6.	Sexual reproduction	Isogamous, anisogamous & oogamous	Gametangial contact or somatogamy	By somatogamy and spermatization	Absent
7.	Sexual spores	Zygospores and Oospores (Diploid)	Ascospores (Haploid) (endogenous)	Basidiospores (exogenous)	Absent

8.	Sexual fruiting body	Absent	Ascomycete Cleistothecium Perithecium Apothecium	Basidiomycete many types like mushroom, Toad stool (like fairy rings)	Absent
9.	Special character	- Some occur in aquatic habitat also. - Motile cells are formed. - These two are algal characters.	- Unbranched conidiophore <i>Aspergillus</i> - Branched conidiophore <i>Penicillium</i>. <i>Morchella</i>-edible fungi - Yeast (<i>Saccharomyces</i>) Budding, Fission - Yeast (Bakery & Brewing) <i>Neurospora</i> – <i>Drosophila</i> of plant kingdom.	- Mostly the members are heterothallic - Sex organs are absent but somatogamy is present - Long living dikaryotic stage - Basidium formation, Rust fungi's <i>Puccinia</i>	- When the sexual form is discovered they are moved into other classes <i>Alternaria</i> <i>Colletotrichum</i> <i>Trichoderma</i>
10.	Examples	<i>Mucor</i> , <i>Rhizopus</i> , <i>Albugo</i>	<i>Claviceps</i> - Ergot disease, Ergotamine, LSD	Smut fungus - <i>Ustilago</i>	<i>Colletotrichum</i> , <i>Trichoderma</i>

Viruses :

- Non-cellular.
- Obligate intra cellular parasites.
- Nucleoprotein particles (Nucleic acid and proteins).
- Protein capsid is made up of capsomeres.
- Cause infection in plants, animals and prokaryotes.
- Viroids** are low molecular infectious RNA particles cause disease in plants (PSTV).
- Prions** are infectious protein particles cause disease in animals and humans (CFJ disease, mad cow disease).

NCERT SUMMARY

Biological classification of plants and animals was first proposed by **Aristotle** on the basis of **simple morphological characters**. **Linnaeus** later classified all living organisms into **two kingdoms – Plantae and Animalia**. **Whittaker** proposed an elaborate **five kingdom classification – Monera, Protista, Fungi, Plantae and Animalia**. The main criteria of the five kingdom classification were **cell structure, body organisation, mode of nutrition and reproduction, and phylogenetic relationships**.

In the five kingdom classification, bacteria are included in Kingdom Monera. Bacteria are **cosmopolitan** in distribution. These organisms show the **most extensive metabolic diversity**. Bacteria may be autotrophic or heterotrophic in their mode of nutrition. Kingdom Protista includes all single-celled eukaryotes such as **Chrysophytes, Dinoflagellates, Euglenoids, Slime-moulds and Protozoans**. Protists have defined nucleus and other membrane bound organelles. They reproduce both asexually and sexually. Members of Kingdom Fungi show a great diversity in structures and habitat. Most fungi are **saprophytic** in their mode of nutrition.

They show asexual and sexual reproduction. **Phycomycetes, Ascomycetes, Basidiomycetes and Deuteromycetes** are the four classes under this kingdom. The plantae includes all eukaryotic chlorophyll-containing organisms. **Algae, bryophytes, pteridophytes, gymnosperms and angiosperms** are included in this group. The life cycle of plants exhibit **alternation of generations – gametophytic and sporophytic generations**. The heterotrophic eukaryotic, multicellular organisms lacking a cell wall are included in the Kingdom Animalia. The mode of nutrition of these organisms is **holozoic**. They reproduce mostly by the sexual mode. Some acellular organisms like **viruses and viroids** as well as the **lichens** are not included in the five kingdom system of classification.