DIVERSITY IN THE LIVING WORLD

PLANT DIVERSITY

Taxonomy : Taxis = arrangement, nomos = law

This word was proposed by A.P. de. Candolle in his book "Theories elementaire de Ia botanique" (Theory of elementary botany)

Taxonomy includes study of following points

(1) **Identification:** A process by which an organism is recognised from the other already known organisms and is assigned to a particular taxonomic group is called identification.

(2) **Nomenclature:** Naming of organisms according to international scientific rules is called nomenclature.

(3) **Classification:** A process by which any organism is grouped into convenient categories on the basis of some easily observable characters.

Systematics:-

The term systematics was given by Linnaeus. The word systematics derived from Latin word "Systema" which means "systematic arrangment of organisms". Linnaeus used "Systema Naturae" as a title of his publication. Systematics includes identification. nomenclature, classification and evolutionary relationship between organisms.

Note :- In modem taxonomical studies. taxonomists use external and internal structure. along with the structure of cell. development process and ecological information of organisms.

TYPES OF TAXONOMY

1. **Cytotaxonomy :** The use of cytological characters of plants in classification or in solving taxonomic, problems is called cytotaxonomy. Cytotaxonomy is based on cytological information like chromosome number, structure and behavior etc.

2. **Chemotaxonomy :** It is based on the chemical constituents of plants.

The basic chemical compounds used in chemotaxonomy are alkaloids, carotenoids, tannins, polysaccharide, nucleic acids, fatty acids, amino acids, aromatic compounds etc.

Some Informations :

- Practical significance of taxonomy is → Identification of unknown organism.
- Maximum diversity is found in tropical rain forests.
- Second maximum diversity is found in coral reefs
- The number of species that are known and described range between 1.7 - 1.8 million. This refers to biodiversity or the number and types of organism present on earth.

NOMENCLATURE

Binomial system :

Given by Carolus Linnaeus

Carolus Linnaeus :- Linnaeus used this nomenclature system for the first time on large scale and proposed scientific name of many plants and animals.

- Linnaeus is the founder of binomial system.
- Linnaeus proposed scientific name of plants in his book "Species plantarum". It was published on 1 May 17 53. So this was the initiation of binomial system for plants. So any name proposed (for plants) before this date is not accepted today.
- Linnaeus proposed scientific name of animals in his book "System nature" (10^{th} edition).
- This 10th edition of Systema naturae was published on 1 August 1758. So initiation of binomial system for animals is believed to be started on 1 Aug, 1758.

ICBN

"International Code of Botanical Nomenclature"

- Collection of rules regarding scientific nomenclature of plants is known as ICBN.
- ICBN was first accepted in 1961.

Main rules of ICBN :-

(1) According to binomial system name of any species consists of two components or words-

(i) Generic name - Name of genus

(ii) Specific epithet

e.g. Solanum tuberosum (Potato) Mangifera indica (Mango)

↓ ↓ ↓ ↓

Generic name Specific epithet Generic name Specific epithet

(2) In plant nomenclature (ICBN) autonyms are not valid i.e. generic name and specific epithet should not be same in plants.

eg. Mangifera mangifera

But autonyms are valid in animal nomenclature (ICZN-Intemational Code of Zoological Nomenclature)

eg. Naja naja (Indian cobra) , Rattus rattus (Rat)

(3) First letter of generic name should be in capital letter and first letter of specific epithet should be in small letter.

eg. Mangifera indica

(4) When written with free hand or typed, then generic name and specific epithet should be separately underlined. But during printing name should be in italics to indicate their Latin origin.

(5) Name of scientist (who proposed nomenclature) should be written in short after the specific epithet

eg. Mangifera indica Linn.

(6) Name of scientist should be neither underlined nor in italics, but written in Roman letters (simple alphabets)

(7) Scientific names should be derived from Latin (usually) or Greek languages because they are dead languages.

(8) Type specimen (Herbarium Sheet) of newly discovered plant should be placed in herbarium.

Trinomial system :-

- According to this system name of any organism is composed of three words -
  (i) Generic name (ii) Specific epithet (iii) Subspecific epithet (Name of variety)
  eg. Brassica oleracea botrytis (Cauliflower)
  Brassica oleracea capitata (Cabbage)
  Brassica oleracea caulorapa (Knol-Khol)
  ↓ ↓ ↓
  Generic name Specific epithet Variety

CLASSIFICATION

Biological classification :-

The art of identifying distinctions among organisms and placing them into groups that reflect their most significant features and relationship is called biological classification.
The purpose of biological classification is to organise the vast number of known organisms into categories that could be named, remembered and studied.

Type of Biological classification

(i) **Practical classification :-** In this type of classification, plants are classified on the basis of their economic importance or human use. This classification system is the earliest system.

e.g. Oil yielding plants → Coconut, Walnut, Soyabean
Fibre yielding plants → Jute, Cotton
Medicinal plants → Rauwolfia, Cinchona, Eucalyptus

Note : In this classification, any one plant can be a member of more than one group.
eg. Turmeric : Multi uses plant, it gives both medicines and spices.

(ii) **Artificial Classification :-** In this type of classification plants are classified on the basis of one or two morphological characters. i.e. over all morphology is not considered.
for e.g.- Classification proposed by Linnaeus is Artificial
Linnaeus classified plant kingdom on the basis stamen (mainly) into 24 classes.
Note:
(1) In the book "Genera Plantarum" Linnaeus classified the plant kingdom into 24 classes on the basis of stamen so, classification of Linnaeus is also called sexual classification.
(2) Linnaeus divided phanerogams (gymnosperm and angiosperms) into 23 classes and he included other plants such as algae, fungi, mosses (bryophytes) and ferns (pteridophytes) in a separate class called cryptogamia.
(3) In this system equal weightage is given to both vegetative and reproductive characters.

(iii) **Natural classification :-** In this type, plants are classified on the basis of their complete (gross) morphological characters of (stem, root, leaves, flowers etc.)

Importance-
Natural classification is believed to be the best classification, because it represents the natural similarities and dissimilarities of plants i.e. it represents the inter relationship among plants.
In this classification, the plants belonging to the same group show many similarities, while in artificial classification, the plants belonging to the same group shows only, 1 or 2 similar characters. They have many dissimilarities also.

Natural classification is of two types

(a) Natural non phylogenetic (b) Natural phylogenetic

(a) **Natural non phylogenetic** → In this classification, the phylogeny of the plant is not considered i.e. only the grass morphology of the plant is considered.

(b) **Natural phylogenetic** → In this classification, both grass morphology and phylogeny are considered. In phylogenetic classification, the plants are arranged on the basis of their evolution.

Lamarck - Proposed the term phylogeny.

Charles Darwin - Gave detailed explanation of phylogeny in his book "Origin of species" (1859). It was most popular book of it's time.

Thallophyta → Bryophyta → Pteridophyta → Gymnosperm → Angiosperm (most advanced plants

Note : Phylogenetic classification is also known as cladistic classification

(iv) **Phenetic classification or Numerical classification :-**

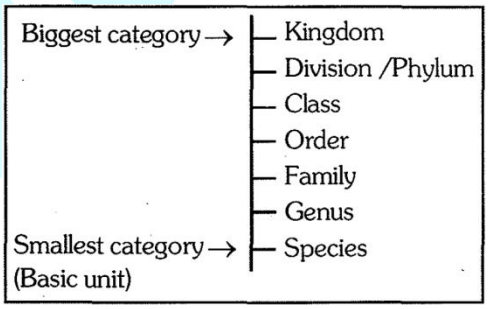
In it plants are classified on the basis of numbers of similarities and dissimilarities. This classification is easily carried out by using computers and it is based on all observable characteristics. In this classification number and codes are assigned to all the characters and the data are prepared and then processed. Those organism which have maximum similarities are placed in same group. In this way each character is given equal importance and at the same time hundreds of characters can be considered.

Note: In this classification importance to any one character is not given, all characters have same importance. While in natural classification floral (reproductive) characters have more importance than vegetative (root, stem and leaves) characters.

TAXONOMIC CATEGORIES

There are 7 main taxonomic categories. They are obligate or essential or broad categories i.e. they are strictly used at the time of any plant classification.

There are some extra or sub categories, like sub division, sub order, sub family, etc. They are used only when they are needed.



Classification of Mango :-

Taxonomic Categories		Taxa (Sing. Taxon)
Kingdom	—	Plantae
Division	—	Angiospermae
Class	—	Dicotyledonae
Order	—	Sapindales
Family	—	Anacardiaceae
Genus	—	*Mangifera*
Species	—	*Mangifera indica*

Classification of Wheat :-

Taxonomic Categories		Taxa (Sing. Taxon)
Kingdom	—	Plantae
Division	—	Angiospermae
Class	—	Monocotyledonae
Order	—	Poales
Family	—	Poaceae
Genus	—	*Triticum*
Species	—	*Triticum aestivum*

- The classification of any plant or animal is written in descending or ascending order.
- Hierarchy- Descending or ascending arrangement of taxonomic categories is known as hierarchy.
- Species - Smallest taxonomic category and basic unit of classification.

Note : As we go higher from species to kingdom number of common characters decreases. Lower the tax more are the characteristics that the members with in the tax on share. Higher the category greater is the difficulty of determining the relationship to other taxa at the same level.

Suffix for taxa (Taxon)

Division	—	phyta
Class	—	opsida, phyceae,ae
Order	—	ales
Family	—	aceae

Note : There is no suffix for Genus, Species and Kingdom

Classification is not a single step process but involves hierarchy of steps in which each step represents a rank or category since the category is a part of overall taxonomic arrangement it is called the taxonomic category and all categories together constitute the taxonomic hierarchy. Each category referred to as a unit of classification infect, represents a rank and is commonly termed as tax on (Pltaxa)

Species: Taxonomic studies consider a group of individual organism with fundamental similarities as a species. One should be able to distinguish one species from the other closely related species based on the distinct morphological differences.

Genus: Genus comprises a group of related species which has more characters in common in comparison to species of other genera. Each genus may have one or more than one specific epithet representing different organisms but having morphological similarities.

For example: Solanum tuberosum (potato). Solanum melongena (brinjal) and Solanum nigrum (Makoi) are three different but related species. Hence they all belong to the same genus Solanum.

Family: Family has a group of related genera with still less number of similarities as compared to genus and species. Families are characterised on the basis of both vegetative and

reproductive features of plant species but reproductive or sexual or floral characters are used mainly.

For example: Three different genera Solanum, Petunia and Datura are included in family Solanaceae.

Order : Order has a group of related families with still less number of similarities as compare to family, genus and species. Order being a higher category is the assemblage of families which exhibit a few similar characters only.

For example: Plant families like Convolvulaceae, Solanaceae are included in the order Polymoniales mainly based on the floral or reproductive or sexual characters.

Class: Class includes organisms of related orders having less similarities than orders.

Division: Division includes all organisms belonging to different classes having a few common characters.

Note: Order and other higher taxonomic categories are identified on the basis of aggregates of characters.

TAXONOMICAL AIDS

Biologists have established certain procedures and techniques to store and preserve the information as well as the specimens some of these are explained to help you understand the usage of these aids.

(1) Herbarium/Dry garden:- Herbarium is a store house of collected plant specimens that are dried pressed and preserved on sheet. Standard size of herbarium sheet is 11.5 x16.5 inches. Further these sheets are arranged according to a universally accepted system of classification. These specimens along with their descriptions on herbarium sheets become a store house or repository for future use. The herbarium sheets also carry a label providing information about date and place of collection. English local and botanical names, family, collector's name, etc. Herbaria also serve as quick referral systems in taxonomical studies.

(2) Botanical Gardens :- These specialised gardens have collections of living plants for reference. Plant species in these gardens are grown for identification purposes and each plant is labeled indicating its botanical/scientific name and its family. The famous botanical gardens are at Kew (England). Indian Botanical Garden, Howrah (India) and at National Botanical Research Institute, Luck now (India).

(3) Museum :- Biological museums are generally set up in educational institutes such as schools and colleges. Museums have collections of preserved plant and animal specimens for study and reference. Specimens are preserved in the containers or jars in preservative solutions. Plant and animal specimens may also be preserved as dry specimens. Insects are preserved in insect boxes after collecting, killing and pinning. Larger animals like birds and mammals are usually stuffed and preserved. Museums often have collections of skeletons of animals too.

(4) Zoological Parks :- These are the places where wild animals are kept in protected environments under human care and which enable us to learn about their food habits and behavior. All animals in a zoo are provided, as far as possible, the conditions similar to their natural habitats. Children love visiting these parks, commonly called Zoos.

(5) Key :- Key is used for identification of plants and animals based on the similarities and dissimilarities. (A booklet containing a list of characters and their alternates which are helpful in identification of varous taxa.)

- The keys are based on the contrasting characters generally in a pair called couplet. It represents the choice made between the two opposite options. This results in acceptance of only one and rejection of the other.

- Separate taxonomic keys are required for each taxonomic category such as family, genus and species for identification purpose.
- Each statement of couplet in the key is called a lead.
- Keys are generally analytical in nature.

Catalogue - It is a small booklet which gives account for books related to botanical titles, full name of authors and their publication. (A list that enumerates methodically all the species found in an area with brief description aiding identification.)

Flora - It contains the index, name and actual account of habitat and distribution of plants of a particular area.

Manuals - They are useful in providing information for identification of names of species found in an area.

Monographs - They contain information on any one taxon.

SPECIES CONCEPT

John Ray :- Proposed the term and concept of species. He described more than 18 thousands plants and animals in his book Historia generalis plantarum.

Biological concept of species :-

(1) Ernst Mayr (Darwin of 20th century) proposed the biological concept of species.

(2) Mayr defined the "species" in the form of biological concept.

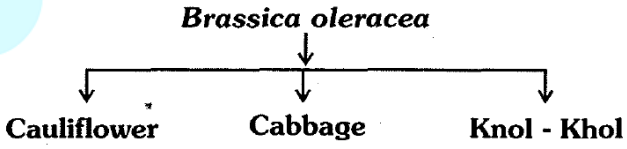
(3) According to Mayr "All the members that can interbreed among themself and can produce fertile offsprings are the members of same species"
But this definition of Mayr was incomplete because this definition is applicable to sexually reproducing living beings becau~e there are many organisms that have only asexual mode of reproduction.
eg. Bacteria, Mycoplasma, BGA

(4) The main character in determination of any species is interbreeding. But this character is not used in taxonomy. In taxonomy, the determination of species is mainly based on morphological characters.

Taxonomic concept of species :-

When the species is determined on the basis of morphological characters then it is called as taxonomic species.

eg. If two plants have almost same fundamental morphological characters, then they belong to same species.



These 3 have same morphological characters. Therefore they belong to same taxonomic species i.e. one taxonomic species.

- In higher plants, the determination of species is mainly based on the morphology of flower (floral morphology). Because floral (reproductive) characters are more conservative as compared to vegetative (Root, Stem, Leaf) characters i.e. they do not show major changes.

GOLDEN KEY POINTS

1. Word taxonomy was proposed by A.P. De. Candolle.
2. Practical significance of taxonomy is identification of unknown organisms.
3. It was Linnaeus who for the first time used 'BINOMIAL SYSTEM' at large scale.
4. ICBN was accepted· in 1961.
5. In practical classification plants are classified on the basis of their economic importance.
6. In artificial classification plants are classified on the basis of one or two morphological characters.
7. In natural classification plants are classified on the basis of their gross morphology.
8. In phonetic classification plants are classified on the basis of numbers of similarities and dissimilarities.
9. Species is smallest taxonomic category and basic unit of classification.
10. Each rank or taxon in fact represents a unit of classification. These taxonomic groups/categories are distinct biological entities and are not merely morphological aggregates.
11. Herbarium sheets are arranged in a universally accepted system of classification.
12. In museum insects are preserved in insect box after collecting, killing and pinning .
13. Biological concept of species is based on reproductive isolation.

BEGINNER'S BOX-1

1. Term systematic was derived from __ word "Systema" which means __ :-
(1) Greek, evolutionary relationship (2) Latin, systematic arrangment of organism
(3) English, taxonomy of organisms (4) Both 2 & 3

2. Taxonomically known number of species is :-
(1) 1. 7 billion (2) 1.7 lakh (3) 5-30 million (4) 1.7 million

3. Family is placed between:
(1) Genus and species (2) Order and class (3) Class and genus (4) Order and genus

4. Which of the following system of classification is based on gross morphology of plants ?
(1) Natural system (2) Artificial system (3) Practical system (4) All system

5. Which is first step in Taxonomy :-
(1) Phylogeny of the organism (2) Identification of the organism
(3) Nomenclature of the organism (4) Classification of the organism

6. Manuals are useful in providing information for :
(1) Identification of name of plant species
(2) Any one taxon
(3) Economic importance of plant species in a particuler areas
(4) Books related to botanical titles

7. Smallest unit of classification is :-
(1) Genus (2) Species (3) Order (4) Kingdom

8. Plant classification based on their economic importance is called :-
(1) Artificial classification (2) Practical classification
(3) Natural classification (4) Adansonian classification

HISTORY OF TAXONOMY

(1) Aristotle :- Father of biology & father of zoology

- He classified plants on the basis of morphological character (Growth habit) in three groups
  (i) Trees (ii) Shrubs (iii) Herbs

(2) Theophrastus :-

(A) He is known as father of ancient plant taxonomy and father of botany.
(B) Theophrastus wrote book on plants ⇒ Historia plantarum
(C) He classified plant kingdom in to four groups on the basis of growth habit-
(a) Trees (b) Shrubs (c) Under shrubs (d) Herbs
(D) It is artificial classification.
(E) He proposed the term Annual, Biennial and Perennial.

(3) Carolus Linnaeus :- [1707 - 1778]

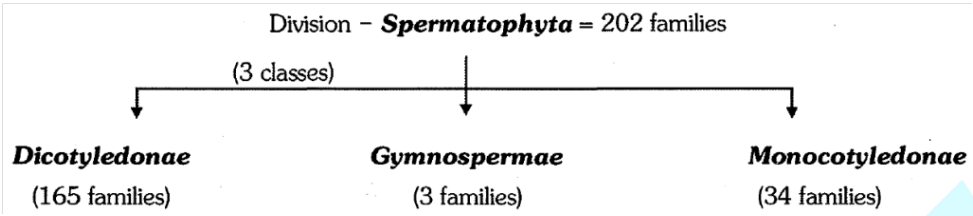
(A) His real name was -Carl Von Linne
(B) On the basis of work in Latin language, he changed his name to Carolus Linnaeus. He was the Swedish scientist
(C) He is known as father of taxonomy, father of plant taxonomy and father of animal taxonomy.
(D) Linnaeus gave the two kingdom system classification. He grouped plants and animals into kingdom Plantae and kingdom Animalia respectively.

Demerits of two kingdom classification :-

(1) In two kingdom classification (bacteria, blue green alage) and eukaryotes (fungi, mosses/bryophytes, fern/pteridophytes, gymnospem and angiosperm) placed in the same group plants/plantae.
The character that unified this whole kingdom was the all the organism included had a cell wall in their cells.
(2) In two kingdom system unicellular organism (Chlymydomonas and Chlorella) and multicellular organism (Spirogyra) are placed together under algae/plantae.
(3) 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.
(4) Position of Euglena is not fixed.

(4) George Bentham (1800 -1884) and Joseph Dalton Hooker (1817 -1911) :-

(A) Both Bentham and Hooker were related to Royal botanical garden.
(B) Scientists working in botanical garden are known as curator.
(C) They wrote the book "Genera plantarum" (1862- 1883).
In this book, Bentham and Hooker gave the biggest and natural classification of spermatophyta i.e. plants with seeds.



Merits of Bentham and Hooker classification :-

- The classification of Bentham and Hooker was natural.
- The classification of Behtham and Hooker was mainly based on the floral characters. This was very appreciable because floral characters are more stable than vegetative (root, stem, leaves) characters.
- It is the simplest classification. Although it is not the best classification but yet the arrangement of herbarium sheets in herbarium is based on it, because it is the simpler one. The main reason for its simplicity is that this classification is based on actual observations.

Demerits of Bentham and Hooker :-

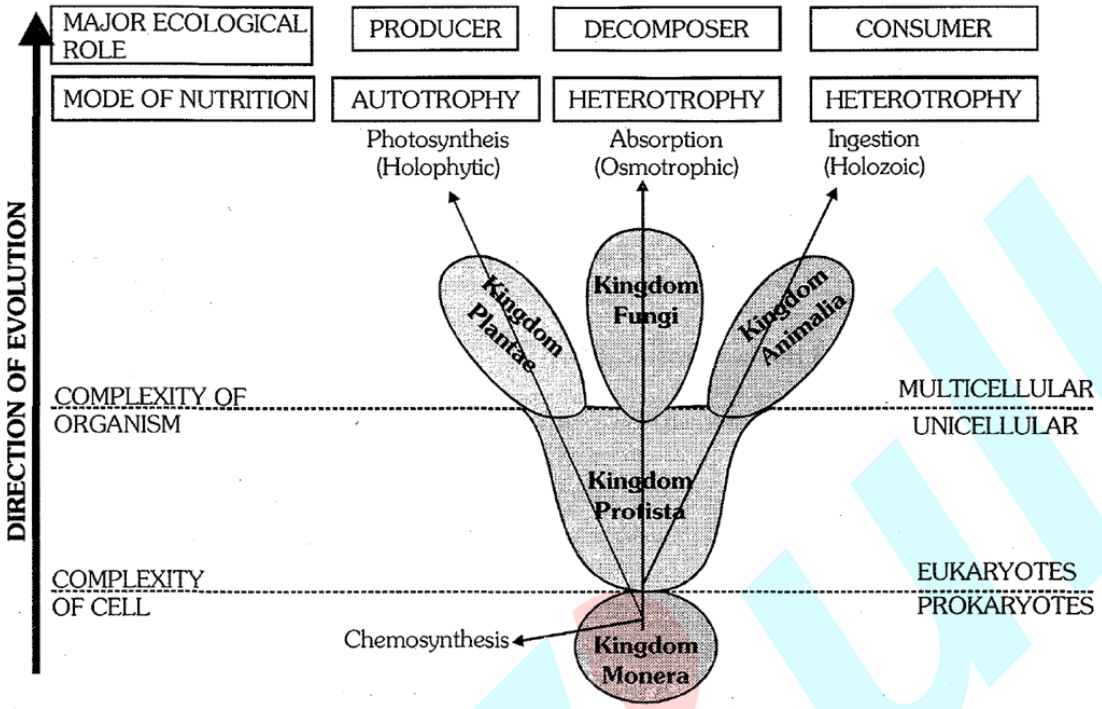
- In this classification the phylogeny of plants is not considered, because in it, gymnosperms are placed in between dicots and monocots. The sequence of evolution is as follows :-

  Phylogeny = Gymnosperm → Dicots → Monocots

(5) R. H. Whittaker (1969) :-

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

(i) Cell structure (Complexity of cell)
(ii) Thallus organisation (complexity of organism)/Body organization
(iii) Mode of nutrition
(iv) Reproduction/Life style
(v) Phylogenetic relationship



Five Kingdoms showing increasing complexity during evolution

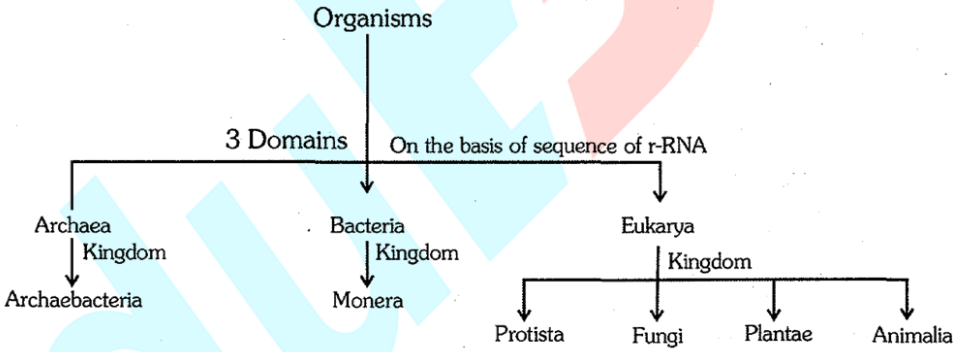
FIVE KINGDOM

1. **Monera :-** All the prokaryotes → (Eubacteria, Rickettsia, Chlamydia, Actinomycetes, BGA, Archaebacteria, Mycoplasma)
2. **Protista :-** All the Unicellular eukaryotes → [Dinoflagellates (Fire algae), Diatoms/Desmids (Golden algae), Euglenoids, Slime moulds (false fungi) and Protozoans]
3. **Fungi :-** All the True fungi→ (Phycomycetes, Ascomycetes, Basidiomycetes, Deuteromycetes)
4. **Plantae :-** All the multicellular eukaryotic plants → Algae [Green algae eg. Spirogyra, Brown algae, Red algae], Bryophyta, Pteridophyta, Gyrnnosperm,Angiosperm
5. **Animalia :-** All the multicellular eukaryotic animals

Note: (i) In five kingdom classification Virus, Viroid, Prions and Lichens are not mentioned.
(ii) According to five kingdom classification. Chlamydomonas and Chlorella are placed in kingdom protista.

CHARACTERISTICS OF THE FIVE KINGDOMS					
Characters	**Five Kingdoms**				
	Monera	**Protista**	**Fungi**	**Plantae**	**Animalia**
Cell type	Prokaryotic	Eukaryotic	Eukaryotic	Eukaryotic	Eukaryotic
Cell wall	Noncellulosic (Polysaccharide + amino acid	Present in some	Present (without cellulose) (with chitin)	Present (cellulose)	Absent
Nuclear membrane	Absent	Present	Present	Present	Present
Body organisation	Cellular	Cellular	Multiceullar/ loose tissue	Tissue / organ	Tissue / organ / organ system
Mode of nutrition	Autotrophic (chemosynthetic and photosynthetic) and Heterotrophic (saprophytic / parasitic)	Autotrophic (Photosynthetic) and Heterotrophic	Heterotrophic (Saprophytic/ Parasitic)	Autotrophic (Photosynthetic)	Heterotrophic (Holozoic / Saprophytic etc.)
Mode of reproduction	Conjugation (Sort of sexual reproductions)	Syngamy and conjugation	Fertilization	Fertilization	Fertilization

(6) **Carl Woese :-** He gave three domain theory. In these three domain 6 kingdoms are included. He suggested separate kingdom for Archaebacteria.



Note : Domain is a super kingdom category and extra taxonomic category

GOLDEN KEY POINTS

1. Theophrastus classified plant kingdom in to four groups on the basis of growth habit.
2. Theophrastus proposed the term annual, biennial and perennial.
3. Linnaeus proposed two kingdom classification.
4. Classification given by Linnaeus is artificial.
5. Classification proposed by Bentham and Hooker is natural.
6. Whittaker gave the five kingdom (Monera, Protista, Fungi, Plantae and Animalia) Classification.

KINGDOM-MONERA

(PROKARYOTES)

Bacteria are the sole members of Monera Kingdom.

Main characteristic of prokaryotes :-

(1) Cell wall :-

Cell wall of prokaryotes is made up, of peptidoglycan (murein) which is a type of mucopeptide.

(2) Cell membrane :-

(A) Like eukaryotes the cell membrane of prokaryotes is made up of lipoprotein [lipid + protein]

(B) The space between cell wall and cell membrane is known as periplasmic space. This space, is analogous to lysosome because in this space the digestion of complex substance is done.

(3) Cytoplasm :-

(A) The cytoplasm of prokaryotes lacks membrane bound cell organelles.

(B) In Prokaryotic cell, the nucleus is indistinct. The nucleus of prokaryotes is also known as incipient nucleus, genophore, nucleoid or fibrillar nucleus. Nuclear membrane is absent around nucleus. It also lacks nucleolus. Prokaryotes also lack the true chromosome. Instead of it, a false chromosome is present, which is made up of ds circular naked DNA+ Non histone protein like polyamines. This false chromosome coils and forms the chromosomal region, which is known as nucleoid.

(C) In prokaryotes ribosomes are of 70s type. Ribosome's are the site of protein synthesis.

Examples of Prokaryotes

(1) Eubacteria (True bacteria)
(2) Actinomycetes
(3) Blue Green Algae
(4) Mycoplasma
(5) Archaebacteria
(6) Rickettsia
(7) Chlamydia

EUBACTERIA

HISTORY

1. They were first observed in rainy water and later in teeth scum by Leeuwenhoek (1675) and called them "Animalcule".

2. F.J. Cohn and Ehrenberg first of all coined the name "Bacteria".

3. Bergey placed bacteria in "Prosophyta group" and wrote a book "Manual of Determinative Bacteriology/Microbiology". This book is known as "Bible of bacterial classification".

SHAPE

Bacteria have variations in their shape. On the basis of their shape bacteria are of different types.

1. Coccus/Cocci -

- ♦ These Bacteria are spherical
- ♦ These are smallest bacteria
- ♦ Maximum resistant bacteria

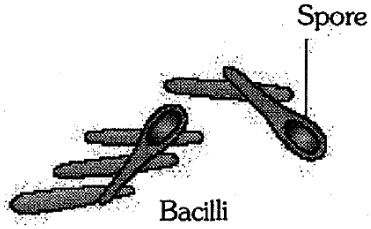
eg. Diplococcus pneumonia

Cocci

2. Bacillus/Bacilli - This group includes most of the bacteria

- ♦ These are rod shaped

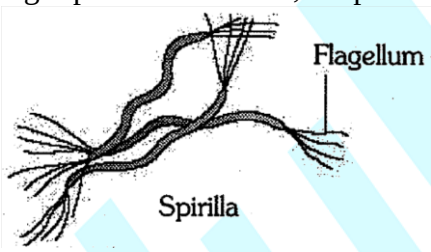
eg. E. coli, Bacillus anthracis



Bacilli

3. Spirillum/Spirilla - These are spiral shaped bacteria

e.g. Spirillum volutans, Treponema

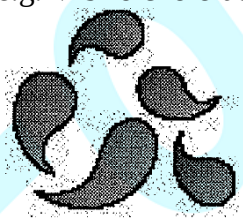


Spirilla

4. Comma/Vibrio -

- ♦ These are comma shaped bacteria

e.g. Vibrio ckolerae



Vibrio

MOTILITY IN BACTERIA

Bacteria are motile as well as non motile. Movement in bacteria takes place by means of flagella.

On the basis of number and arrangement of flagella (flagellation) bacteria are of following types

1. **Atrichous -** When flagella are absent, it is called atrichous form

e.g. Micrococcus

2. **Monotrichous -** When only one flagellum on one end of the bacterium

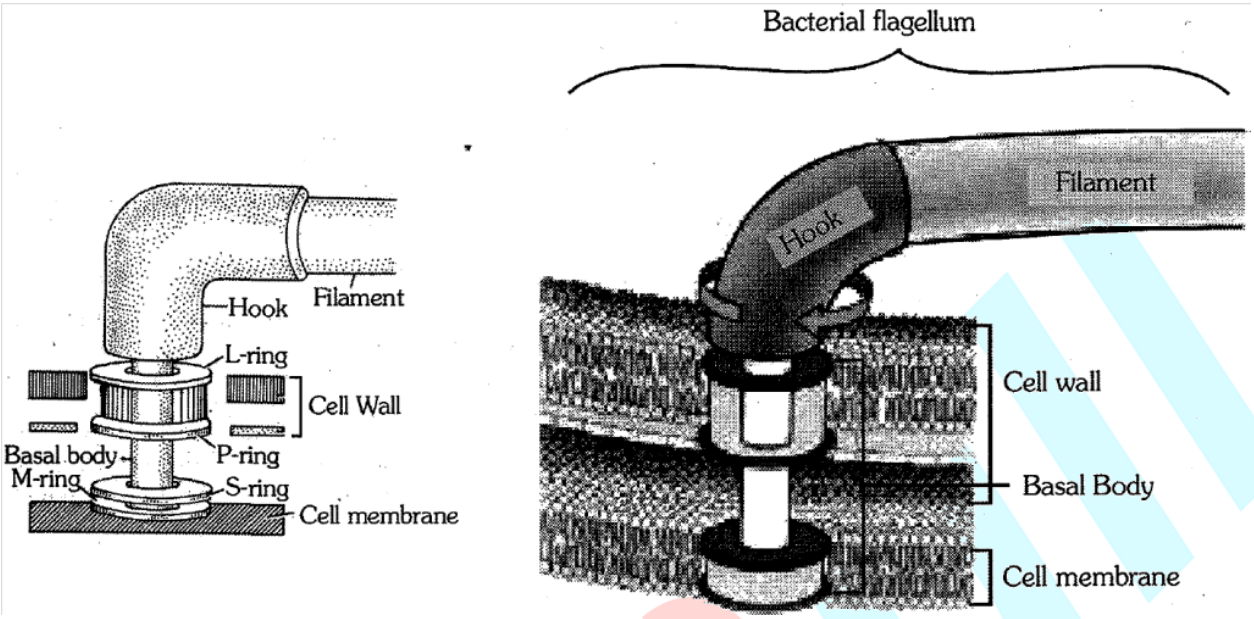
e.g. Vibrio

3. **Amphitrichous -** When single flagellum is present on both the ends of bacterium.
   e.g. Nitrosomonas
4. **Lophotrichous -** When a bunch of flagellum is present on both end of bacterium.
   e.g. Salmonella
5. **Cephalotrichous -** When a bunch of flagella is present on one end of bacteria.
   e.g. Corynebacterium
6. **Peritrichous -** When flagella are found on the whole body of bacterium
   e.g. E.coli., Salmonella typhi

STRUCTURE OF FLAGELLA

A flagellum of bacteria is made up of three parts
(1) Basal body (2) Hook (3) Filament

1. **Basal body -**
   A. It is the basal part of flagellum and rod shaped in structure.
   B. It lies with in the cell wall and cell membrane
   C. This proteinaceous rod shaped structure is surrounded by two pairs of rings
      (i) Outer pair (ii) Inner pair
   D. Outer pair of ring lies with in the cell wall. One ring of this pair is called Land the another called P.
   E. Inner ring of inner pair lies with in the cell membrane. One ring of this pair is called S and the another is M.
   F. In Gram (+) bacteria only one pair of rings (inner pair) is found.
2. **Hook-**
   A. It connects the basal body to filament
   B. It is the middle part of flagellum
   C. It's some part lies with in the cell wall.
3. **Filament -**
   A. It is cylindrical hollow structure made up of protein monomers.
   B. Each monomer is made up of ftagellin protein. Aagellin is a contractile protein.
   C. These monomers are arranged spirally in 4 + 4 manner.



PILI

1. Bacterial cell wall is covered by numerous hair like structures called pili. Pili are smaller than the flagella.
   (Pl.- Pili → Sing. - Pilus)
2. They are of two types- (A) Longer pili, (B) Shorter pili
3. Longer pili is also known as 'F' pili or 'sex' pili. Longer pili occurs in only donor (P or male) bacteria and help in conjugation. These are absent in recipient bacteria or female.
4. 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.

Structure-

1. Every pilus is cylindrical hollow structure and composed of protein monomers.
2. Each monomer is made up of 'pilln' protein. Pilin is non-contractile protein.
3. Pili do not play role in motility

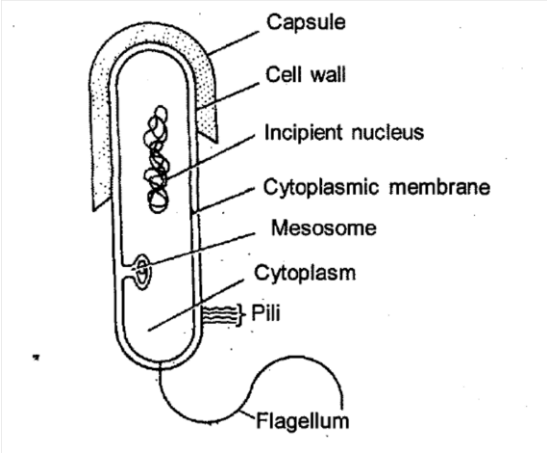
STRUCTURE OF EUBACTERIA

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.

(1) Outermost glycocalyx (may be capsule or slime layer)
(2) Cell wall
(3) Cell membrane

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



STRUCTURE OF A EUBACTERIAL CELL

1. Glycocalyx (Capsule or Slime layer)-

A. Loose and thin layer is called slime layer and thick and tough layer is called capsule. Formation of Glycocalyx is done by cell membrane.

B. Capsule is made up of polysaccharides and polypeptides while slime layer is made up of mainly polysaccharides.

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

2. Cell Wall-

Bacterial cell wall is rigid and made up of mainly peptidoglycan.

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.

L - form - Bacterial cell wall can be dissolved by lysozyme enzyme. When bacterial cell wall is removed artificially by Lysozyme then, bacteria are called L- form (Lister form).

3. Cell membrane-

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

4. Cytoplasm-

A. In bacterial cytoplasm membrane bound cell organelles viz. Mitochondria, Chloroplast, E.R., Lysosome, Golgibody, Microbodies etc. are absent.

B. Bacterial cytoplasm shows no streaming or cyclosis.

Cytoplasmic organelles -

1. Mesosomes-

A. The cell membrane of bacteria invaginates (extensions) in cytoplasm at different places and form mesosomes or chondrioid. These extensions are in the form of vesicles. tubules and lamellae.

Functions ofMesosomes :

(i) Cell respiration (increases the surface area of the plasma membranes and enzyme content)

(ii) Cell wall secretion.

(iii) DNA replication
(iv) Cell division (distribution of daughter cells).

B. Mesosomes functionally mitochondria like structures because respiratory (Oxidative) enzymes are found in mesosome.

2. Storage granules/Inclusion bodies -

Reserve material in prokaryotic cells are stored in the cytoplasm in the form of inclusion bodies. These are not bounded by any membrane system and lie free in the cytoplasm.

A. Glycogen granules- They store carbohydrate

B. Volute granules- These are also known as met achromatic granules. The volutin granules are phosphate polymers and function as storage reservoir for phosphate.

3. Chromatin material (Nucleotide)-

A. Nucleus of bacterial cell is called nucleotide or gonophores or incipient nucleus or fibrillar nucleus. Nuclear membrane and nucleolus are absent and DNA is ds circular naked.

B. Beside the main DNA another small and ds-circular DNA is also present in bacterial cell, which is called Plasmid. It is also known as extra chromosomal or extranuclear genetic material. (The term 'plasmid' was given by Lederberg).

C. Plasmids have the ability to replicate independently.

Plasmid are of many types on the basis of their functions and phenotypic characters.

(1) For fertility factor (F-plasmid) :-On the basis of presence or absence of 'F' factor, there are two mating types of bacteria.

(a) F^+ - Cells, carrying 'F' factor acts as donor and are called f^+ or male.

(b) F^- - Cells, lacking 'F factor acts as recipient and are called F^- or female.
When 'F" plasmid is attached with main DNA, it is designated as episome and this type of cell is known as Hfr (High frequency recombination) cell.

(2) R-Factor - Resistance to antibiotics.

STAINING OF BACTERIA

Gram Staining technique :

1. First of all H. C. Gram differentiated bacteria on the basis of staining.

2. In the first step of this method bacteria are stained with Crystal Violet or gentian violet and then KI solution.

3. After staining, bacteria are washed with Acetone or Ethyl alcohol. After washing some bacteria retain the stain and some bacteria are decolourised.

4. Bacteria which retain stain (violet or purple) are called Gram(+) and bacteria which decolourise are known as Gram(-). Gram(-) bacteria are counter stained by saffranine.

NUTRITION IN BACTERIA

Compared to many other organisms, 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.

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 -

- These bacteria use light energy for food synthesis.
- Photosynthetic pigments are present in cytoplasm for photosynthesis.
- In these bacteria photosynthesis is non oxygenic.

Some photosynthetic bacteria are :-

- Purple sulphur bacteria - e.g. Chromatium
- Green sulphur bacteria- e.g. Chlorobium, Thiothrix·
- Purple non sulphur bacteria- e.g. RhodospiriUum, Rhodopseudomonas

(ii) Chemosynthetic autotrophs -

- They use chemical energy instead of light energy for food synthesis.
- Chemical energy is obtained from oxidation of chemical compounds (inorganic or organic).

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

$$NH_3 \xrightarrow{\text{Nitrosomonas or Nitrococcus}} NO_2 \xrightarrow{\text{Nitrobacter}} NO_3$$

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

Heterotrophs

- Most of the bacteria are heterotrophic i.e.. they can not manufacture their own food. The majority of heterotophic bacteria are important decomposers. They are useful in making curd from milk, Production of antibiotic, fixing nitrogen in legumes. Some are pathogens to human being, animals and plants.
- 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.

These are of two types

(a) Obligate saprotrophic - These bacteria obtain food only from dead organic matter. These are completely saprotrophs

e.g. Bacillus vulgaris, Clostridium botulinum

(b) Facultative parasite- These are normally saprophytic in nature, but in the absence of dead organic matter they can become parasitic.

e.g. Pseudomonas, Staphylococcus

(ii) Parasitic bacteria - They obtain their food from living organism

These are of two types

(a) Obligate parasite - They always remain parasitic.

e.g. Mycobacterium leprae

(b) Facultative Saprotrophic - They are normally parasitic in nature but in the absence of living host, they may become saprotrophs

e.g. Mycobacterium tuberculosis

Symbiotic bacteria

These bacteria convert atmospheric nitrogen into nitrogenous compounds like Amino acid, NO_3 or Salts of ammonia. e.g. Rhizobium

RESPIRATION

On the basis of respiration bacteria are of two types

Aerobic bacteria

These are of two types

(A) **Obligate aerobic -** These are completely aerobic and die in the absence of O_2
eg. Azotobacter

(B) **Facultative anaerobic-** These are normally aerobic bacteria but can survive in the absence of O_2 eg. Acetobacter aceti (it causes souring of wine), Clostridium tetani

Anaerobic bacteria

These are of two types.

(A) **Obligate anaerobic -** These are completely anaerobic bacteria and do not have capacity of aerobic respiration.
eg. Clostridium botulinum

(B) **Facultative aerobic -** These are normally anaerobic but also have capacity of aerobic respiration.
eg. Fermentation bacteria (Lactobacillus) except Acetobacter aceti
Lactobacillus causes souring of milk.

REPRODUCTION

Bacteria reproduce by two methods

(1) Asexual reproduction (2) Genetic recombination

(1) **Asexual reproduction**

(i) **Binary fission -**

(a) This is the most common method of bacterial reproduction.

(b) Under favourable conditions first of all DNA replication takes place in bacterial cell then bacterial cell divides into two daughter cells due to formation of transverse septum in the centre of the cell. Each daughter cell grows into a new bacterium.

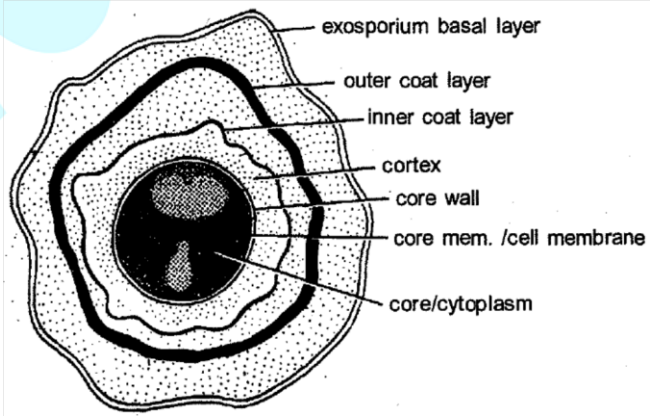
(c) Under favorable conditions, the cells of bacteria divides by amitosis which is faster than mitosis and meiosis.

(ii) **By Endospore -** Endospore formation occurs under unfavourable conditions.

(a) It is a highly resistant structure. It is resistant to temperature, radiations, antibiotics and chemicals.

(b) Endospore is highly resistant structure due to presence of Ca-dipicolinate in cortex.

(c) Endopspore formation is seen in mostly bacillus type bacteria.



2. Genetic Recombination -

Genetic Recombination includes three methods :

(I) Transformation (II) Transduction (III) Conjugation

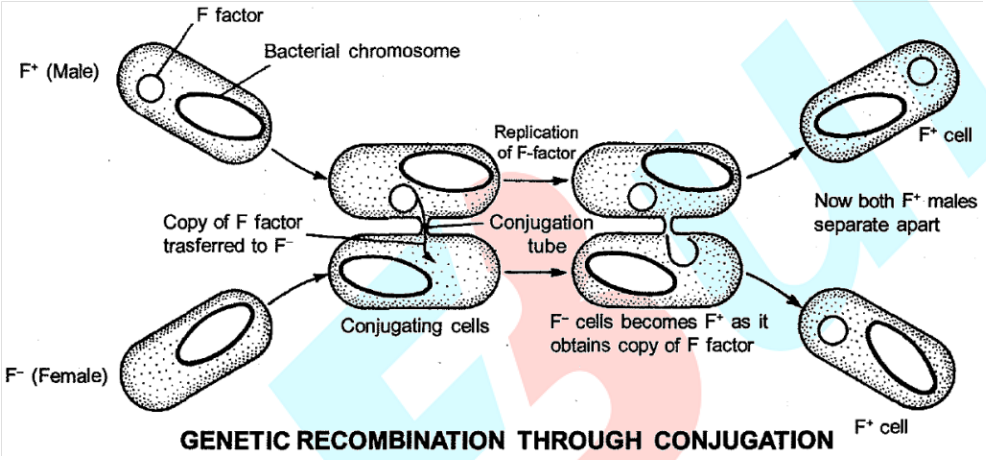
- Conjugation (between F^+ and F^- $\Rightarrow$ (Sort of sexual reproduction)

Conjugation was first discovered in 1946 by Lederberg and Tatum in E. coli.

(a) First of all donor cell (f^+) is attached to recipient cell (F^-) with the help of sex pili. Sex pili functions as conjugation tube.

(b) The 'F' factor (F plasmid) now replicates and the replica moves to F^- through conjugation tube.

(c) Both the cells are then separated. Due to transfer of 'F' factor F^- bacteria now becomes f^+ bacteria.



GENETIC RECOMBINATION THROUGH CONJUGATION

Differences between Gram positive and Gram negative Bacteria

	Gram positive	Gram negative
(1)	The bacteria remain purple coloured with Gram staining even after washing with alcohol.	The bacteria do not retain the stain when washed with alcohol.
(2)	Cell wall is single layered.	Cell wall is bilayered.
(3)	Cell wall of peptidoglycan is 20–80 nm. thick.	Cell wall of peptidoglycan is 8–12 nm. thick.
(4)	Murein (Peptidoglycan) content is 70–80%.	Murein (Peptidoglycan) content is 10–20%.
(5)	The wall is smooth.	Wall is wavy and comes in contact with cell membrane only at a few loci.
(6)	Basal body of the flagellum contains 2 rings (S & M).	Basal body of the flagellum has 4 rings (L, P, S & M).
(7)	Mesosomes are quite prominent.	Mesosomes are less prominent.
(8)	A few pathogenic bacteria belong to Gram–positive group.	Most of the pathogenic bacteria belong to Gram–negative group.
(9)	Teichoic acid present in cell wall	Teichoic acid absent

ECONOMIC IMPORTANCE OF BACTERIA

HARMFUL ACTIVITIES

1. Disease in Human beings :

Disease		Bacterium
Tuberculosis (T.B.)	-	Mycobacterium tuberculosis
Leprosy	-	Mycobacterium leprae
Tetanus	-	Clostridium tetani
Typhoid	-	Salmonella typhi
Cholera	-	Vibrio cholerae

2. Disease in Animals -

Anthrax	-	Bacillus anthracis
Black leg	-	Clostridium chauvoei

3. Disease in plants -

Citrus canker	-	Xanthomonas citri
Crown gall in many plants	-	Agrobacterium tumefaciens
Black leg and soft rot of potato	-	Erwinia camtovora atroseptica
Bacterial leaf blight of rice	-	Xanthomonas oryzae

4. **Denitrification - Denitrifying bacteria -**
Some bacteria convert soil nitrates into nitrites and then nitrogen. These bacteria reduce the fertility of soil. e.g. Thiobacillus denitrificans, Pseudomonas denitrificans

5. Food poisoning-

- Botulism- Clostridium botulinum-It is most lethal type of food poisoing. These bacteria survive in absence of 0 2.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.

6. Water pollution-
Several bacterial forms cause water pollution. These bacteria spoil the water.
e.g. Vibrio cholerae, Salmonella typhi.

7. Biological Weapons - Some bacteria are used as bio weapons such as Anthrax causing, Botulism, Cholera causing bacteria.

USERJL ACTIVITIES

1. Ammonification - Ammonifying bacteria -
Some bacteria convert Protein (present in decaying plants & animals) into Ammonia.
e.g., Bacillus vulgaris

2. Nitrification - Nitrifying bacteria -
These bacteria convert Ammonia in to Nitrite and later into Nitrate.

$$NH_3 \xrightarrow{\text{Nitrosomonas}} NO_2\,(\text{Nitrite}) \xrightarrow{\text{Nitrobacter}} NO_3\,(\text{Nitrate})$$

3. Nitrogen fixation - Nitrogen fixing bacteria -
These bacteria convert the atmospheric nitrogen into nitrogenous compounds like amino acids, nitrate or ammonium salts.
Nitrogen fixation is done by two methods -

(A) Symbiotically- Some bacteria live symbiotically and do nitrogen fixation.

e.g.
- Rhizobium - found in the root nodules of legumes
- Azorhizobium -found in the stem nodules of Sesbania plant

- Azospirillum-Found on root surface of cereals i.e., superficial symbiosis (eg. Wheat, Rice, Maize).
- Frankia (Filamentous bacteria or actinomycetes) -It is found In root nodules of non leguminous plant Casuarina and Alnus plants.

(B) Asymbiotically - Some bacteria are found freely in soil and do nitrogen fixation.

e.g. Clostridium, Chromatium, Azotobacter, Azospirillum, Beijernickia Rhodomicrobium, RhodospiriUum, Rhodopseudomonas

Note : Azotobacter and Beijemickia are aerobic Rhodospirillum is anaerobic bacteria. Both Rhizobium and Frankia are free living in son, but as symbionts, can fix atmospheric nitrogen.

4. Dairy products -

Dairy products are formed with the help of bacterial fermentation.

$$\text{Milk} \xrightarrow[\text{Lactobacillus lactis}]{\text{Streptococcus lactis or}} \text{Curd}$$

Note : Lactobacillus lactis (LAB/Lactic acid bacteria) increase vitamin B_{12} in curd LAB also help in checking the disease causing microbes in stomach.

5. Antibiotics -

- For example streptomycin is obtained from Streptomyces griseus (It is an actinomycetes)
- Term antibiotic was given by S.A. Waksman
- First discovered antibiotic was Penicillin it was obtained from fungi Penicillium.
- First discovered antibiotic from bacteria was streptomycin.
- Many antibiotic medicines are obtained from the bacteria.
- Some substances produced by microorganism which inhibit the growth of other micro-organism are called antibiotic substances.

6. Industries -

Many bacteria are used in industries

(A) Vinegar formation (Acetic acid) -

$$\text{Ethanol} \xrightarrow{\text{Acerobacter aceti}} \text{Acetic acid}$$

(B) Retting of fibres - Separation of fibres from plants by the help of bacteria

e.g. Clostridium, Butyric acid bacteria

(C) Flavoring /curing of tea leaves and processing of tobacco leaves-

g. Bacillus megatherium, Micrococcus condiscence

(D) Production of Vitamins-

- Clostridium butylicum produces → Riboflavin (Vit. B_2) and Butyric acid
- Propionibacterium and Bacillus megatherium produce- Vit. B_{12}
- E.coli(coliforrn bacteria) produces → Vit. E., Vit. K.
- E. coli bacteria found in alimentary canal of human beings.

7. Purity of Ganga water - In Gangatic water a bacteria Bdellovibrio bacteriovorus is found, they kill the other water polluting bacteria.

8. 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.

9. Bacteria for genetic engineering -

eg. E. coli and Agro bacterium → These are Gram(-) bacteria

BLUE GREEN ALGAE (B.G.A)

(A) According to Two kingdom system B.G.A. were included in class Cyanophyceae or Myxophyceae of Algae. But now they are included in Kingdom Monera, because of their prokaryotic nature.

(B) B.G.A. is now known as cyanobacteria. The name cyanobacteria was suggested by ICNB [International Code of Nomenclature for Bacteria).

(C) BGA are found in fresh water (mostly), marine water and terrestrial habitat.

(D) Cyanobacteria are photosynthetic oxygenic prokaryotes .
Cyanobacteria were the first organisms that produced O_2 on our earth.

They have following pigments.

- Chlrophyll 'a' - green
- Carotenoids- yellow
- C - Phycocyanin - blue
- C - Phycoerythrin - red

Note: Cyanobacteria are not always of blue-green colour. eg. Trichodesmium is a red coloured. The red colour of water of red sea is due to this alga.

Different forms of BGA or Cyanobacteria :

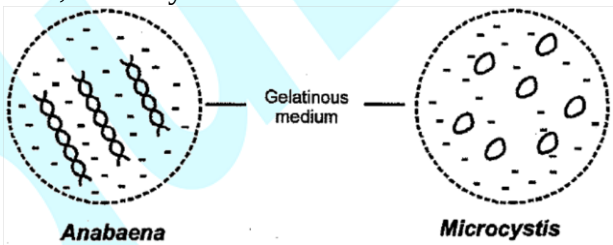
(A) Unicellular :- Some B.G.A. are found only in unicellular forms.

eg. *Spirulina*

Note : Spirulina is an edible B.G.A. because it has very large amount of proteins. It can be grown artificially in water tanks. It is used as a fodder for cattle

(B) Colonial:- Some B.G.A. are found in colony. i.e. cell colonies.

eg. Anabaena, Microcystis



(C) Filamentous :- Some B.G.A. are filamentous. There are many cells arranged in a row in their body. The filament of B.G.A. is known as trichome.

Eg. Oscillatoria

Structure of B.G.A. :-

(A) The structure of B.G.A. is similar to Gram (-ve) eubacteria.

(B) B.G.A. are surrounded by a mucilagenous sheath. This sheath is made up of mucopolysaccharides [Pectic acid]. The cell wall of B.G.A. is also bilayered. Outer wall is made up of lipopolysaccharides and the inner wall is made up of peptidoglycan.

(C) The cell membrane of B.G.A. is also made up of lipoproteins.

Cytoplasm of BGA contains following structures :-

(a) Thylakoid or chromatophore- These are membrane bound structure which contains photo synthetic pigment.

(b) Inclusion bodies-

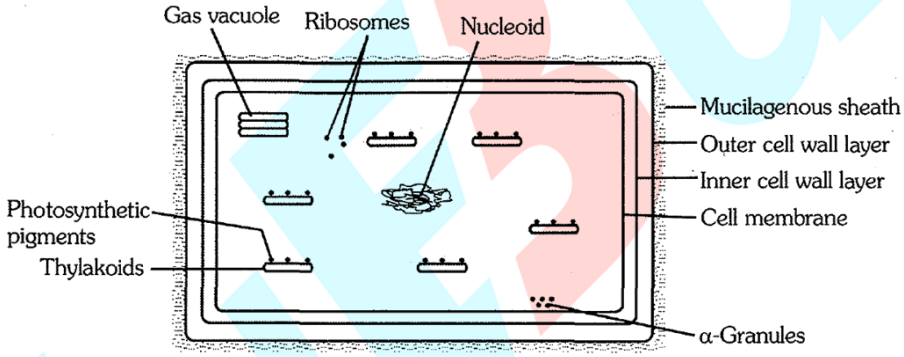
(1) B.G.A. store its food in the form of a-granules.

- α-granules -They are made up of cyanophycean starch. It is structurally similar to glycogen.

(2) Gas vacuole-it is membrane bound structure and found in blue green algae, purple and green photosynthetic eubacteria.

(c) Nucleoid/DNA – ds circular naked

(d) Ribosomes – 70s type



Nitrogen fixstion :-

(A) Some of the B.G.A., can perform Nitrogen fixation. They converts atmospheric nitrogen in to nitrogenous compounds like amino acids, nitrates. These nitrates increases the fertility of soil. Hence B.G.A. improves the fertility of soil by nitrogen fixation.

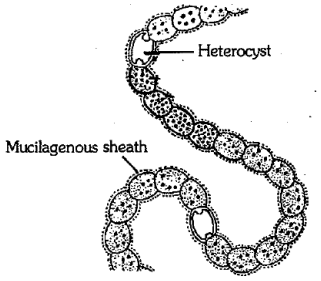
(B) B.G.A. fix nitrogen in two forms:-

Symbiotic form and Asymbiotic or free living form

Symbiotic form	**Free living form**
eg. ***Anabaena*** & ***Nostoc*** These B.G.A. form symbiotic association with many plants and performs nitrogen fixation. **for eg :-** ☛ In the leaves of ***Azolla*** ☛ In the coralloid roots of ***Cycas*** ***Azolla*** → If *Azolla* is grown with rice, than the production increases up to 50% [because ***Anabaena*** are found in the leaves of ***Azolla***]	eg. ***Anabaena, Nostoc*** Some B.G.A. are found free living in water and soil and perform nitrogen fixation. ***Aulosira*** → This.B.G.A. is found in plenty in paddy fields. It germinates in water. This B.G.A. performs nitrogen fixation due to which the production of rice is increased. ***Oscillatoria*** = also fix N_2 in paddy fields.

IMPORTANT POINT

A special type of cell is found for nitrogen fixation in BGA which is known as heterocyst. Heterocyst is thick walled, non green cell.



Nostoc

REPRODUCTION

In BGA reproduction is done by two main processes

(1) Vegetative (2) Asexual

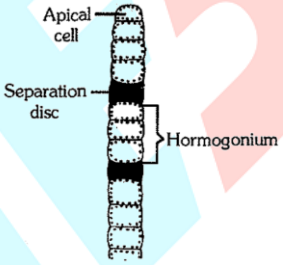
(1) Vegetative Reproduction :

(i) Binary fission :-

This is the most common method of reproduction in prokaryotes.

eg. Spirulina

(ii) Fragmentation :- By Hormogonia (Hormocyst) formation. Filamentous prokaryotes, reproduce by this process. eg. Oscillatoria

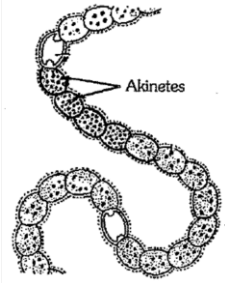


Oscillatoria

(2) Asexual Reproduction :-

It is method of protection to overcome unfavourable conditions

eg. - Akinete formation in Nostoc



Nostoc

WATER BLOOM :-

"Excessive growth of blue green algae in polluted water bodies is called bloom"

ECONOMIC IMPORTANCE OF BGA

Useful activities :-

(1) It gives fertility to sterile alkaline soil and usar soil. B.G.A. secrete acidic chemical which decrease the alkalinity of soil
(2) Some B. G.A. are used as green manure
(3) Some B.G.A. secrete toxin, which inhibits the growth of mosquito larva in water

Harmful activities :-

(1) Water bloom (2) B.G.A. that grow in water tanks, pollute the water eg. Oscillatoria

MYCOPLASMA

- In 1898, two French scientists E. No card and R. Roux while studying pleural fluids of cattle suffering from pleuropneumonia disease, discovered the organisms which are known as mycoplasma and were designated as PPLO (i.e. Pleuropneumonia like organism).
- Nowak (1929) put these organisms under the genus Mycoplasma.
- The Japaneese Doi et.al. (1967) first discovered that the "Aster yellow" diseases of plants are caused by Mycoplasma. Doi et.al. named these pleomorphic organisms as mycoplasma like organisms (MLO). According to Doi, phloem cells (Sieve tube & phloem parenchyma) of plants are much affected by this disease.

MAINS POINTS :-

1. Mycoplasmas are unicellular, smallest prokaryotic organisms.
2. Cell membrane is tri-layered and made up of lipoprotein. Both DNA (ds DNA ciruclar mainly) and RNA (ssRNA) are present.
3. They are cell wall less hence, they exhibit pleomorphism and thus called as Joker of microbiology or plant kingdom.
4. Osmotrophic mode of nutrition (absorption of nutrients by osmosis) is found in Mycoplasra.
5. They are resistant to antibiotics like penicillin which act on cell wall.
6. They are sensitive to tetracycline & chloramphenicol that act on metabolic activities.
7. Most of the species of Mycoplasma are facultative anaerobs. (Mycoplasma can survive without oxygen)
8. Species of Mycoplasma are saprophyte or facultative parasite.

Reproduction

1. Binary fission: Most common method of reproduction in Mycoplasma ..
2. By primary structures or "Elementary bodies"

Piant disease

(i) Little leaf disease of Brinjal
(ii) Bunchy top of papaya.
(iii) Witches broom of Ground nut (Legume) I Potato.
(iv) Aster yellow disease of sunflower.

Note : In plants, mycoplasmal diseases are usually transmitted by leaf hopper.

ARCHAEBACTERIA

"Group of ancient bacteria"

- Evolutionary they are primitive. They were the first to be born on our planet and they are present nowadays with their primitive characters. They are the "Oldest living fossils".
- Mostly archaebacteria are obligate anaerobes.
- Thermococcus, Methanococcus and Methanobacterium exemplify archaebacteria that contain proteins homologous to eukaryotic core histones.
- 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.
- Their cell membrane is not a unit membrane, while in eubacteria the cell membrane is unit membrane. Cell membrane of archaebacteria is highly complex because of branched lipid chain.
- Due to complex cell wall and cell membrane archaebacteria can survive in harsh habitat.

Archaebacteria includes following bacteria

1. Methanogens :-

"Methane producing bacteria"

(a) Methanogens are found in manshy area and gobar gas fermenter and produce methane. eg. Methanobacterium, Methanococcus, Methanomicrobium

(b) An archaebacterium (Rumenococcus) is found in the rumen of cattle and responsible for the production of methane (biogas)

2. Halophiles :-

These archaebacteria are found in extreme salty areas.

3. Thermoacidophiles :-

(A) These archaebacteria are found at those places where temperature is approx 80°C to 100°C and medium is acidic. [pH = 2]

(B) They are found in hot sulphur springs. Hot water sulphur springs are found in the Himalyan region.

Note : Barophilic prokaryotes - Prokaryotes which grow and multiply in very deep marine sediments.

GOLDEN KEY POINTS

1. The cytoplasm of prokaryotes lack membrane bounded cell organelles.

2. Cyanobacteria are Gram(–), photosynthetic and oxygenic prokaryotes.

3. Though the bacterial structure is very simple, they are very complex in behaviour, because they are both autotroph (Phototrophs and Chemotrophs) and heterotrophs (Parasites, Saprophytes and Symbionts).

4. As a group bacteria show most extensive metabolic diversity.

5. Cell membrane of archaebacteria is not unit membrane.

6. 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. There cell wall contain mycolic acid. Filamentous bacteria are heterotrophus.

e.g Streptomycetes (Source of antibiotics), Mycobacterium, Beggiattoa, Noccardia, Frankia

7. Rickettisia are also small and parasitic bacteria.

BEGINNER'S BOX-2

1. The bacteria which are associated with some plant roots and fix atmospheric nitrogen are :-
(1) Azotobacter (2) E. coli (3) Rhizobium (4) Pseudomonas

2. In paddy field blue green algae are grown:
(1) For medicinal use (2) To increase fertility of soil
(3) To serve as food for fishes (4) To conserve water

3. The digestive tracts of ruminants contain :
(1) Halophilic bacteria (2) Methanogens
(3) Thermoacidophile bacteria (4) Mycoplasma

4. Archaebacteria differ from eubacteria in one of the following respect :
(1) Their cell wall lack peptidoglycan
(2) They tolerate extreme environment
(3) They have uniquecell membrane with branched lipid chain
(4) All of these

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

6. Which of the following may be used in the reclamation of soil?
(1) Mycoplasma (2) Methanogen (3) Nostoc (4) E. coli

7. Murein is found in the cell wall of :-
(1) Diatoms (2) Cyanobacteria (3)Archaea (4) Mycoplasma

8. Which of the following is first oxygenic photosynthetic organism?
(1) Green algae (2) Red algae (3) Blue-green algae (4) Golden algae

9. Teichoic acid is present in :-
(1) Gram + ve bacteria (2) Gram - ve bacteria
(3) Mycoplasma (4) Blue green algae

10. Blue green algae can photosynthesize due to presence of :-
(1) Heterocyst (2) Akinetes (3) Chromatophore (4) Leghaemoglobin

KINGDOM - PROTISTA

All the organism included in Protista are unicellular (acellular) eukaryotes. Members of protista are primarly aquatic. This kingdom forms a link with the others dealing with plants, animals and fungi. Boundaries of this kingdom are not well defined.

Living organisms included in Protista are as follow

Dinoflagellates, Cryophytes, Euglenoids, Slime molds, Protozoans

Reproduction :-

Protists reproduce Asexually and Sexually

1. Asexual Reproduction :-

This is the most common method of reproduction in protists.

It is of following types

(a) Binary fission :- Two daughter cells are formed by the division of one mother cell. After this each daughter cell grows to form a normal organism.
eg. Dinoflagellates, Chrysophytes, Euglenoids

(b) Spore formation :- Some protists have special structure known as sporangia. Spores are formed in sporangia. The sporangium bursts after sometime and all the spores become free. Every spore forms a new member.
eg. Slime moulds

2. Sexual Reproduction:-

Sexual reproduction was first of all seen in. protists. In sexual reproduction two haploid gametes fuse to form a, diploid zygote. This process is known as syngamy.

Syngamy is of three types

(a) Isogamy :- It is the simplest way of sexual reproduction. In isogamy the fusing gametes are morphologically (i.e. shape, size, structure) similar but physiologically (i.e. functionally or genetically) they may be similar or dissimilar when fusing gametes are physiologically dissimilar, process is called physiological anis gamy.

(b) Anisogamy :- The fusing gametes are morphologically dissimilar (smaller - larger) but physiologically they may be similar or dissimilar (usually).

(c) Oogamy :-

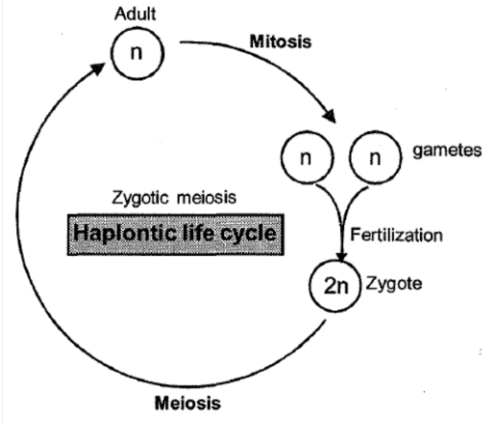
It is the developed form of anisogamy. Male gamete is small and motile while female gamete is large and non motile. This female gamete is known as egg. In it the formation of male & female gametes take place in sex organs. In this process the female gamete remains within the female reproductive structure, it does not come outside.

Patterns of Life Cycle

(1) Life cycle showing zygotic meiosis:-

When Protest is haploid and meiosis occurs in zygote then it is known as zygotic meiosis. In this type of life cycle during sexual reproduction gametes are formed by mitosis. These gametes are haploid: These gametes fuse to form a diploid zygote. After that meiosis takes place in zygote, as a result haploid cells are formed again.

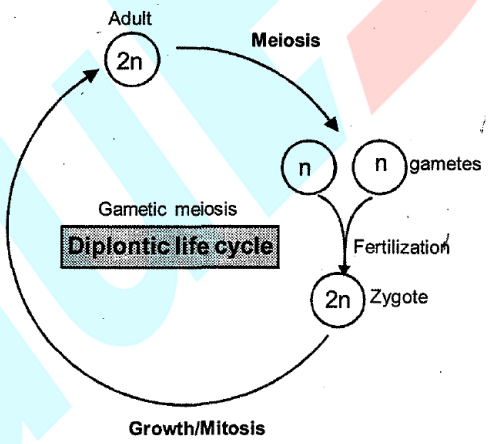
Note : In this type of life cycle the zygotic phase is only diploid and remaining all the phases are haploid so this type of life cycle is known as haplontic life cycle.
eg. Dinoflagellates



(2) Life cycle showing gametic meiosis :-

When Protist is diploid and meiosis takes place during gamete formation, then it is called gametic meiosis. In this type of life cycle during sexual reproduction, meiosis takes place in diploid cell , due to which haploid gametes are formed. Now haploid gametes fuse to form diploid zygote. And after that mitosis takes place in zygote, due to which diploid cells are formed again.

Note : In this type of life cycle only gametic phase is haploid and remaining all phases are diploid so this type of life cycle is known as diplontic life cycle.
eg. Diatoms



Division – Pyrrophyta – Class Dinophyceae – DINOFLAGELLATES

"Protist with two flagella"

- Dinoflagellates are mainly marine. They are found on the surface of water. They appear yellow. Green, brown blue or red depanding on the main pigments present in their cells.
- In Dinoflagellates, the nutrition is mainly holophytic (Plant like nutrition I Photosynthesis).

eg. of dinoflagellates -
Ceratium, Gonyaulax, Gymnodinium, Pyrocystis

Structure :-

(A) Their cell wall is divided in to plates, which is made up of cellulose. Therefore the covering of Din flagellates is seen as armored so they are called armored algae.

(B) Din flagellates have two flagella - one lies longitudinally and the other transversely in a furrow between the wall plates. Din flagellates show a special type of movement which is like whirling whips, therefore they are called as "whirling whips".

(C) Cell is eukaryotic but histone protein is absent in its chromosome. Due to this reason Din flagellates are called mesokaryote.

(D) Din flagellates are yellow-brown or golden brown in colour. These colour of Din flagellates are due to the pigments present in them- Chlorophyll'a', Chi. 'c' and Xanthophylls (Dinoxanthin & Didinoxanthin).

Stored food- Starch

Some informations of Dinoflagellates -

1. Dinoflagellates show 'bioluminescence' due to presence of photogenic granules in cytoplasm, so these dinoflagellates are also known as 'night light'. Dinoflagellates are also called "fire algae", because they appear as glowing light due to bioluminescence.

2. Gonyaulax spreads on the surface of sea water. through rapid multiplication due to which the sea water appears red. It is called red tide.

3. Both Gymnodinium & Gonya.u lax are toxic. They secrete toxins. These toxins cause paralysis in human beings. Humans acquire these toxins through food chain. These algae also affect the marine animals (water bloom).

Dinoflagellates

DIVISION - SHRYSOPHYTA

This group includes diatoms and golden algae (desmids). They are found in fresh water (mainly desmids) as well as in marine (mainly diatoms) environment.

Structure of diatom :-

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

2. The cell wall 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".

Note : 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 descomposed after their death so at the bottom of sea, very huge rocks of dead diatoms are formed which is known as "diatomite" or "diatomaceous earth" or "keiselgurh".

3. Diatoms have pigments Chlorophyll 'a', Chi 'c', and xanthophyll (fucoxanthin).

4. They are chief producers in the ocean.

5. **Stored food-** Leucosin (Chrysolaminarin) & fats (Oil).

6. **Movement-** They are irnmotile, because flagella are absent in them. They float passively on the surface of water.

Note : In diatoms, during reproduction special type of spores are formed which are known as "Auxospore".

Use of Diatoms :-

(A) Sound proofing (B) Filteration of oils and syrups (C) Stone polishing

(D) As "Heat insulator" in steam boilers because the keiselgurh is bad conductor of heat.

Division - Euglenophyta - EUGLENOIDS

- 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 (stagnant water) etc. But some times 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 hetertrophs by predating on other smaller organisms.

eg. of Euglenoids - Euglena

Structure :-

(A) 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.

(B) At the anterior end of Euglenoids, a cavity is present, which is known as reservoir. Flagellum is orginated from the base of reservoir. Euglenoids have only one functional flagellum and one non functional flagellum. One eye spot is present at anterior position.

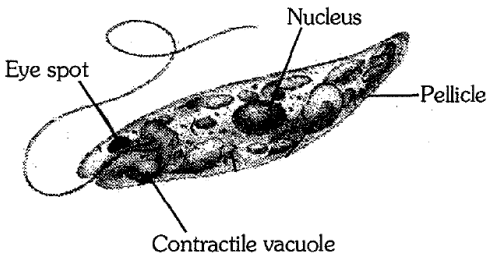
(C) They have a contractile vacuole. The contractile vacuole helps in osmoregulation.

(D) Eulgenoids have chloroplasts.

Chloroplast has following pigments -

Chi. 'a', Chi. 'b' and Xanthophyll (Zeaxanthin)- These pigments are identical to higher plants

(E) Stored food- Paramylum and fat



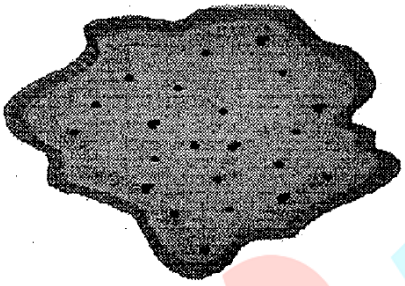
Euglena

SLIME MOULDS/MYXOMYCETES [Consumer - decomposer]

(1) These organisms develop a slimy mass at the time of their vegetative phase, therefore they are called slime moulds. They are also called as false fungi.

(2) Slime moulds are saprophytic found on decaying twigs and the leaves body moves along decaying twig engulfing organic material.

(3) Under suitable conditions they form an aggregation which may grow and spread over several feet called, plasmodium. During unfavorable 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.
eg. Physarum



Slime mould

KINGDOM – FUNGI

Mycology	-	Study of fungi
Father of Mycology	-	P.A. Michele → book. Nova Plant arum Genera

CHARACTERS

(1) Fungi show a great diversity in morphology and habitat. Fungi are cosmopolitan. They prefer to grow in warm and humid places. Fungi are found mostly in humus rich soil. But in the presence of moisture, these can grow on leather, wood, pickle, bread and rotten fruits. Some fungi live parasitically in plants, animals and human body.

(2) Chloroplast is absent in fungi, so fungi are heterotrophs. The fungi constitute the unique kingdom of heterotrophic organism. Fungi obtain their own food from dead organic matter or living organisms.

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

(a) **Saprophytic :-** These fungi obtain their own food from dead organic matter such as bread, rattening fruit, vegetable and dung.

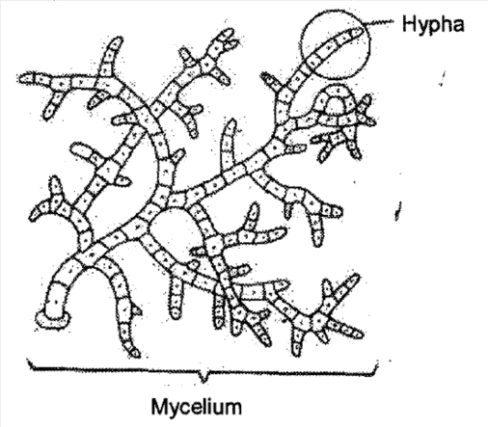
- Nutrition is of absorptive type in saprophytic fungi

(b) **Parasitic :-** These obtain their own food from living organism such as plants, animals and human beings.

- They obtain nutrition with the help of haustoria.

(3) Some fungi are found symbiotically associated with algae and form lichens. Some fungi are found symbiotically in the roots of higher plants and form mycorrhiza.

(4) The body of fungi is called mycelium. Mycelium is composed of filaments called hypha.
(Hypha- plural → Hyphae)



(5) Cell wall is made up of chitin (fungal cellulose) and polysaccharides but Cell wall of the members of classoomycetes is mainly made up of cellulose.

(6) In fungi the stored food remains in the form of glycogen and oil .

Heterothallism and Homothallism :

Homothallic fungi :-

Those in which every thallus is sexually self fertile and can, therefore, reproduce sexually by itself without the aid of another thallus.
e.g. Chaetomium, Albugo candida

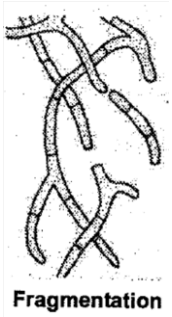
Heterothallic fungi :-

Those in which every thallus is sexually self-sterile and requires the aid of another compatible thallus of a different mating type for sexual reproduction.
e.g. Species of Mucor, Rhizopus, Puccinia & Maximum fungi

REPRODUCTION

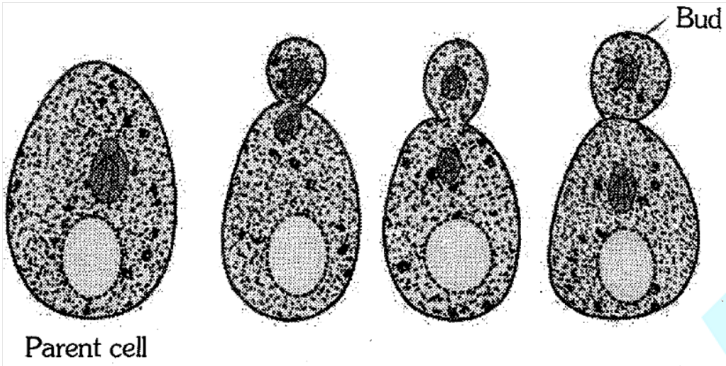
(1) Vegetative reproduction:-

(A) Fragmentation :- Some times the fungal filament (mycelium) breaks into small pieces due to any reason. Now these pieces form a new fungal filament and starts working like normal filament.


Fragmentation

(B) Budding :-

eg. : Saccharomyces (Yeast)



Budding in yeast

(C) Fission :-

eg. : Schizosaccharomyces (Yeast)

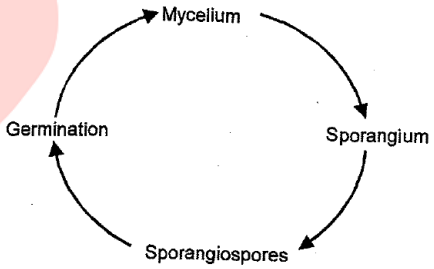
Note : Reproduction through bud formation and fission takes place only in nonmycelial form.

(2) Asexual reproduction -

Asexual reproduction takes place by the formation of different types of spores. These spores are formed by mitotic division.

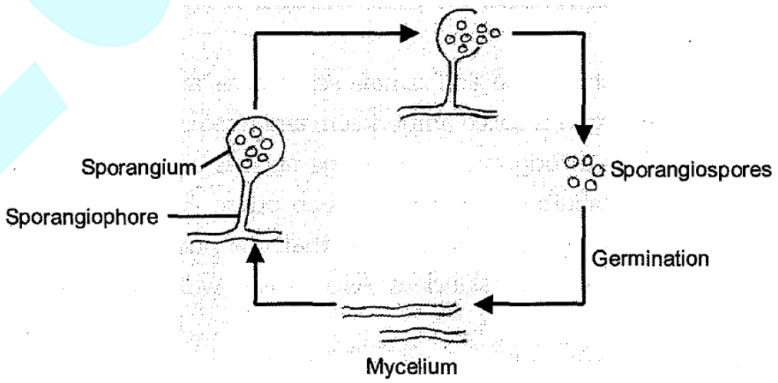
Spores are the following types

(A) Sporangiospores: They are formed in sporangium. Sporangium is formed at the tip of fungal filament. Those fungal filaments on which sporangia are formed is called as sporangiophore. Numerous spores (sporangiospores) are present in the sporangium, that comes out by rupturing of sporangium and germinate to form fungal filaments. The formation of sporangiospores takes place endogenously.

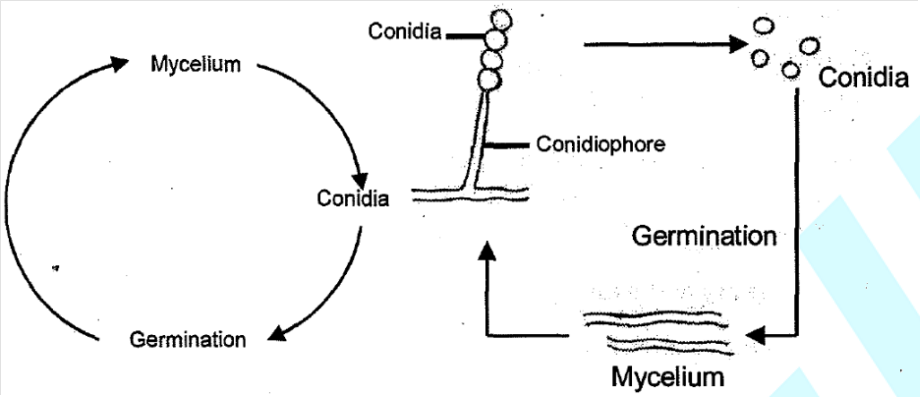


Sporangiospores are of Two types

- **Zoospore :-** When the sporangiospores formed in sporangium are flagellated and motile, then they are called as zoospores. In this condition the sporangium is called as zoosporangium.
- Aplanospore :- When sporangiospores are non flagellated and non motile then they are called aplanospores.



(B) Conidia :- The formation of conidia takes place exogenously. These conidia are formed at the tip of conidiophores

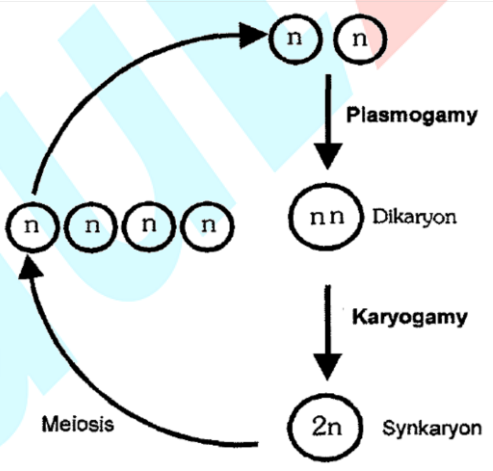


(3) Sexual Reproduction :-

The structure in which gametes are formed are called gametangia.

Sexual reproduction in fungi completes in three steps

(A) Plasmogamy :- This is the first stage of sexual reproduction. In this stage two motile or non-motile sex cells fuse with each other but their nuclei do not fuse, due to which a single cell has two nucle. This binucleate or dikaryotic stage is called dikaryon. In phycomycetes the fusion of two haploid cells immediately result in diploid cell (2n). However in other fungi (ascomycetes and basidiomycetes), an intervening (prolonged gap) dikaryotic stage (n + n, i.e. to nuclei per cell) occurs (long gap between plasmogam and karyogamy) such a condition is called a dikaryon and the phase is dikaryophase.



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

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

Note: Sexual reproduction is by the formation of zygospore /oospore, ascospores and basidiospores.

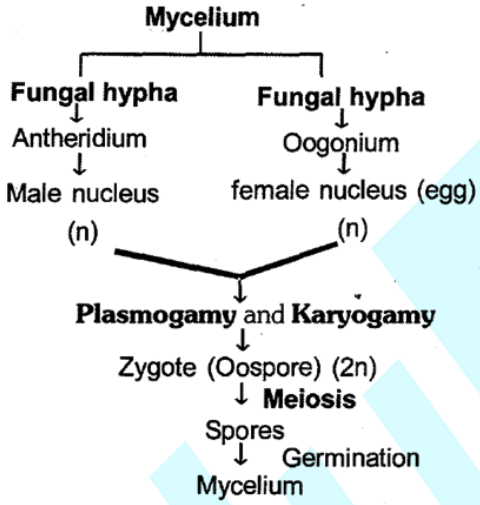
METHODS OF SEXUAL REPRODUCTION

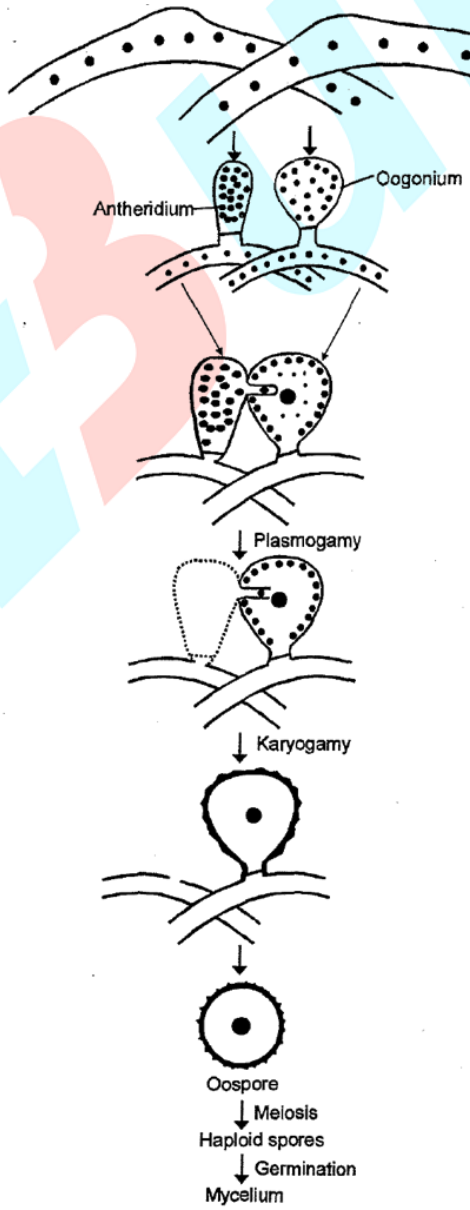
(1) Gametangial Contact:-

(a) In this process, first of all male and female sex organs are formed on two different hypha of same mycelium. Male sex organ is called antheridium and female sex organ is called oogonium.

(b) In mature antheridium & oogonium one - one nucleus behave like a male and female gamete. Now antheridium and oogonium come close to each other. After that a fertilizing tube comes out from antheridium and enters the oogonium. After that, the nucleus of antheridium goes to the oogonium through this tube and fuse with its nucleus. As a result of which a diploid zygote is formed, which is called oospores.

(c) Now meiotic division takes place in the nucleus of oospores, as a result of which haploid spores are formed. Now each spore germinates and gives rise to a new mycelium.

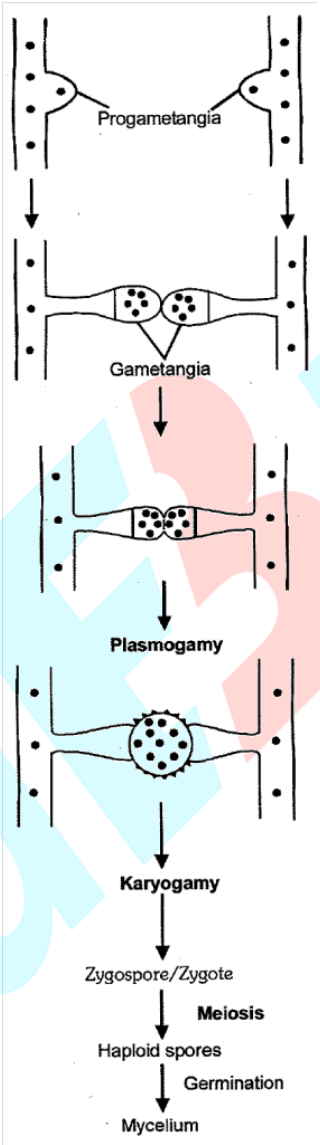




(2) Gametangial copulation :-

(a) In this process, gametangia are formed on two different mycelium.
First of all the a part of hypha become swollen and form progametangia. Both the gametangia have many nuclei. Now these gametangia fuses with each other. Due to which a zygote is formed which is known as zygospore.

(b) Now meiotic division takes place in zygospore, as a result of which haploid spores are formed. Now each spore germinates and gives rise to a mycelium.



(3) Somatogamy :-

In it, no sex organs are formed. In this process two mycelium comes close to each other and their cells get fused.

True fungi are divided into following classes on the basis of structure of mycelium & sexual reproduction -

(A) PHYCOMYCETES (B) ASCOMYCETES
(C) BASIDIOMYCETES (D) DEUTEROMYCETES

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 of sexual reproduction.

(a) Oomycetes :-

Asexual reproduction - By the formation of sporangiospores (zoospores) & conidia.

Sexual reproduction - By Gametangial contact

Type of sexual reproduction

- Oogamous - All the members

eg.

(1) **Phytophthora infestans** - Causes "late blight of potato". This disease is known as" Famine of Ireland"- 1845

(2) **Pythium species** - Causes "Damping off" disease in tobacco & "vegetable crops"

(3) **Sclerospora graminicola** - Causes "Green ear disease" of Bajra. The main characteristics of this disease is Phylloidy (Phylloidy- i.e. all the parts of flower are modified into green leaves).

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

(5) **Saprolegnia parasitica** - It causes disease in Salmon fish.

(b) Zygomycetes :-

Asexual reproduction - By the formation of sporangiospores (aplanospores).

Sexual reproduction - By Gametangial copulation.

Type of sexual reproduction

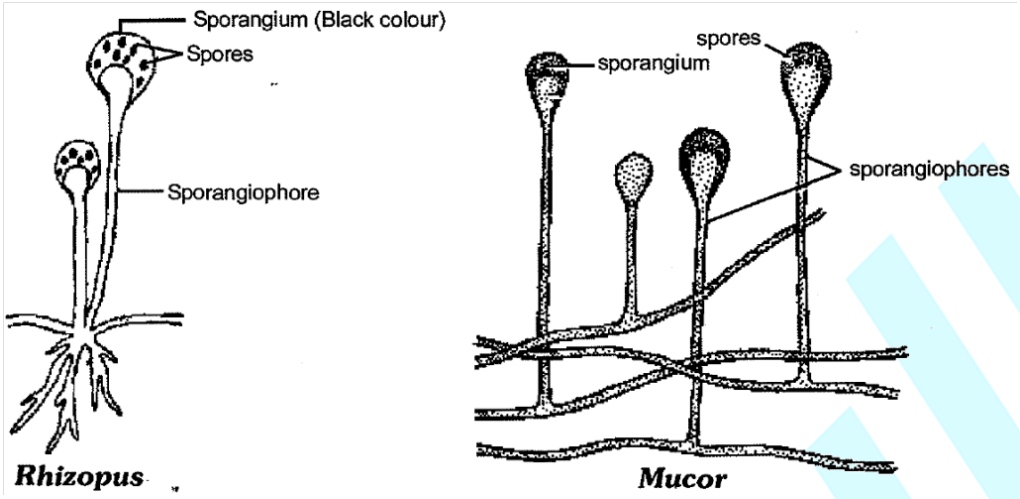
- Isogamous - All the members

eg.

(1) **Pilobolus :-**

(2) **Rhizopus & Mucor :-** These are known as **bread mold** -They prefer to grow on bread.

Note : Rhizopus is common bread mold. The tip of mycelium of Rhizopus is black coloured. Therefore this fungus looks black coloured.



ASCOMYCETES

"The sac fungi"

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

Habitat :-

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

Mycelium:-

Septet 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 :- By somatogamy and gametangial contact

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

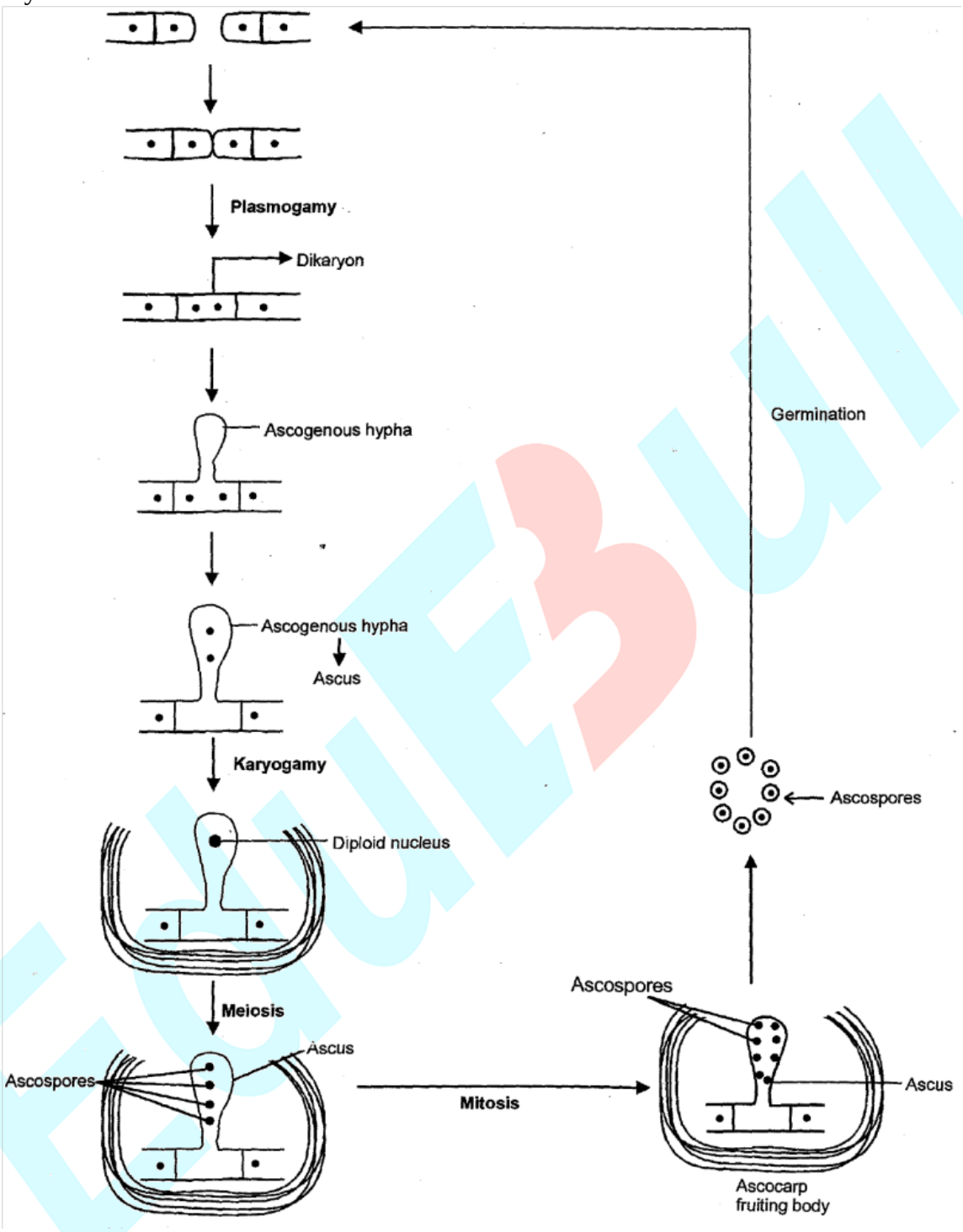
(b) In it two fungal hypha of mycelium come dose to each other and their cells fuse to form dikaryon.

(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.



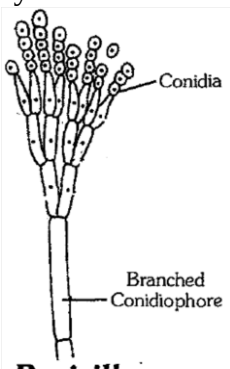
Three Types of Ascocarp

Cleistothecium	**Perithecium**	**Apothecium**
Closed, ball shaped	flask shaped	Open, disc shaped

eg. Of Ascomycetes

(1) Penicillium :- Blue or Green mold.

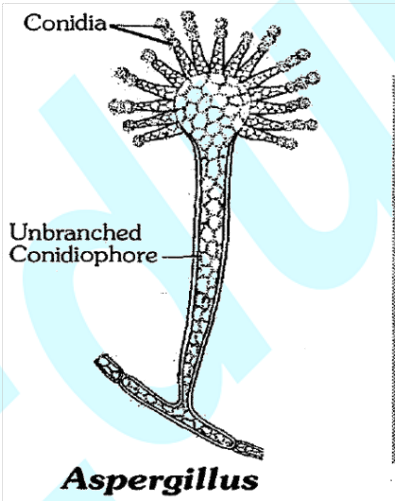
P. notatum - A. Fleming obtained the antibiotic penicillin from it. Penicillin is the first discovered antibiotic. A Fleming was awarded Nobel Prize for it. But now a dyas more quantity of Penicillin is obtained from P. chrysogenum. A. Fleming was doctor in British army and while working on bacterium Staphylococcus, he by chance discovered the penicillin. Discovery of Penecillin was a serendipity i.e. by chance discovery.



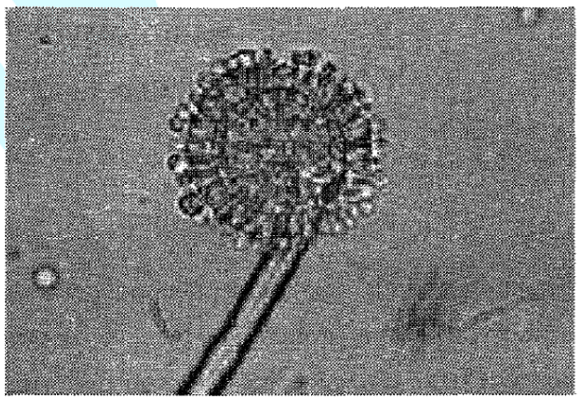
Penicillum

(2) Aspergillus :- Black or Brown mold or Blacky - smoky mold .

- **A. proliferans -** An antibiotic 'Proliferin' is obtained from it.
- A. fumigatus- It causes many diseases in humans & cattles. These disease are known as "aspergillosis"
- A. flavus- It prefers to grow on stored food (groundnut, cashewnuts etc.) and fodder. It secre't s toxic substances. These toxic substances are known as aflatoxins.
- Aflatoxins -They are carcinogenic i.e. they develop cancer. Aflatoxin causes liver cancer.
- A. Niger - Known as weed of laboratory and produce citric acid.



Aspergillus



(3) Claviceps :-

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

(4) Morchella :- The species of Morchella are commonly called as morels. It is an edible fungus.

(5) **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. They were awarded Nobel prize for it.

(6) **Erysiphe :-** Different species of Erysiphe causes "powdery mildew" disease on plants.

(7) **Truffles :-** Some members of Ascomycetes are known as Truffles. It is an edible fungus.

YEAST

Yeasts are unicellular fungi.
Yeast grows on ripened fruits like grapes, sugarcane, date palm and flowers. Mycelium is absent in yeast. If yeasts are grown in sugar solution then pseudomycelium is formed. Because in sugar solution, they grow very fast i.e. it reproduces fast and exhibit excessive budding.

Economic Importance:-

Yeasts are also called as fermentation fungi, because different types of products are formed by fermentation, with the help of yeast.

- It is used as fermentation agent in bakery (bread industry) and brewery (wine industry). So Saccharomyces, cerevisiae is also called "Baker's yeast".
- Riboflavin (vitamin B2) is obtained from Saccharomyces cerevisiae.

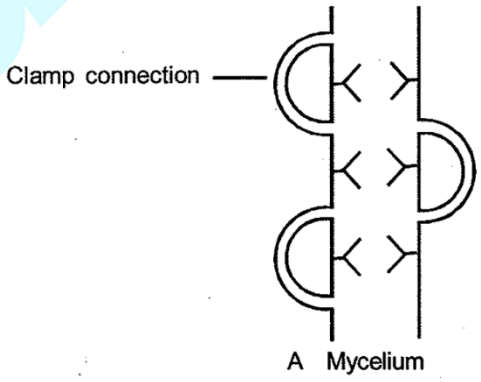
BASIDIOMYCETES

"Club fungi"

Habitat :- Grow in soil. on logs. on tree stumps and in living plant bodies as parasites.

Mycelium:-

Branched, septate, In basidiomycetes, septa are of special type and they are called dolipore septa. One big pore is present between every septum. The boundary of pore is spread on both sides, this boundary is called as parenthesome. Due to the spreading of the boundary on both sides, the shape of septum becomes dome shaped due to which it is called as dolipore septum.
Clamp connection :- It is a tubular relationship between two neighbouring cells. With the help of this connection the nucleus of one cell can migrate to the neighbouring cell, due to which the other cell becomes dikaryotic (binucleate). Clamp connection is used to change monokaryotic mycelium to dikaryotic mycelium in basidiomycetes.
Asexual reproduction- the asexual spores are generally not found. but vegetative reproduction by fragmentation is common.



A Mycelium

Sexual reproduction :-

Sexual reproduction is performed by two methods

(1) Somatogamy **(2) Spermatization**

(1) Somatogamy :-

This is the most common method of reproduction among the members of Basidiomycetes.

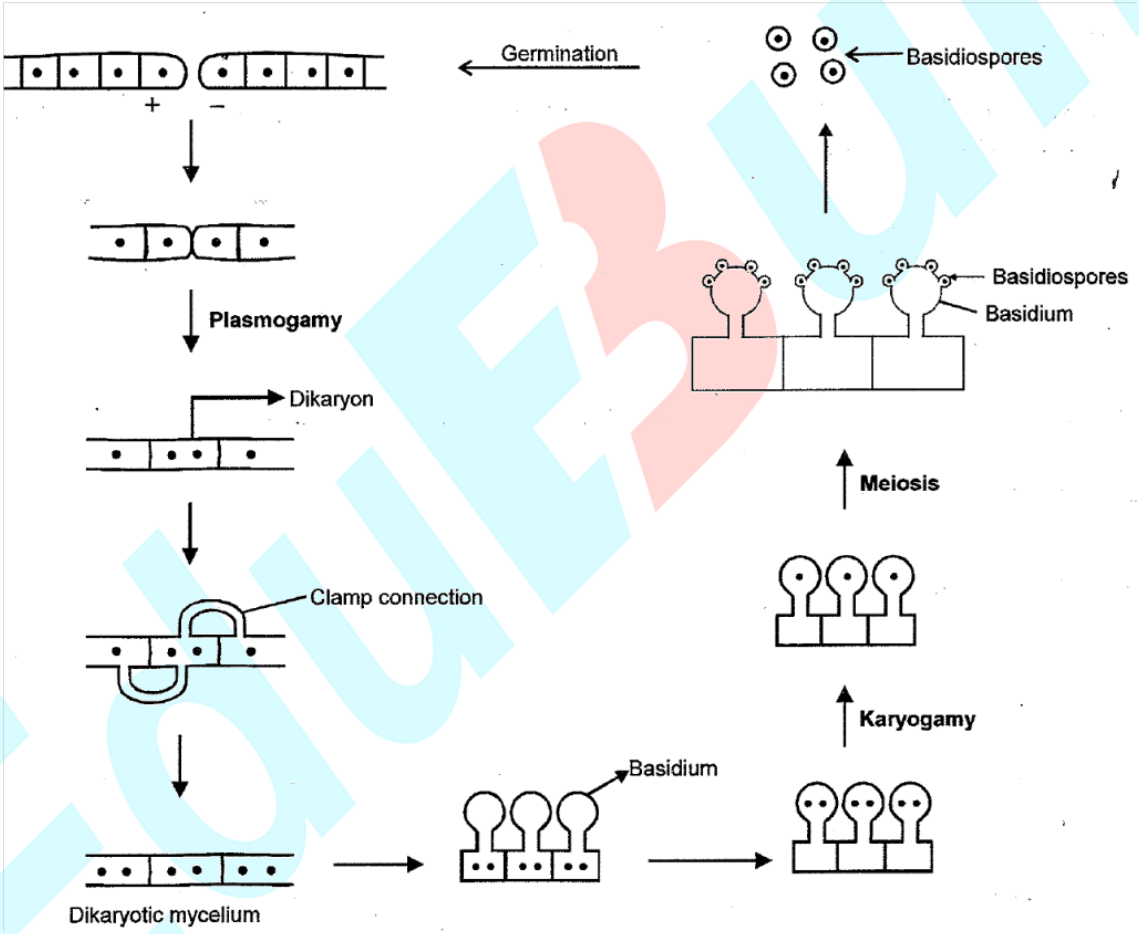
e.g. Ustilago, Agaricus

(a) First of all, the two vegetative or somatic cells of different strains or genotypes come close to each other.

(b) Now their apical ends fuse with each other (Plasmogamy), as a result of which dikaryon is formed.

(c) Now, with the help of clamp connection all the cells of mycelium becomes binucleate or dikaryotic.

(d) Now a club shaped structure is formed on every cell, which is known as basidium.



(e) After that both nuclei come in to this basidium and fuse with each other (Karyogamy) and further meiosis takes place as a result of which four haploid spores are formed on every basidium, which are known as basidiospores. The surrounding fungal hyphae grows to form a fruiting body, which is known as basidiocarp.

(f) Now the basidiospores become free from basidiocarp and produce a new mycelium by germination.

Note:

- It is belived that basidium is similar to ascus, because both of them produces spores.
- But basidiospore is different from ascospores because the origin of ascospores is endogenous and that of basidiospores is exogenous.

(2) Spennatization :-

This type of reproduction is more commonly seen in those fungi which cause rust disease
e.g. -Rust fungi- Puccinia
Three different species of Puccinia develop rust in wheat

- Puccinia graminis Black rust or stem rust
- Puccinia recondita Brown rust or leaf rust
- Puccinia striiformis Yellow rust or stripe rust

Puccinia is a heteroecious fungi i.e. the fungus that needs two types of host to complete its life cycle.

(1) Wheat (Primary host) **(2) Barberry (Lateral or alternate or secondary host)**

- Life cycle of Puccinia - called rust cycle
- Rust cycle was discovered by Prof. K.C. Mehta. He did a lot of hard work on rust.
- Starting of rust disease on wheat plants through aeciospores. i.e. Primary infection takes place through aeciospores and secondary infection takes place through uredospores.

eg. of Basidiomycetes

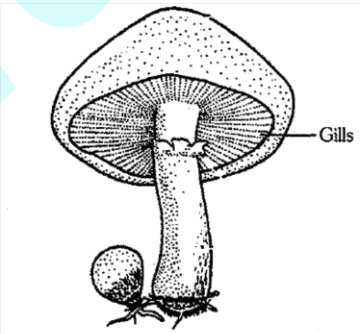
(1) Bracket or Shelf fungi :-

These are epixylic fungi i.e. these like to grow on wood. Their fruiting body is similar to bracket therefore they are called as bracket fungi.

(2) Puff balls - These are saprophytic fungi. Fruiting body of puff ball fungi is large and beautiful. If touched, fruiting body bursts violently to release a black powder (basidiospores) out side.
Note : Clavatia-A drug 'clavatin' is obtained from it. It is an anticancer medicine.

(3) Mushrooms (Basidiocarp) - These are umbrella like fungi often seen growing in grounds during rainy season. Some mushroom are edible.

- Most delicious mushroom - Agaricus bisporus
- World's most poisonous mushroom- Amanita muscaria -[It is Hallucinogenic]
  (Poisonous mushrooms are known as Toad- stool)
- Inky cap mushroom- Coprinus muscatus



***Agaricus* (basidiocarp)**

(4) Smut fungi :- It causes smut disease on plant. Smut diseases mainly affect the seeds of crop plants. Smut fungi infect seed and form black sooty spores inside the seed.

eg. Ustilago nuda tritici- It causes "loose smut of wheat." This disease spreads by infected flowers and seeds.

(5) **Agaricus:-** It is called as "gill fungi" because gills like pores are present irl its fruiting body. It is also called fairy rings because its fruiting body looks like rings.

(6) **Birds nest fungi :-** Cyathus and Nidularia etc. are commonly known as birds nest fungi, their fruitinb bodies resemble with birds nest.

DEUTEROMYCETES

It is also called "fungi imperfect", 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 disease.

Fungi	Disease
Alternaria solani	Early blight of Potato
Cercospora personata	Tikka disease of groundnut
Colletotrichum falcatum	Red rot of sugarcane
Helminthosporium oryzae	Leaf spot of Rice [Famine of Bengal (1945)]

- **Trichophyton & Microsporum :-** It produces "Ringworm" in humans. e.g. -eczema, itching.
- **Trichophyton interdigitale and Tinea pedis -** It causes "Athelete foot disease" in humans. It is also called "Ring worm of foot".

GOLDEN KEY POINTS

- All the unicellular eukaryotes are placed in Kingdom Protista.
- Histone protein is absent in chromosome of dinoflagellates, due to this reason dinoflagellates are called mesokaryote.
- Pigments present in dinoflagellates are Chi 'a' and Chi 'c'.
- Stored food of din flagellates is starch.
- Cell wall of diatoms is made up of cellulose + silica.
- Pigments present in diatoms are Chi 'a' and Chi 'c'.
- Stored food of diatom is leucosin and fats .
- Mixotrophic nutrition is present in Euglenoids.
- Stored food of Euglenoids is paramylum and fat.
- Slime moulds are also called fungus animal.

- At the time of reproduction slime moulds have cell wall.
- Mode of nutrition is absorptive in fungi
- Cell wall of fungi is made up of chitin.
- In fungi the stored food remains in the form of glycogen and oil.
- Mycelium of class phycomycetes is coenocytic aseptate.
- Phytophthora infestans causes late blight disease in potato. This disease is known as "Famine of Ireland".
- Mycelium of class - ascomycetes is uninucleate septate .
- Class ascomycetes is known as "Sac fungi" .
- A Flemming obtained the antibiotic penicillin from Penicillium notatum .
- Fungus Neurospora is known as "Drosophila of Plant Kingdom" .
- Yeast is unicellular or non mycelial fungi.
- Mycelium of class- basidiomycetes is septate and uni or binucleate .
- Basidiomycetes is known as club fungi.
- Special type of septa are found in mycelium of class basidiomycetes which are known as dolipore septum .
- Clamp connection are formed during reproduction in basidiomycetes .
- Puccinia is rust fungus, it causes rust disease in wheat.
- Starting of rust disease (Primary infection) on wheat plants takes place through aeciospores.
- Deuteromycetes is known as Fungi Imperfecti .

BEGINNER'S BOX-3

1. Dinoflagellates are considered as connecting link between monera and protista because:(
   (1) They spin while they move
   (2) They have flagella irr grooves
   (3) They show bioluminescence
   (4) They have condensed chromosome lacking histone protein

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

3. In Dinoflagellates meiosis occurs in :-
   (1) Gamete (2) Zygote
   (3) Sporangium (4) Zoospores

4. The famous Irish famine is related to a disease of potato known as:-
   (1) Late blight (2) Early blight
   (3) Dry rot of potato (4) Red rot

5. Cellulose is the major component of cell wall of :-
   (1) Pythium (2) Puccinia (3) Morchella (4) Saccharomyces

6. Among rust, smut and mushroom all the three:
(1) are pathogen (2) Puccinia (3) Morchella (4) Saccharomyces

7. Ethanol is commercially produced through a particular species of :-
(1) Aspergillus (2) Saccharomyces (3) Clostridium (4) Trichoderma

8. The dominant part in the life cycle of protista and fungi is mostly :-
(1) Haplontic (2) Diplontic (3) Haplodiplontic (4) Diplohaplontic

9. Taxonomy of fungi is based on:-
(1) Sexual reproduction (2) Nutrition
(3) Shape of fruiting body (4) Cell wall

10. Which of the following fungus can cause disease in human?
(1) Aspergillus (2) Ustilago (3) Mushroom (4) Puccinia

11. Which of the following pair belongs to basidiomycetes ?
(1) Puff ball and Claviceps (2) MOrchella and mushroom
(3) Peziza and Aspergillus (4) Brid's nest fungi and puffball

12. Asexual reproduction is fungi occurs by:
(1) Aeciospores (2) Basidiospores (3) Conidia (4) Oospores

13. Clamp connection are observed in:
(1) Basidiomycetes (2) Zygomycetes (3) Ascomycetes (4) Oomycetes

KINDGOM - PLANATE

All the multicellular eukaryotic plants are placed in Kingdom-Planate. They are autotrophic i.e. they manufacture their food by photosynthesis.

Following plant groups are included in Kingdom-Planate

(1) ALGAE (2) BRYOPHYTA (3) PTERIDOPHYTA
(4) GYMNOSPERM (5) ANGIOSPERM

(1) - ALGAE

- Phycology - Study of algae.
- Father of Phycology - Fristch and Father of Indian phycology - M.O.P. Iyengar

NATURE-

(1) Algae are found in both fresh and marine water. Algae are found in many forms like filamentous, colonial.

(2) Algae are surrounded by mucilagenous sheath and below the sheath cell wall is present which is made up of cellulose and pectin but mainly made up of cellulose, galactans, mannans and mineral like calcium carbonate.

(3) On the basis of structure, algae are thalloid i.e. plant body is not differentiated into root, stem and leaves. Tissue system is also absent in algae.

(4) On the basis of nutrition, algae are photoautotrophic. They have plastid in which photosynthetic pigments are present. Classification of algae is mainly based on pigments. Chi-a and β carotene are universal pigment of algae.

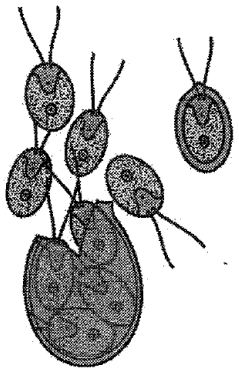
REPRODUCTION

(1) Vegetative (2) Asexual (3) Sexual

Vegetative reproduction :- By Fragmentation - Filaments break down into small pieces & form new filaments.

Asexual reproduction :-

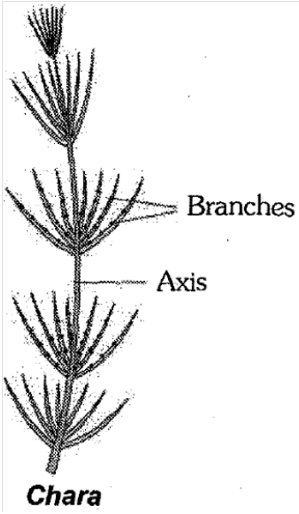
Zoospores are formed in favourable conditions and Aplanospores, hypnospore and akinete etc. are formed in unfavourable condition.



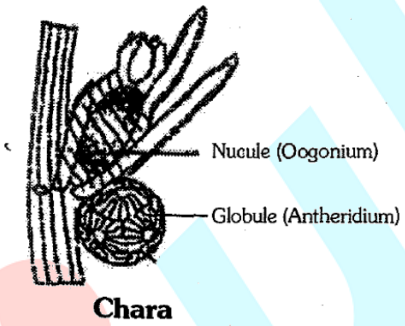
Zoospores of Chlamydomonas

Sexual reproduction :-

(i) Male sex organ is called antheridium and female is called oogonium. The sex organs of algae are unicellular & jacketless. But exceptionally sex organs of green algae Chari (Chari green algae - known as stone wort) are multicellular and Jacketed.
The male sex organ of Chara is known as globule and female is known as nucule.



Chara



Chara

(ii) Plant body of algae is haploid so sexual reproduction take place through zygotic meiosis. So their life cycle is haplontic. But exceptionally brown algae are diploid. [Ex. In Fucus life cycle in diplomatic]

(iii) Algae reproduce by zygotic meiosis i.e. first division in zygote is meiosis so embryo is not formed.

Sexual repro. is of three types

(a) **Isogamous** - Chlamydomonas debaryanum, Ulothrix, Ectocarpus, Spirogyra, Cladophora

(b) **Anisogamous** - Chlamydomonas braunii

(c) **Oogamous** - Chlamydomonas coccifera, Sargassum, Volvox, Fucus and Chara

Note: (1) Chlamydomonas exhibits complete evolution of sexual reproduction.
(2) In Chlamydomonas debaryanum gametes are flagellated and similar in size. asogamy)
(3) In Chlamydomonas braunii gametes are motile and dissimilar in size. (Anisogamy)
(4) Most of the species of Chlamydomonas show isogamy.
(5) In Spirogyra gametes are non flagellated (non motile) and similar in size (isogamy)
(6) In Cladophora, green algae isogametes are biflagellate. (Isogamy)
(7) In Eudorina (Green algae) fusion between two gametes dissimilar in size (Anisogamy)

The classification of algae is mainly based on the photosynthetic pigments. In addition to this, cell wall composition and stored food are also the base of classification.

Algae is divided into following classes

(1) **AHLOROPHYCEAE** - **GREEN ALGAE**
(2) **PHAEOPHUCEAE** - **BROWN ALGAE**
(3) **RHODOPHYCEAE** - **RED ALGAE**

CHLOROPHYCEAE

Green Algae

- Green algae are the most advanced algae. It is believed that green algae are the ancestors of the higher plants.

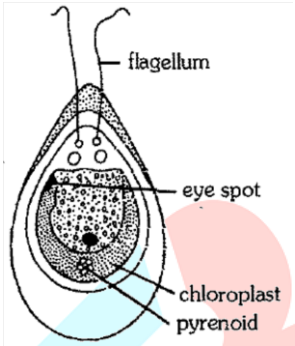
Habitat : Green algae are cosmopolitan in nature.

Structure : Green algae usually have a rigid cell wall made up of an inner layer of cellulose an outer layer of pectase.

Green algae are found in many forms

(1) Unicellular :-

(i) Chlamydomonas - Motile unicellular algae. This algae moves with the help of flagella.



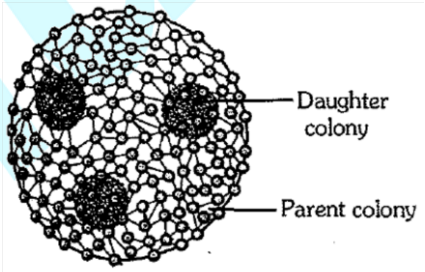
Chlamydomonas

(ii) Chlorella - Non motile unicellular alga.

(iii) Acetabularia - It is the largest unicellular plant.

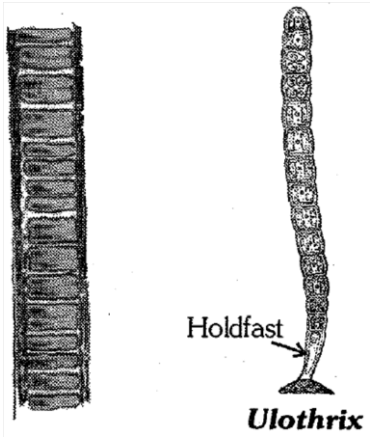
Note : According to five kingdom system the algae described above should be placed in Protista but because their life cycle is similar to green algae, they are studied in Planate.

(2) Colonial - Some green algae are found in colonies. They form colony of cells. The number of cells in a colony is fixed. Colony with fixed number of cells called coenobium.
eg. Volvox -Motile colony



Volvox

(3) Multicellular filamentous - Mostly the green algae are multicellular and filamentous.
eg. Ulothrix, Spirogyra



Ulothrix

(4) Multicellular thalloid or Parenchymatous - Some algae,are multicellular in length & width. eg. Ulva

Photosynthetic pigments :

Chlorophyll	-	Chi 'a' and Chi 'b'
Carotene	-	β carotene
Xanthophylls	-	Luteaxanthin and Violoxanthin -Yellow coloured

Stored food - Most of the members of green algae have starch as stored food and some have oil droplets also.

Asexual reproduction - Zoospores are formed in favourable condition and aplanospores, hypnospores and akinetes are formed in unfavourable condition.

Sexual reproduction - Sexual reproduction may be isogamous. anisogamous or oogamous.

Notes :

1. On the basis of pigments (Chi 'a', Chi 'b', Carotenoids), stored food (starch) & cell wall (made up of cellulose and pectose), green algae are considered similar to higher plants.

2. One or more pyrenoids are also present in chloroplast as storage bodies. Pyrenoids contain protein besides starch.

Economic Importance :

(1) Food - Chiarella is used as food, Chlorella has large amount of protein.

(2) Antibiotics - Chlorellin antibiotic is obtained from ChloreUa.

(3) Space research - In space, Chlorella is used as a source of food and 0 2 by space travellers

(4) Parasitic algae - Cephaleuros is present parasitically in the leaves of tea plant and causes 'red rust' disease.

PHAEOPHYCEAE

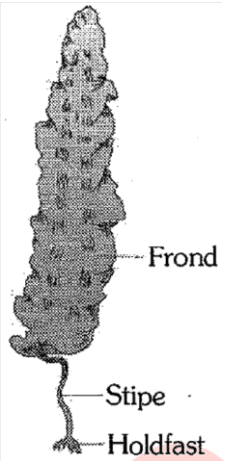
Brown algae or Sea weeds or Kelp

Habitat ⇒ Brown algae are found in marine water.

Structure

- Brown algae are multicellular filamentous .
- Brown algae are the largest in size (upto 100 meter in length) .

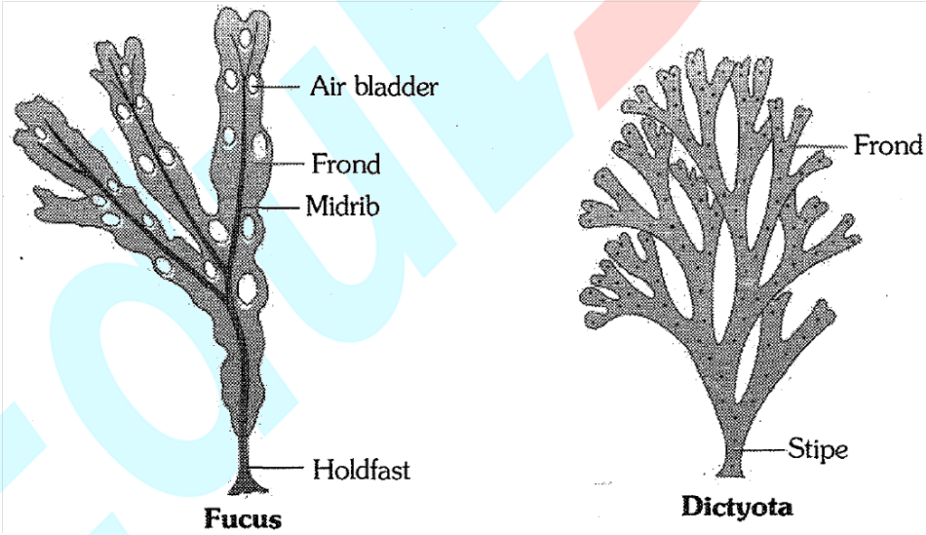
- Largest brown algae - **Macrocystis**
- The plant body is usually attached to substratum by a holdfast and has a stalk (stipe) and leaf like photosynthetic part, frond or lamina, so brown algae are known as leafy algae. (eg. Laminaria)



Laminaria

- The vegetative cells have a cellulosic wall usually covered on the outside by a gelatinous coating of align. In brown algae protoplast contains plastid, centrally located vacuole and nucleus.

  e.g. Focus, Dictyota, Ectocarpus



Fucus **Dictyota**

Gelatinous coating/Phycocolloids/Hydrocolloids : Gelatinous coating made up of algin has very high water holding capacity.

- Phycocolloids (Algin) protects brown-algae against dessication and shocks. Phycocolloids are used in ice-cream as thickening agent. Algin used for dentury measurement.
- Algin used in the manufacturing of soap, ice-cream, polish, cream and plastic.

Pigments:

Chlorophyll	-	Chl'a', Chl'c'
Carotene	-	Only β carotene
Xanthophylls	-	Mainly Fucoxanthin

Note: The amount of Fucoxanthin is more in brown algae due to which these algae are brown in colour. (Xanthophylls are mostly yellow but fucoxanthin is brown)

Stored food :

Laminar in and mannitol- both are-derivatives of carbohydrates.

Asexual reproduction :

By Zoospores

Sexual reproduction :

Sex repro, in brown algae may be isogamous, anisogamous or oogamons.

Note:

(1) Zoospores and gametes are pear shaped and have two unequal laterally attahced flagella.

(2) Life cycle of Ectocarpus and kelps are diplohaplontic, life cycle of Fucus is diplontic.

Examples:

Sargassum - used as a food

Laminaria -

(1) used as a food

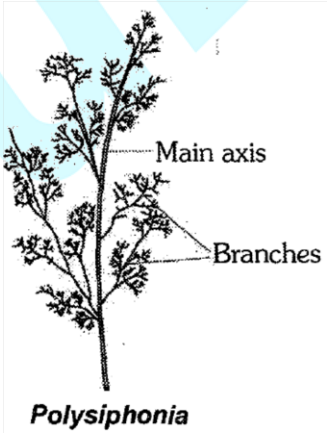
(2) Iodine and Bromine - Obtained from this algae.

RHODOPHYCEAE

Red Algae

(1) Red algae are ancient (Primitive) algae

eg. Polysiphonia



Polysiphonia

(2) There is no motile stage found in life cycle of red algae and BGA i.e. cilia & flagella are absent.

Habitat:

Red algae mainly found in marine water with greater concentration found in the warmer areas. But exceptionally Batrachospermum is found in fresh water (river).

Structure :

(1) Red algae are multicellular

(2) Cell wall of red algae is complex because made up of cellulose & pectin with polysulphate esters.

(3) Some red algae may secrete and deposite calcium carbonate and appear like corals.

Pigments:

Chlorophyll - Chi 'a' and Chi 'd'

Carotenes - β carotene

Phycobilins - R - phycoerythrin (red coloured) and R - phycocyanin (blue coloured)

(1) On the basis of pigments red algae are similar to blue green algae.

(2) Red algae is deepest algae, found in depth.

Stored Food:

Floridean starch - floridean starch is structurally similar to glycogen and amylopectin

Asexual - Non motile spores

Sexual reproduction -

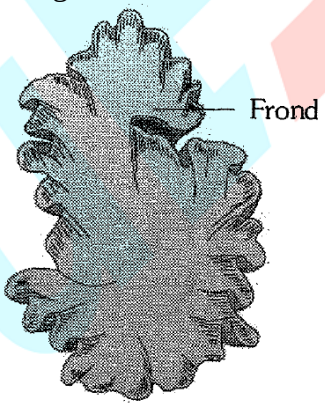
(I) Sexual reproduction is oogamous and accompanied by complex post fertilization developments.

(II) Life cycle of Polysiphonia is diplobiontic and Batrachospermum is haplobiontic

Economic importance :-

(1) Harveyella - It is a colourless parasitic alga. It remains as parasite on other alga.

(2) Porphyra - It is an edible algae and used as a food.



Porphyra

(3) Gelidium and Gracilaria - Agar- Agar is a hydrocolloid (Phycocolloid) is obtained from these red algae. It is used to prepare culture medium to grow microbes and in prepartion of ice creams and Jellies.

(4) Chondrus crispus - Carrageenin colloid is obtained from this alga. It is used as gelating agent in food industries (i.e. to make the food item viscous)

- Capsule of medicines is also prepared from carrageenin.

CLASSES OF ALGAE AND THEIR MAIN CHARACTERISTICS						
Classes	**Common Name**	**Major Pigments**	**Stored Food**	**Cell Wall**	**Flagellar Number and Position of Insertions**	**Habitat**
Chlorophyceae	Green algae	Chlorophyll a, b	Starch	Cellulose and Pectose	2-8, equal, apical	Fresh water brackish water, salt water
Phaeophyceae	Brown algae	Chlorophyll a, c fucoxanthin	Mannitol, laminarin	Cellulose and algin	2,unequal lateral,	Fresh water (rare) brackish water, salt water
Rhodophyceae	Red algae	Chlorophyll a, d, phycoerythrin	Floridean starch	Cellulose and Pectin with Polysulphate ester	Absent	Fresh water (some), brackish water, salt water (most)

Note - Porphyra, Laminaria and Sargassum algae are used as a food.

HABITAT OF SOME IMPORTANT ALGAE

(1) **Epizoic**- Algae which are present on animals
eg. Cladophora (present on Mollusca shell)
Cyanoderma and Trichophilus (Blue green algae) (Present on sloth bear)

(2) **Endozoic** - Algae which are present inside the body of animals
eg. Zoochlorella and Zooxenthellae (inside the Hydra)

(3) **Parasites** - Algae that live as parasite and causes diseases
eg. Cephaleuros (algae remain in the leaves of tea plant)
Cephaleuros causes red rust disease of tea

Name of Algal cell	Shape of Chloroplast
• ***Chara***	Discoid
• ***Fritschiella***	Plate like
• ***Chalamydomonas***	Cup-shaped
• ***Ulothrix***	Girdle shaped
• ***Spirogyra***	Ribbon / Spiral shaped
• ***Zygnema***	Stellate (Star shaped)
• ***Oedogonium***	Reticulate

THALLOPHYTA

(1) The term "Thallophyta" was given by "Endlicher". According to two kingdom classification, all the algae, fungi and prokaryotes were placed in thallophyta, because their plant body is thallus.

(2) In thallophyta the male sex organs are called as Antheridia and female sex organs are called as Oogonia. Sex organs are unicellular & Jacket less [Jacket - layer of sterile cells]

(3) The sexual reproduction in thallophyta is isogamous, anisogamous and oogamous.

(4) In thallophyta, sexual reproduction takes place through zygotic meiosis, therefore embryo is not formed.

(2) - BRYOPHYTA

- The term "Bryophyte" was proposed by "Robert Braun".
- The study of Bryophytes is known as Bryology.
- Hedwig is considered to be the father of bryology. But according to some scientist it is believed that Cavers is the father of Bryology.
- Father of Indian Bryology is Prof. Shiv Ram Kashyap.

General characteristics :

1. Bryophytes are the first land plant. It is believed that, they originated from aquatic plant and they come on land through water. Because some bryophytes have characters similar to aquatic plants (eg. presence of air canal)

2. Bryophytes are known as amphibians of the plant kingdom, because these plants can live in soil but are dependent on water for fertilization.

3. Bryophytes are not considered as the successful land plants because vascular tissue is absent and they need water for fertilization. Due to the absence of vascular tissue bryophytes can not grow very tall. The process of water conduction in bryophytes takes place with the help of parenchyma. Parenchyma is a living tissue.

4. Roots are absent in bryophytes. Stem like and leaf like structure of bryophytes are functionally similar to the stem and leaves of higher plants.

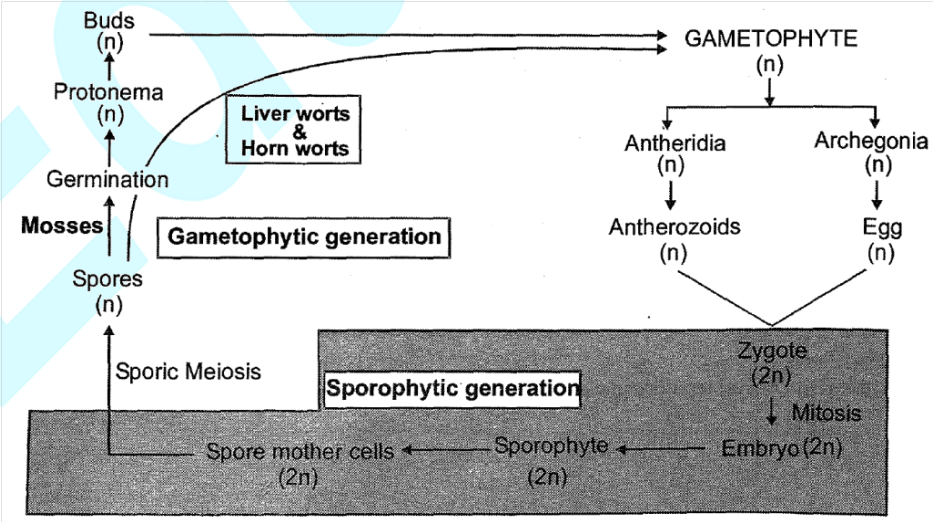
5. Bryophytes are sciophytes, i.e. bryophytes prefer to grow in moist (wet) and shady places.

Life cycle of Bryophytes :

1. The main plant body of bryophyte is haploid. It produces gametes, hence is called a gametophyte.

2. Sex organs are formed on gametophyte. Sex organs are multicellular and jacketed in bryophytes. Male sex organs are called antheridium ana female sex organs are called archegonium. Archegonium is flask shaped.

3. The male gametes of bryophytes are motile. These motile male gametes are called as antherozoids. Antherozoids are usually comma shaped and biflagellate. Female gamete is called egg.



4. In Bryophyta, fertilization is performed by zoidogamy i.e. male gamete swims into water to reache the female gametes and fertilizes it.

5. As a result of the fertilization, a diploid zygote is formed. Zygote does not undergo reduction division (meiosis) immediately. This zygote initiates the sporophytic generation. Sporophytic generation is a diploid stage.

6. Zygote forms embryo and then sporophyte by mitosis. The sporophyte of bryophyta is not made of root, stem and leaves, but it is made of foot, seta and capsule, so it is known as sporogonium.

7. Some of cells present in capsule of sporophyte function as spore mother cells. Now meiosis takes place in spore mother cells, result of it haploid spores are formed. The germination of spores is direct or indirect. In Liverworts & Homworts the germination of spore is direct i.e. each spore forms a gametophyte after germination i.e. each spore forms one thallus.

But the germination of spores in Mosses is indirect. In mosses a multicellular filament is formed after the germination of spore. This filament is known as protonema. Now buds are formed on protonema. Each bud develops and forms a gametophyte plant. Indirect germination is best for survival. Mosses are gregarious in nature because they appear in group.

Note : Protonema developed from spores is called primary protonema and the protonema developed from parts other than spores are known as secondary protonema.

- Sexual reproduction in bryophytes is oogamous type and life cycle is halplodiplontic type.
- IN Bryophyte the sporophyte is dependent on gametophyle. This is a unique character of bryophyte.

Bryophyte sis divided into three classes

1. Hepaticopsida **2. Anthocerotopsida** **3. Bryopsida or Musci**

HEPATICOPSIDA – LIVER WORTS

(i) Bryophytes included in this class have shape like liver (eg. Marchantia) or flat (eg. Riccia) so they are known as liverworts.

(ii) Plant body of this group is thallus like and dorsiventral. Rhizoids and scales are present on thallus. Rhizoids are unicellular and unbranched. Scales are multicellular.

(iii) The leafy members (eg Porella) have tiny leaf like awendages in two rows on the stem like structures.

(iv) The sporophyte of Uverworts is completely dependend on gametophyte i.e. it is dependent on gametophyte for food, water and habitat.

(v) The sporophyte of Uverworts is made up of foot, seta and capsule. (Exception - In Riccia sporophyte is made up of only capsule).

(vi) True Elaters are present in sporophyte of some members of liverworts. (eg. Marchantia). Elaters are hygroscopic and they help in dispersal of spores.

Eg. of Liverworts -
Riccia, Marchantia , Cryptothallus, Parella

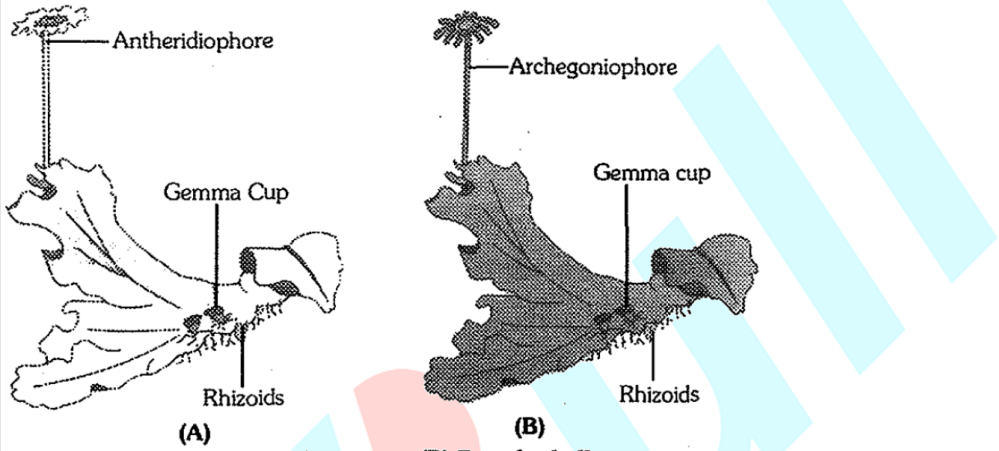
Note : (1) In Bryophytes, saprophyte of Riccia is the simplest.

(2) Asexual (vegetative) reproduction in Liverworts takes place by fragmentation of thalli. or by the formation of specialised structures called gemmae (sing. gemma). Gemmae are green, multicellular, asexual buds, which develop in small receptacles called gemma

cups located on the thalli. The gemmae become detached from the parental body and germinate to form new individuals.

Eg. Marchantia

(3) During sexual reproduction male and female sex organs are produced either on same (eg. Riccia) or on different thallus (Eg. Marchantia)



***Marchantia* – (A) Male thallus (B) Female thallus**

ANTHOCEROTOPAIDA - HORNWORTS

(i) The plant body of this group is also thallus like. Scales are absent but rhizoids are present on thallus. Rhizoids are unicellular and unbranched.

(ii) The sporophyte of Hornworts is divided into foot and capsule.

(iii) The sporophyte of Hornworts is not completely dependent on its gametophyte i.e. it is partially depend because its sporophyte is photosynthetic therefore it can manufacture its own food. So it does not depend on gametophyte for food, it depends only for water and habitat.

(iv) In hornworts at the basal part of capsule, a special, type of meristem is present. Due to the activeness of this, meristem, the capsule grows rapidly. It grows like the horn of animals.

eg. Notothylus, Anthoceros

Note : Pseudoelaters are present in hornworts, which help in spores dispersal.

BRYOPSIDA OR MUSCI - MOSSES

(i) All the Mosses are included in this class. The plant body of mosses is made up of stem like, leaf like and rhizoids (roots like). The Rhizoids present in the plants of this class are multicellular, branched and obliquely septet.

Note - The presence of leaf like structure in gametophyte is the unique character of Moss because in plant kingdom any gametophyte do not have leaf like structure. They consist of upright slender axis bearing spirally arranged leaves.

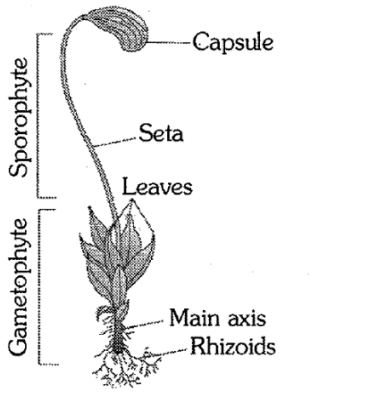
(ii) Vegetative reproduction in mosses is by fragmentation and budding in the secondary protonema.

(iii) During sexual reproduction, sex organs are produced at the apex of the leafy shoots.

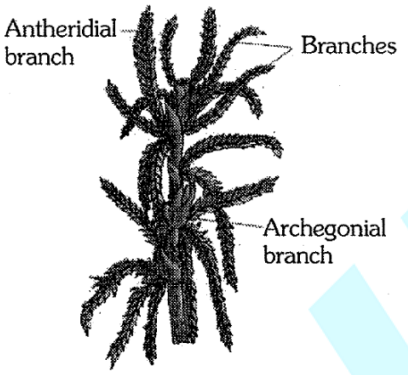
(iv) The saprophyte in mosses is more elaborated (developed) than that in liverworts. The saprophyte of moss is divided into foot, seta, capsule.

(v) The saprophyte of mosses is also partially depend like, that of Hornworts, i.e. it is photosynthetic. The moses have an elaborate mechanism of spore dispersal.

Note : Peristomial teeth are present in moss saprophyte which help in spores dispersal.



***Funaria*, gametophyte and sporophyte**



***Sphagnum* gametophyte**

E.g. of Mosses :

- Fun aria - Rope moss
- Polytrichum - Hair cap moss
- Buxbaumia - Saprophytic moss
- Sphagnum
  - ♦ **Peat moss** – It is a fossil fuel that obtained from bog. The formation of peat takes place by the fossilization of sphagnum. Sphagnum grows in acidic bog. The number of bacteria are less in bog due to which the degradation of dead cell could not takes place. Hence it is present in the form of fossil.
  - ♦ **Absorbent cotton** - Sphagnum can absorb water in very high amount, therefore it is used in the form of absorbent cotton in Europe.
  - ♦ Bryophytes in general are of little economic importance but some mosses provide food for herbaceous mammals, birds and other animals. Species of sphagnum, a moss, provide peat that have long been used as fuel, and because of their capacity to hold water as packing material for trans-shipment of living material. Mosses along with lichens are the first organisms to colonies rocks and hence, are of great ecological importance. They decompose rocks making the substrate suitable for the growth of higher plants. Since mosses form dense mats on the soil, they reduce the impact of falling rain and prevent soil erosion.

(3) - PTERIDOPHYTA

Term pteridophyta was proposed by Haeckel
The study of pteridophytes is known as pteridology.
Pteridophytes are known as reptiles of plant kingdom.

1. Pteridophytes are also called as vascular cryptogames. Pteridophytes are vascular plants i.e. xylem and phloem are present in it. In pteridophytes, vessels in xylem and companion cells in phloem are absent.
2. Pteridophytes are used for medicinal purpose and as soil binders. They are also frequently grown as ornamentals.
3. Pteridophytes are more adapted terrestrial plants as compared to bryophytes. Because -
   (i) Vascular tissue is present in pteridophytes.
   (ii) They have roots.
4. Pteridophytes are not completely successful terrestrial plants because they need water for fertilization, so pteridophytes grow in cool, shady and moist places.
5. In pteridophyta, the plant body is completely differentiated in to root, stem and leaves.
   - The primary root remains alive for short period. After some time it is replaced by adventitious roots.
   - Stem is erect or prostrate. When in pteridophytes stem is underground, which is known as rhizome.
   - On the basis of leaves, pteridophytes are of two types -

   First in which stem is smaller while leaves are larger. They are known as megaphyllous Pteridophytes.
   eg. Ferns
   Second, in which stem is larger and leaves are smaller. They are called as microphyllous Pteridophytes.
   eg. Selaginella

LIFE CYCLE OF PTERIDOPHYTES

1. Plant is sporophyte. i.e. diploid and they reproduce by spore formation.
2. Most of the pteriophytes are homosporus i.e. only one type of spores are formed during reproduction.
Exception- Some pteridophytes are heterosporus i.e. two types of spores microspores and megaspores.
3. Formation of spores takes place in sporangia. Sporangia are formed at the abaxial surface of leaves.
4. The leaves on which sporangia are formed are called sporophylls (reproductive leaves) and normal photosynthetic leaves are called trophophylls (vegetative leaves). Sporangia are present in groups, these groups are called sorus (Plural-sori). Sori are found on sporophylls.
Note: In pteridophyta, sporophylls are also photosynthetic. This is a unique character of pteridophyta.
5. Spore mother cells are present in sporangia. Spores are formed with in sporangium by meiosis in spore mother cells and these spores start the gametophytic generation.
6. In pteridophyta, the germination of spores is exosporic.
7. In soil, a inconspicuous, small and multicellular gametophyte is formed by the germination of each spore, which is known as prothallus. The formation of gametophyte takes place in the soil therefore it is free (independent) and mostly photosynthetic. These gametophyte require cool,

damp, shady places to grow. Because of this specific restricted requirement and the need for water for fertilisation, the spread of living pteridophytes is limited and restricted to narrow geographical regions.

Note : In some pteriophytes prothallus is saprophytic.

8. There is no relation between the main sporophytic plant and prothallus. Prothallus (gametophyte) is made up of thallus and rhizoids. It is non vascular.

Note : In plant kingdom, gametophyte is always non vascular

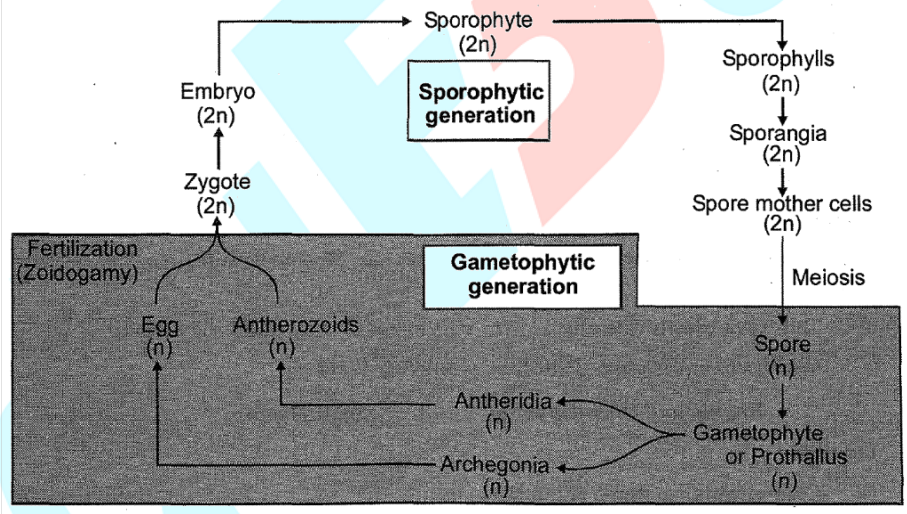
9. In homosporus pteridophytes, gametophyte is monoecious.

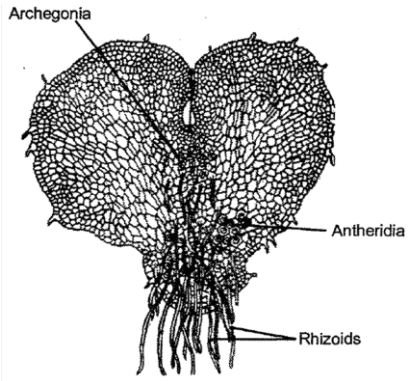
10. The formation of sex organs takes place on this gametophyte. Male sex organ is called antheridium and female sex organ is called as archegonium. The formation of male gametes takes place in Antheridia which are called as antherozoids.

Antherozoids are spiral and multiflagellate but exceptionaly antherozoid of SelagineUa are spindle shaped and biflagellate. Egg is formed in archegonium.

11. Fertilization takes place by zoidogamy and zygote is formed as a result of fertilization. Zygote develops and forms an embryo. Now this embryo develops and forms a sporophytic plant with root, stem, leaf.

- Type of sexual reproduction in pteridophyta is oogamous.
- Their life cycle is diplo-haplontic type.
- The unique character of life cycle of Petridopyte is – Independent alternation of generation i.e. saprophyte and gametophyte are independent of each other.





Ventral surface of fern prothallus

Heterospory :-

- In few pteridophytes two types of spores are formed i.e. microspore and megaspores in microsr and megasporangium respectively this phenomenon is known as heterospory or heterosporous condition.
- Some heterosporous pteridophytes are :-
- Selaginella, Azolla, Salvinia, Marsilea.
- In heterosporous pteridophytes, microspore produces male gametophyte and megaspore produces female gametophyte hence the gametophytes in these plants are dioecious.
- The development of zygote into young embryo takes place within the female gametophyte and the female gametophyte is retained on the parent sporophyte for variable periods.
- This event is precursor of seed habit considered an important step in evolution.
- The developement of male and female gametophytes in these plants takes place inside the microsporangium and megasporangium respectively hence the gametophytes are not completely independent and are not very much developed so they are generally not completely regarded as prothallus.

Pteridophyta is divided in to 4 classes

(1) Psilopsida (2) Lycopsida (3) Sphenopsida (4) Pteropsida

1. Psilopsida :

The most ancient vascular plants are placed in this class. The plants in this class have many primitive characters -

(i) Their plant body is differentiated in to stem (rhizome), scaly leaves and rhizoids.

living genus in this class - Psilotum $\rightarrow$ A living fossil

Rhynia and Homeophyton - Fossil plants

2. Lycopsida :

(i) Club mosses are placed in this class.

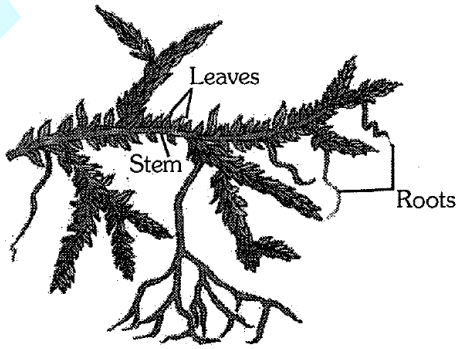
(ii) The plant body of club mosses is differentiated into root, stem and leaves. Leaves are green and photosynthetic and known as trophophylls.

(iii) Sporophylls are present in group. at the tip of plant. This groups is called as strobilus or cone.

Lycopodium - Common club moss

It is a medicinal plant. It is used as tonic in Homeopathic medicines.

Selaginella - Spike moss or Resurrection plant. It is known as "Sanjeevani"

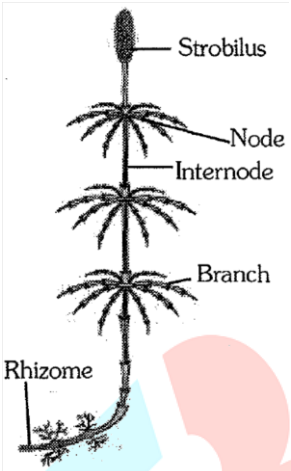


Selaginella

3. Sphenopsida

(i) In this class Horse tails are included.

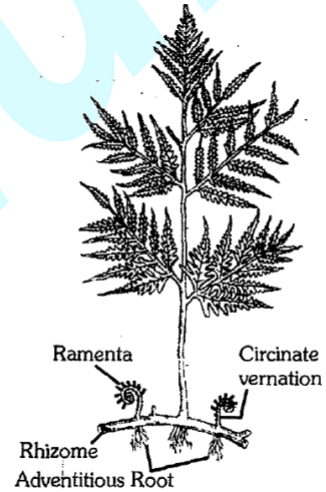
(ii) The plant body oi horse tails is differentiated into root, stem or rhizome & scaly leaves.
(iii) Silica is present in the epidermis of these plants. Due to this, surface of plant become rough. If two horse tail plants collide, then there is a dangerous chance of fire in the forest.
(iv) Cone (strobilus) is formed at the apical part of aerial stem.
e.g. Equisetum (Pipe)



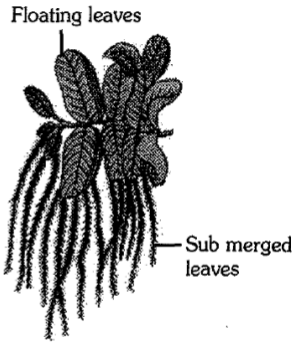
Equisetum

4. Pteropsida :

(i) This is the largest group of pteridophytes.
(ii) They are commonly called as ferns. Most of the pteridophytes are ferns.
(iii) Ferns are megaphyllous (macrophyllous) i.e. rhizome is small and leaves are comparatively larger and these leaves are known as 'Fronds'.
(iv) Multicellular hair are present on the young leaf and young rhizome of ferns which are called as rarnenta. They are for protection.
(v) Cones are not produced in ferns.

Fern



Salvinia

Examples of Ferns :

Azolla - Alsophila -
Azolla - Aquatic fern (Smallest pteridophyte and biofertilizer)

Adiantum	-	**Walking fern :** This name is given to them due to rapid vegetative reproduction. Vegetative reproduction in Adiantum takes place by means of leaf tip. It spreads very fast.
Alsophila	-	Tree fern (Largest pteridophyte)
Pteridium		
Dryopteris		
Marsilea		
Pteris		
Salvinia		

(1) Some example of Aquatic fern - In aquatic fern sporangia are found in specialised structure called sporocarp.
eg, Marsilea, Azolla, Salvinia

(2) Most of fossil fuels (coal) we obtained presently is the result of fossilization of giants ferns (Pteridophytes).

(4) - GYMNOSPERM

1. The gymnosperms (gymnos = naked, sperma = seed) and plants in which the ovule are not enclosed by any ovary wall and remain exposed, both before and after fertilization.

2. Study of Gymnosperm known as Gymnosperm logy.

- Main plant body of Gymnosperm is divided in to Root, Stem and leaves.
- The roots are generally tap roots.

Note :- Roots in some genera have fungal association in the form of mycorrhiza (Pinus), while in some others (Cycas) small speciallised roots called coralloid roots are associated with N2-fixing cyanobacteria.

- In Cycas roots are of two types i.e. tap root and coralloid roots.
- The stems are unbranched (Cycas) or branched (Pinus, Cedrus).
- The leaves may be simple or compound.
- In Cycas the pinnate leaves persist for a few years.
- The leaves in gymnosperms are well-adapted to extreme conditions like temperature, humidity and wind.
- In conifers the needle like leaves reduce the surface area, their thick cuticle and sunken stomata also help to reduce water loss.

3. Gymnosperm & Angiosperm are collectively included under spermatophyta i.e. seed bearing plants.

4. Gymnosperms are naked seeded plant i.e. no fruit formation takes place in these plant.
In gymnosperm embryo & seed formation takes place but no fruit formation occur.

5. Gymnosperms are very limited in distribution. They are mainly found in cold regions. ln India Gymnosperms are found on Himalayan mountains. They usually occur on slopes of mountain in cold region therefore gymnosperms are xerophytes.

6. All gymnosperms are vascular plants. Therefore vascular tissue present i.e. xylem & phloem. Xylem lacks vessels & phloem lacks companion cells.

Note:-

- Exceptionally in xylem of Gnetum, Ephedra, Welwitschia true vessels are present .
- Secondary growth takes place in gymnosperms stem, so Gymnosperms stem is woody .

7. Most of the gymnosperms are arborescent (woody) and tree habit - but some are present as shrub.

eg. Ephedra

Some Gymnosperm are Iiana or woody climbers.

eg. Gnetumula

UFE CYCLE OF GYMNOSPERM-

1. All gymnosperms are heterosporeus plants. They produce two kinds of haploid spores; microspores and megaspores within microsporangium and megasporangium respectively.

2. Sporangia are borne on sporophylls which are arranged spirally along an axis to born lax (loose) or compact strobilli or cones.

3. The strobilus (sing strobilus) bearing microsporophyll's and micro sporangia are called microsporangiate cones or male strobilli or male cone.

4. Within microsporangium many microspore mother cells are present which undergo meiosis and produce many haploid microspores. Germination of microspore takes place with in microsporangium hence it is called endosporic germination.

5. The microspore develop into pollen grain and then male gametophyte which is highly reduced and is confined to made of only a limited number of cells (e.g. In Cycas-5 cells and Pinus-6 cells are present in mature male gametophyte).

6. The development of pollen grains take place within the microsporangium.

7. The cones/strobilli bearing cluster group of megasporophylls with megasporangia are called megasporangiate cones or female cones.

8. When the male and female cones are produced on the same tree, the member is known as monoecious eg. Pinus and when male and female cones or megasporophylls are borne on different trees, the member is called dioecious. In Cycas male cones and megasporophylls are borne on different tree, so it is dioecious.

9. In gymnosperms the mega sporangium is made of a diploid tissue also called nucellus. It is covered with integument (envelope) also hence this composite structure is called integumented mega sporangium or ovule.

10. One cell of nucellus (2n) is differentiated into megaspore mother cell and undergoes meiosis to form four haploid megaspores. Three of them degenerate and only one megaspore remains functional.

11. The functional megaspore germinate inside the megasporangium (endosporic germination) and develops into a multi cellular female gametophyte also called endosperm(n).

12. The female gametophyte (endosperm) produces two or more archegonia or female sex organs in one ovule.

13. This multicellular but less developed female gametophyte is retained within megasporangium (ovule).

- In bryophytes and pteridophytes, the male and female gametophytes have an independent free living existence.
- In gymnosperm and angiosperm male and female gametophyte do not have free living existence. They remain within the sporangia retained on the saprophyte.

14. The pollen grain are released from the microsporangium and are carried in air currents (wind pollination = Anemophily) and come in contact with the opening (micropyle) of ovules on megasporophylls.

15. Each p1llen grain produces pollen tube carrying two male gametes which grows towards archegonia in the ovule and release (discharge) its content (two male gametes) near the mouth of archegonia.

16. One male gamete fuses with female gamete and another male gamete degenerates. The fertilisation is performed which results in zygote and then embryo formation within the ovule.

17. Now fertilized ovule having embryo is called seed.

18 . These seed are not covered with ovary wall or fruit wall so they are called naked seeds.

19. Means in gymnosperm seeds are formed but ovary or fruits are not formed, so they are called as naked seeded plants.

20. Seeds containing embryo (2n) form new diploid sporophytic plants on germination.

- Pollinated pollens are strored in pollen chamber of ovule.

FERTILIZATION -

Two types of fertilization take place in gymnosperms

(1) **Zoido-siphonogamy -** This type of fertilization occurs in lower gymnosperms. Male gametes are motile and transfered to female gamate by pollen tube.

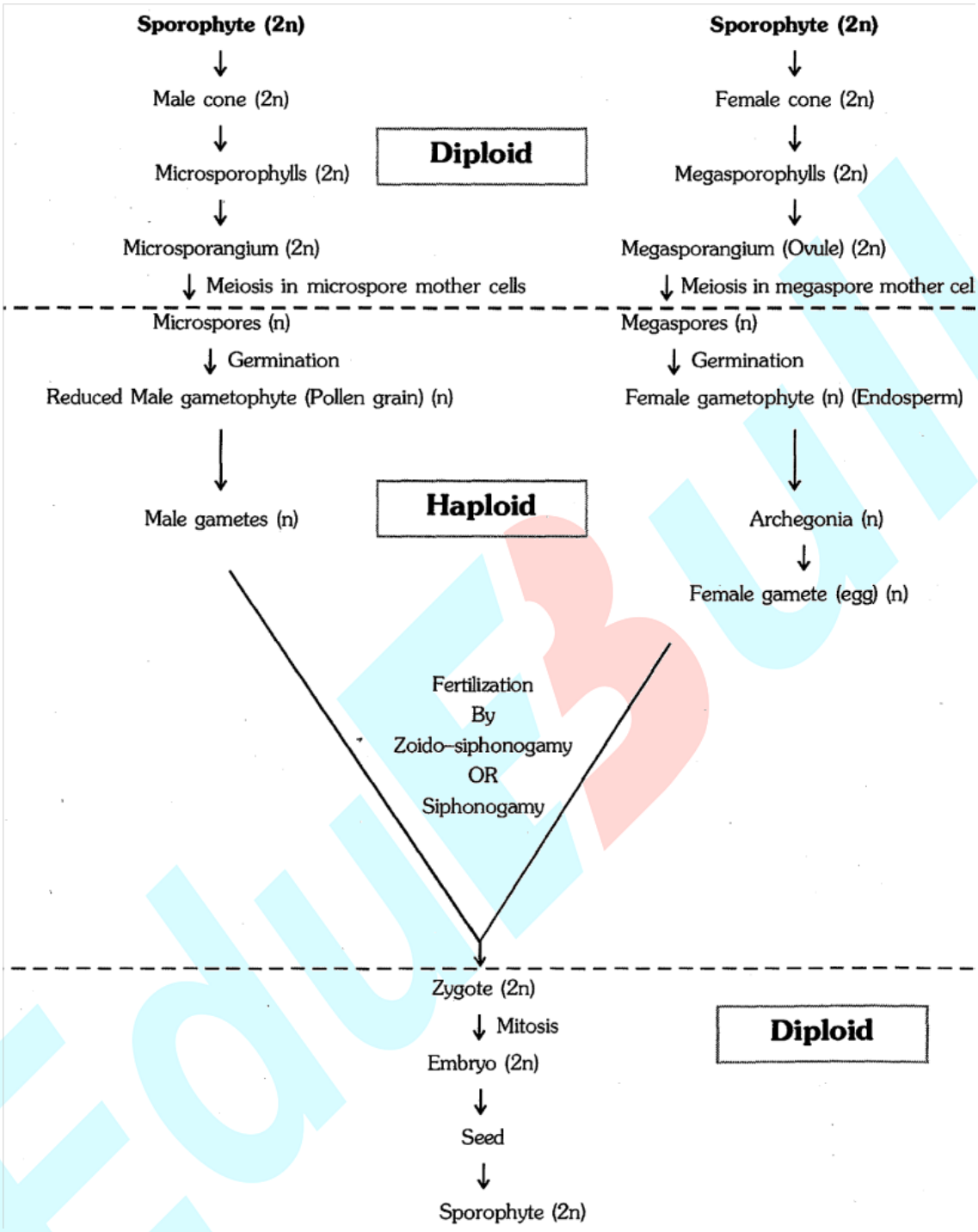
(2) **Siphonogamy -** This type of fertilization occur in higher gymnosperms. Male gametes are non motile transferred to female gamete (egg) by pollen tube. After Pollination male & female gametes are fused & form a diploid zygote.

- In gymnosperm single fertilization takes place so only zygote is formed through fertilization. In Angiosperm double fertilization takes places so two product are formed after it **(i) Zygote (ii) Endosperm.**
- In gymnosperm, endosperm is formed before fertilization by megaspore so it is haploid but in angiosperm endosperm is formed after fertilization by triple fusion (sec. nucleus (2n) + male gamete (n). So, endosperm of angiosperm is triploid.
- In angiospenn, fertilization take place by siphonogamy.
  Gymnospenn + Angiosperm = Siphonogama

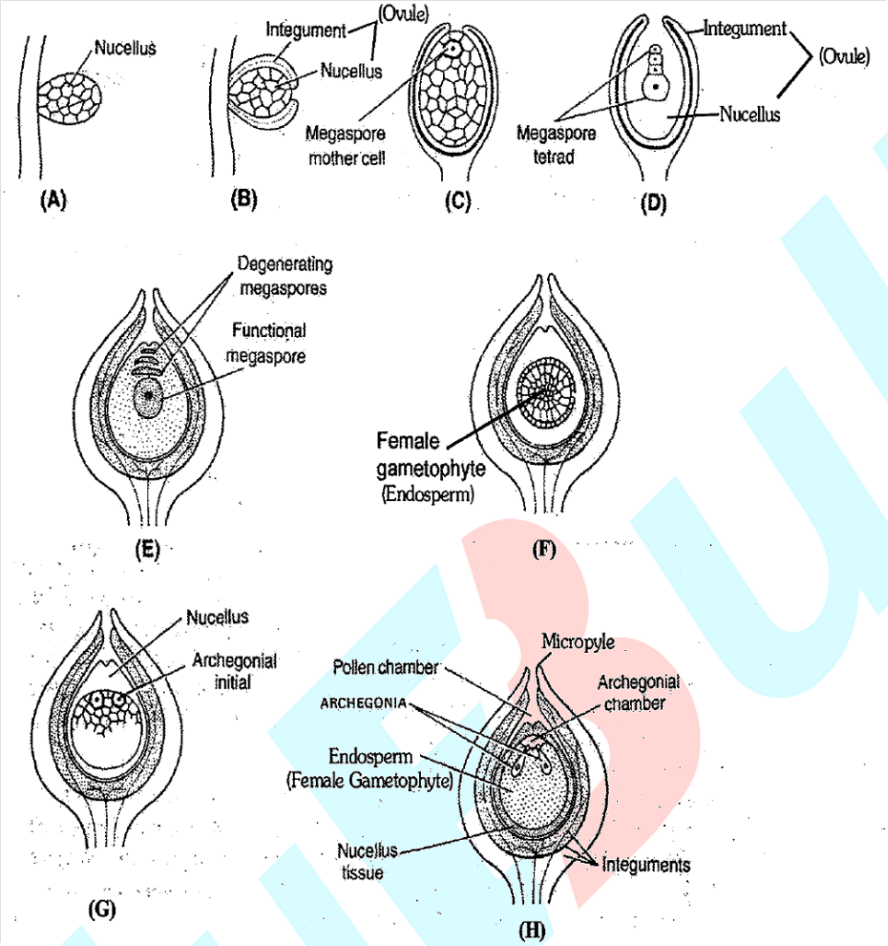
Note :- Different types of polyembryony are found in gymnosperm i.e. occurence of more than one embryos with in seed.

UFECYCLE:

Life cycle of Gymnospenn & angiospenn is diplontic because gametophytic generation is short lived. Gametophyte is very reduced & depends on its sporophyte.


Sporophyte (2n)
Male cone (2n)
Microsporophylls (2n)
Microsporangium (2n)
Meiosis in microspore mother cells
Microspores (n)
Germination
Reduced Male gametophyte (Pollen grain) (n)
Male gametes (n)
Diploid
Haploid
Sporophyte (2n)
Female cone (2n)
Megasporophylls (2n)
Megasporangium (Ovule) (2n)
Meiosis in megaspore mother cel
Megaspores (n)
Germination
Female gametophyte (n) (Endosperm)
Archegonia (n)
Female gamete (egg) (n)
Fertilization
By
Zoido-siphonogamy
OR
Siphonogamy
Zygote (2n)
Mitosis
Embryo (2n)
Seed
Sporophyte (2n)
Diploid

LIFE CYCLE OF GYMNOSPERM



Gymnosperms are divided into two groups

(1) Cycadophyta (Lower Gymnosperm) (2) Coniferophyta (Higher Gymnosperm)

CYCADOPHYTA

(A) The plants of this group are megaphyllous or macrophyllous with circinate vernation.

(B) Presence of Ramenta.

(C) Male gamete is motile.

Cycadophyta is divided into three orders

(i) Cycadofillicales or Pteridospermae :-

This order is completely extinct. Plant of this order known as seed fern.

(ii) Benettitales :-

(a) It is also a completely extinct group.
eg. Williamsonia - fossil plant
Note : Its fossils were discovered by **Prof. Birbal Sahani**

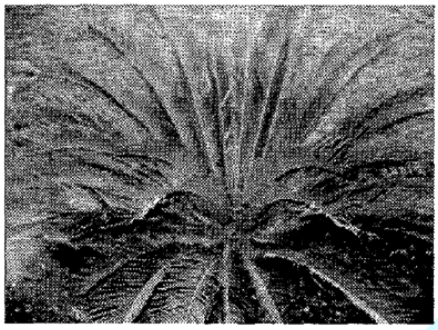
(iii) Cycadales -

(a) Presently living cycadophytes are included in this order.

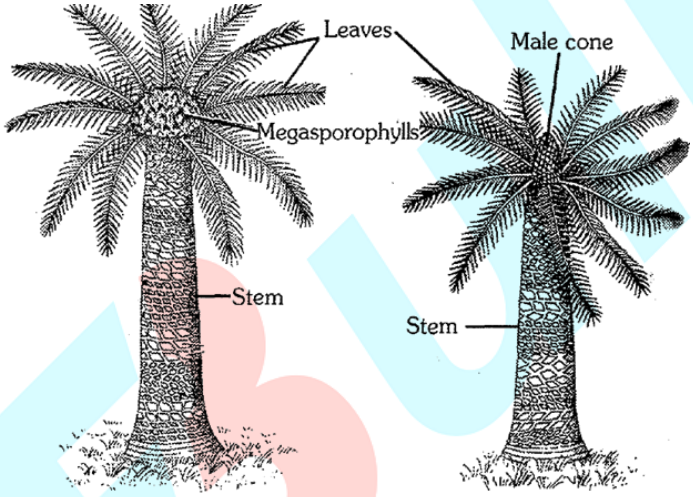
(b) All the plants of this group are living fossils.

- Zamia pygmea - Smallest Gymnosperm
- Cycas - Fern palm or Sago palm Sago is obtained from its stem.

The diameter of its ovules is 7 cm. Its ovule, male gametes, egg and male cone are largest in plant kingdom. In embryo of Cycas two cotyledons are present. In Cycas male gamates are top shaped. In Cycas female cone is absent.



Cycas



***Cycas* :- (A) Female Plant, (B) Male plant**

CONIFEROPHYTA

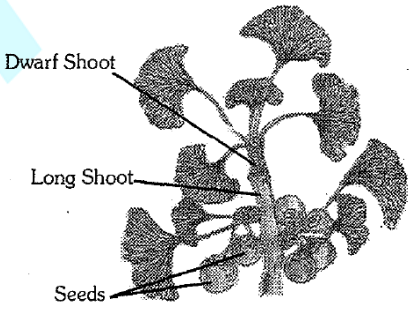
Four orders are included in this group

(i) 'Ginkgo ales:-

(a) It is the oldest order of coniferophyta. Maximum plants of this group are extinct.

Ginkgo biloba - living fossil -It is also known as "Maiden hair tree".

Note : Exceptionally Ginkgo biloba belongs to higher gymnosperm but its male gametes are motile.



Ginkgo

(ii) Cordaitales :-

(a) It is completely extinct group

(iii) Conifer ales :-

(a) Conifers are included in this group.
(b) It is the largest group of gymnosperm.

Examples of Conifer ales-

(a) Pinus (Pines) - A resin "turpentine" is obtained from it.
- It is known as "chilgoza pine" or "chirpine".

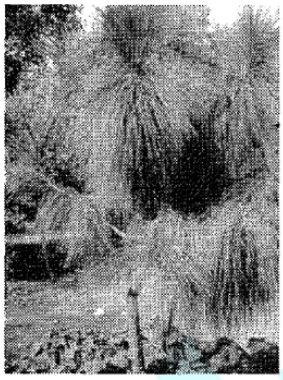
(b) **Cedrus** - It is known as Yew tree. An anticancer medicine "Taxol" is obtained from its bark.

(c) **Taxus** - It is known as Yew tree. An anticancer medicine "Taxol" is obtained from its bark.

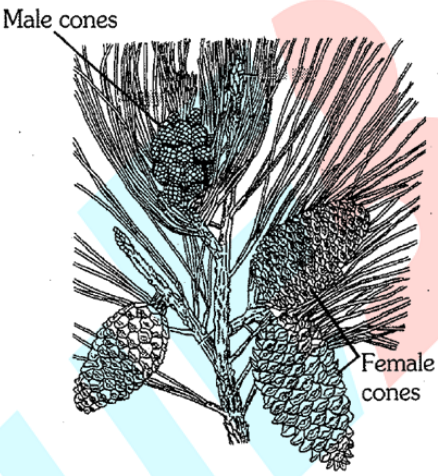
(f) **Amucaria** - It is known as Christmas tree.

(g) **Sequoia** - The plants in this genus are heavy. It is the largest or tallest tree so that it is called as father of forest. It is called Red wood tree or Sherman tree.

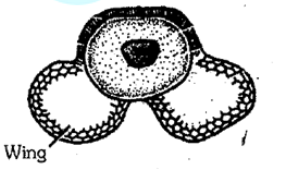
(h) **Met sequoia** - It is a living fossil.



Pinus



Pinus [Monoecious plant]



Microspore (Pollen grain) of *Pinus*
(Winged Pollen grain)

Gnetales -

(a) They are the most advanced gymnosperms.
(b) Exceptionally members of this group have vessels in xylem.
(c) Archegonia is absent il1 the members of this group.

eg. **(1)** **Gnetum**
(2) **Welwitschia**
(3) **Ephedra** - Exceptionally archegonia are present in Ephedra.

Ephedra - This gymnosperm is commonly found in Rajasthan. Ephedra is a medicinal plant. Ephedrine (Medicine) is obtained from it. It is an effective medicine in asthma. Athletes misuse it, so ephedrine is restricted for them.

There is mainly two requirements for seed formation

(1) Plant should be heterosporus (2) Germination of megaspore should be endosporic

SOME IMPORTANT POINTS:

1. Antheridia is absent in gymnosperm & angiosperm i.e. pteridophyte is last group having antheridia. But archegonia is also absent in angiosperm. So gymnosperm is last group having archegonia.

2. During evolution Gametophyte becomes reduced & sporophyte becomes well-developed.

Gametophyte	Very reduced	–	In Angiosperm
	Well developed	–	In Moss
Sporophyte	Very reduced	–	In Thallophyta (Only zygote)
	Well developed	–	In Angiosperm

GOLDEN KEY POINTS

1. Plant body of algae is not differentiated into root, stem and leaves, such plant body is called thallus/thalloid.
2. Algal sex organs are unicellular and jacketless but exceptionally sex organ of Chara are multicellular and jacketed.
3. Spirullina-BGA and Chlorella is used as a source of food and 0 2 by space travellers.
4. Algin protects seaweeds against dessication and shocks. 9.
5. Major pigments of Rhodophyceae are chlorophyll-a, d and phycoerythrin.
6. Gaudikov's effect is found in both red algae and blue green algae.
7. Bryophytes are amphibians of the plant kingdom because these plants can live in soil but are dependent on water for fertilization.
8. In bryophyta the sporophyte is depend on' gametophyte.
9. Most developed gametophyte in kingdom plantae is found in mosses.
10. Mosses along with lichens are the first organisms to colonise rocks hence are of great ecological importance.
11. Pteridophytes are vascular cryptogams and first successful terrestrial plants.
12. Prothallus is independent and mostly photosynthetic gametophyte.
13. Selaginella, Salvinia, Marsilea and Azalia are heterosporous pteridophytes, which show precursor of seed habit.
14. Gametophyte is monoecious in homosporous pteridophytes.
15. The ovules are not enclosed by ovary wall and remain exposed, both before and after fertilization in gymnosperms.
16. Integumented mega sporangium is called ovule.
17. In gymnosperm single fertilization takes place so only zygote is formed through fertilization.
18. Pollen grains and seeds are winged in Pinus.
19. Ephedra and Taxus are medicinal gymnosperms.

BEGINNER'S BOX-4

1. According to Whittaker, kingdom plantae includes all
(1) Unicellular, eukaryotic autotrophic plants ,
(2) Multicellular, eukaryotic, autotrophic plants
(3) Multicelluler, eukaryotic organisms
(4) Unicellular/multicellular eukaryotic autotrophic plants

2. Which of the following thick walled spores protect the algae from unfavourable condition ?
(1) Akinetes (2) Aplanospores
(3) Hypnospores and Akinetes (4) Zoospores and Aplanospores

3. Which of the following is not found in algae ?
(1) Meiosis (2) Embryo (3) Zygote (4) Fertilization

4. In Chladophora isogametes are :-
(1) Non flagellated (2) Single flagellated (3) Biflagellate (4) Multiflagellated

5. Coenobium is the colony of :-
(1) Volvos (2) Spirogyra (3) Ulothrix (4) Acetabularia

6. Which one is unicellular algae :-
(1) Ulothrix (2) Acetabularia (3) Chara (4) VIva

7. Chondrus algae is used to obtained :-
(1) Agar agar (2) Carrageenin (3) Citric acid (4) Aflatoxin

8. True elaters and gemmae are concerned with :-
(1) Riccia (2) Marchantia (3) Anthoceros (4) Notothylus

9. The sporophyte of mosses is :-
(1) Parasite (2) Semiparasite
(3) Free living (4) Differentiated in root, stem and leaves

10. Independent alternation of generation is the unique character of the life cycle of :-
(1) Bryophyte (2) Pteridophyte (3) Gymnosperm (4) Spermatophyte

11. Which of the following fern spreads very fast by means of leaf tip ?
(1) Pteridium (2) Azolla (3) Adiantum (4) Alsophila

12. The functional megaspore of gymnosperm germinate :-
(1) Inside the megaspore mother cell (2) Inside the megasporangium
(3) Inside the soil (4) Into endosperm after fertilization

13. Which of the following group of members have vessels in xylem exceptionally ?
(1) Ginkgoales (2) Coniferales (3) Gnetales (4) Cycadales

14. A plant shows thallus level of organisation. It shows rhizoids and is haploid. It needs water to complete its life cycle because the male gametes are motile. Identify the group to which it belongs to:-
(1) Bryophytes (2) Pteridophytes (3) Gymnosperms (4) Angiosperms

15. Holdfast, stipe and frond, constitutes the plant body of :-
(1) Chlorophyceae (2) Phaeophyceae (3) Bryophyta (4) Cyanophyceae

16. Protonema and prothallus are respectively :-
(1) Diploid and Haploid (2) Diploid and Diploid
(3) Haploid and Diploid (4) Haploid and Haploid

SOME SPECIAL POINTS

SOME INFORMATIONS RELATED TO BIOTECHNOLOGY WITH RESPECT TO BACTERIA AND FUNGI-

1. Different varieties of cheese are known by their characteristic texture, flavour and taste, the specificity coming from the microbes used. For example, the large holes in Swiss cheese are due to production of a large amount of CO_2 by a bacterium named Propionibacterium sharmanii.
2. "Toddy" a traditional drink of some parts of southern India is made by fermenting sap from palms with the help of microbes.
3. Streptokinase produced by the bacterium Sterptococcus and modified by genetic engineering is used as a clot buster for removing clots from the blood vessels of patients.
4. Cyclosprin A, that is used. as an immunosuppressive agent in organ-transplant patients is produced by the fungus Trichoderma polysporum. Statins produced by the yeast Monascus purpureus have been commercialized as blood-cholestrollowering agent.

BOTANICAL GARDENS, HERBARIA AND RESEARCH INSTITUTE

(1) Oldest botanical garden is "Padua Botanical Garden" Italy (Established -1545).
(2) Largest Botanical garden in the world is Royal Botanical Garden, Kew, Surrey, England, established by William Aiton, 1759.
(3) Largest herbarium of the world is .. Museum of Natural History" - Paris - with a collection of 8880000 specimens.
(4) Largest Botanical Garden of Asia is Indian Botanical Garden, Sibpur, Kolkota. Established by Robert Kyd, 1786.
- Largest herbarium of Asia is Central National Herbarium located in Indian Botanical Garden, with a collection of 25 lakh specimens.
- Indian Botanical Garden is famous due to the presence of "Great Banyan Tree" in its campus.
- In campus of Indian Botanical Garden Botanical Survey of India (BSI) is present which is established by William Roux burgh 1890.
- BSI $\rightarrow$ Botanical Survey in India is done by BSI

(5) National Botanical Garden, Lucknow. National Botanical Research Institute (NBRI) is located in National Botanical Garden.

(6) Forest Botanical Garden, Dehradun- Forest Research Institute (FRI)is located in Forest Botanical Garden.
(7) Uoyd Botanical Garden - Darjeeling.
(8) CDRI - Central Drug Research Institute - Lucknow
(9) CAZRI - Central Arid Zone Reserch Institute - Jodhpur
(10) CIMAP - Central Institute of Medicinal and Aromatic Plants - Lucknow
(11) IARI- Indian Agriculture Research Inst. (Pusa Inst.)- New Delhi
(12) Birbal Sahni Institute of Paleobotany (National inst. of paleobotany) - Lucknow

SOME INFORMATIVE QUESTIONS FROM PLANT DIVERSITY

1. The protest in which cell size decreases with each division are :-
(1) Diatom (2) Dinoflagellates (3) Euglenoids (4) Slime molds

2. "Systematics, is the study of diversity of organisms and all their comparative and evolution relationship". Above statement is related to :
(1) Mendal (2) Mayer (3) G.Simpson (4) Haeckel

3. Which of the following statement is correct:
(1) When volition granules stained by basic dyes, these granules show different colours. Therefore they are also termed as metachromatic granules.
(2) The volution granules are phqsphate polymers and function as a storage reservoir for phosphate.
(3) Bacterial DNA is attached to cell membrane and the membrane may be involved in separation of duplicated DNA into daughter cells during division.
(4) All of the above

4. In Bentham and Hooker's classification position of some families like Ceratophyllaceae, Salicaceae and Empetraceae not fixed and these families unrelated to each other were placed in a group "Ordines anomali". This group belongs to:-
(1) Polypetalae (2) Gamopetalae (3) Monochlamydeae (4) Gymnospermae

5. ..... is known as incomplete because in this sub class sepals and petals are not distinct. Flowers usually posses only one whorl of perianth which is sepaloid :-
(1) Polypetalae (2) Gamopetalae (3) Monochlamydae (4) Both (1) & (2)

6. According. to Bentham and Hooker's classification which family/ order was considered most primitive
(1) Ranunculaceae/Ranales (2) Orchidaceous/Orchidales
(3) Malvaceae/Malvales (4) Brassicaceae/Parietales

Answer key

1.	(1)	**2.**	(3)	**3.**	(4)	**4.**	(3)	**5.**	(3)	**6.**	(1)		

ANSWER KEY

BEGINNER'S BOX-1

1.	(2)	**2.**	(4)	**3.**	(4)	**4.**	(1)	**5.**	(2)	**6.**	(1)	**7.**	(2)
8.	(1)												

BEGINNER'S BOX-2

1.	(3)	**2.**	(2)	**3.**	(2)	**4.**	(4)	**5.**	(2)	**6.**	(3)	**7.**	(2)
8.	(3)	**9.**	(1)	**10.**	(3)								

BEGINNER'S BOX-3

1.	(4)	**2.**	(1)	**3.**	(2)	**4.**	(1)	**5.**	(1)	**6.**	(4)	**7.**	(2)
8.	(1)	**9.**	(1)	**10.**	(1)	**11.**	(4)	**12.**	(3)	**13.**	(1)		

BEGINNER'S BOX-4

1.	(2)	**2.**	(3)	**3.**	(2)	**4.**	(3)	**5.**	(1)	**6.**	(2)	**7.**	(2)
8.	(2)	**9.**	(2)	**10.**	(2)	**11.**	(3)	**12.**	(2)	**13.**	(3)	**14.**	(1)
15.	(2)	**16.**	(4)										