ALLEN CAREER INSTITUTE KOTA (RAJASTHAN)

path to success

PRE-MEDICAL

BOTANY

ENTHUSIAST | LEADER | ACHIEVER

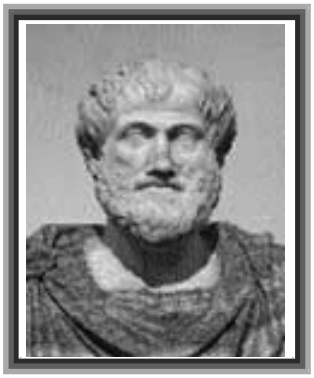
STUDY MATERIAL

Diversity in the living world

ENGLISH MEDIUM

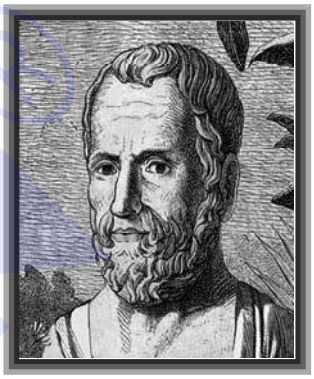
Copyright Statement

Aristotle (384-322 BC)



He was a Greek philosopher and scientist born in the city of **Stagira, Chalkidice** of classical Greece. His father died when Aristotle was a child. At eighteen, he joined **Plato's Academy** in **Athens** and remained there until the age of thirty seven (c.347 BC). His writings cover many subjects including **physics, biology, zoology, metaphysics, poetry, politics** and **government**. Shortly after Plato died, Aristotle left Athens and, at the request of Philip of Macedon, tutored Alexander the Great. Aristotle was the **first genuine scientist in history** and every scientist is in his debt.He is regarded as father of biology and zoology. He first classified plants into three groups **(i) Herbs (ii) Shrubs (iii) Trees**

Theophrastus (371-287 BC)



He was a Greek native of **Eresos** in **Lesbos**, was the successor to **Aristotle.** He came to Athens at a young age and initially studied in **Plato's school.** After Plato's death, he attached himself to Aristotle. He is often considered the **"Father of botany"** for his works on plants.

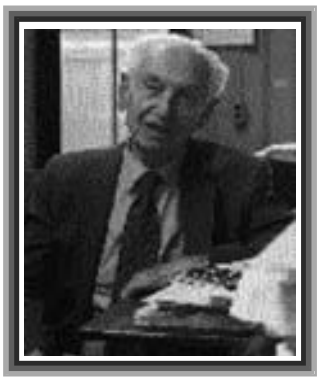
The interests of Theophrastus were wide ranging, extending from biology and physics to ethics and metaphysics. His two surviving botanical works, Enquiry into plants (Historia Plantarum) and On the causes of Plants, were an important influence on Renaissance science. He classified plants into herbs, undershrubs, shrubs and trees. He also gave the names **annual, biennials** and **perennails** to plants. Theophrastus is also known as **"Father of ancient plant taxonomy"**

Carolus Linnaeus (23 May 1707 - 10 January 1778)

He was also known as Carl Von Linne he was a Swedish botanist, physician and zoologist, who formalised the modern system of naming organisms called **binomial nomenclature.** He is known by the epithet "Father of modern taxonomy". Many his writings were in Latin, and his name is rendered in Latin as **Carolus Linnaeus (abbreviation - "Linn").**

Linnaeus received most of his higher education at **Uppsala University,** and began giving lectures in botany there in 1730. He published a first edition of his **Systema Naturae** in the Netherlands. He then returned to Sweden, where he became professor of medicine and botany at **Uppsala university.**

Ernst Mayr (1904-2004)



Born on 5 July 1904, in **Kempten, Germany,** ERNST MAYR, the Harvard University evolutionary biologist who has been called 'The Darwin of the 20th century', was one of the 100 greatest scientists of all time. Mayr joined Harvard's Faculty of Arts and Sciences in 1953 and retired in 1975, assuming the title **Alexander Agassiz Professor of Zoology Emeritus.** Throughout his nearly 80-year career, his research spanned **ornithology, taxonomy, zoogeography, evolution, systematics,** and the **history and philosophy of biology.** He almost single-handedly made the origin of species diversity the central question of evolutionary biology that it is today. **He also pioneered the currently accepted definition of a biological species.** Mayr was awarded the three prizes widely regarded as the triple crown of biology: the **Balzan Prize** in 1983, the **International Prize for Biology** in 1994, and the **Crafoord Prize** in 1999. Mayr died at the age of 100 in the year 2004.

DIVERSITY IN THE LIVING WORLD

01. THE LIVING WORLD

- **What Is Living?**
- **Diversity In The Living World**
- **Taxonomic Categories**
- **Taxonomical Aids**

- Biology is the science of life forms and living processes.
- Biology is the story of life on earth.

  Biology; *Bios* = Life, *Logos* = Study/discourse; means study of life is biology.
- Early man could easily perceive the difference between inanimate matter and living organisms.
- The wide range of living types is amazing.

- The living world is full of amazing diversity of living organisms.
- The diversity of habitats of organisms is also very vast and amazing.
- This diversity makes us deeply reflect on ''What indeed is life'' ? This question actually asks to solve two problems :-
  - First is a technical and seeks answer to, what living is as opposed to the non-living means **Living v/s Non-living**
  - Second is a philosophical one, and seeks answer to what the **purpose of life** is ?

    As scientists we will try to solve the first question, because the second question is more related to philosophy rather than science.

(1) What is Living ?

The distinctive characteristics exhibited by living organisms are

(A) Growth
(B) Reproduction
(C) Metabolism
(D) Cellular Organisation
(E) Consciousness

(A) Growth

- All living organisms can grow.
- Increase in mass and increase in number of individuals are twin characters of growth.
- Growth is an irreversible permanent increase in size of an organism or its parts or even of an individual cell.
- A multicellular organism grows by cell division.
- In plants, this growth by cell division occurs throughout their life span. In animals this growth is seen upto a certain age, however cell division occurs in certain tissues to replace lost cells.
- Unicellular organisms grow by cell division.

- Growth is of two types :-
  - **(i) Intrinsic growth :** This growth is from inside of the body of living organisms.
  - **(ii) Extrinsic growth :** This growth is from outside i.e. accumulation of material on any body surface. Non-living exhibits this type of growth.
- In majority of higher plants and animals, growth and reproduction are mutually **exclusive events**.
- Non-living objects also grow if increase in body mass is taken as criterion for growth. Growth exhibited by non-living is by accumulation of material on surface.
- Because both living and non-living exhibit growth so, it can not be taken as defining property.
- Growth from inside (intrinsic growth) can be taken as **defining property**.
- A dead organism does not grow.

(B) Reproduction :

- Production of new individual or progeny is called reproduction.
- Reproduction in case of multicellular organisms is production of progeny possessing features more or less similar to those of parents.
- Reproduction in case of unicellular organisms like bacteria, unicellular algae or *Amoeba* is synonyms with growth i.e. increase in number of cells.
- In single celled organism we are not very clear about the usage of these two terms growth and reproduction.
- Reproduction is not found in any non-living object.
- There are many living organisms which do not reproduce like mules, infertile human couples and sterile worker bees, etc.
- So, the reproduction also can not be an all inclusive **defining characteristic** of living organisms.
- No Non-living object is capable of reproducing or replicating by itself.
- **Reproduction is of two types.**

(i) Asexual Reproduction : Reproduction in which **gametic fusion** or **fertilisation** and meiosis are not involved is **Asexual Reproduction**. Many methods of asexual reproduction are there.

(a) **By Asexual spores** :- In algae and fungi

(b) **By Budding** :- In Yeast and *Hydra*

(c) **By Fragmentation :-** The filamentous algae, fungi and the protonema of moss all easily multiply by fragmentation.

(d) **True regeneration** :- Fragmented organisms regenerate the lost part of its body and becomes, a new organism. ***e.g.*** *Planaria* (Flat worms)

Note : **Regeneration** is a process in which only the lost part of the body is repaired or regained ***e.g.*** Star fish, Lizard.

(ii) Sexual Reproduction : Reproduction in which gametes are formed by meiosis and fertilisation also takes place to form progeny is called sexual reproduction.

(C) Metabolism :

- The sum total of all the chemical reactions occuring in a living body is **metabolism**.
- All living organisms, both **unicellular** and **multicellular** plants, animals, fungi and microbes exhibit metabolism.
- No **non-living** object exhibits metabolism.
- In this way metabolism is a **defining character** of living organisms because it has no exceptions.
- Metabolic reactions can be demonstrated outside the body in a cell free medium or in a test tube in lab.
- An isolated metabolic reaction outside the body of an organism, performed in a test tube *(in-vitro)* is **neither living nor non-living.**
- Isolated metabolic reactions *in-vitro* are not living things, but surely living reactions because they are similar to the reactions performing in our body.
- Here we should not forget the fact that metabolism is the sum total of all the chemical reactions performing in living body, it is not the sum of few or more living reactions.

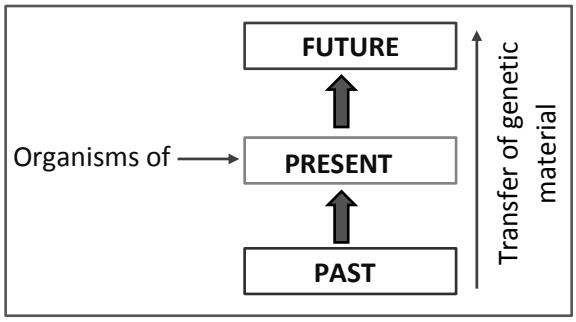
(D) Cellular Organisation :

- Cell is the basic unit of life.
- All living organisms are composed of cells. Some are composed of a single cell and are called **unicellular organisms** while others like us, composed of many cells, are called **multicellular organisms**.
- Unicellular organisms are capable of independent existence and performing essential functions of life.
- Anything less than a complete structure of a cell, does not ensure independent living. Hence, cell is the **fundamental, structural** and **functional unit** of all living organisms.
- Hence **cellular organisation** of the body is **defining property** of all living forms/ organisms.

(E) Consciousness :

- The most obvious and technically complicated feature of all living organisms is Consciousness.
- Ability to sense the surrounding environments and respond to these environmental stimuli which could be physical, chemical or biological is called **consciousness.**
- We sense these environmental stimuli through our sense organs.
- Plants respond to external factors like light, water, temperature, other organisms, pollutants, etc.

- All organisms from the prokaryotes to complex eukaryotes show consciousness to **environmental cues** (factors).
- Photoperiod affects reproduction in seasonal breeders, both plants and animals. All organism handle chemicals entering their body.
- Some common examples of consciousness can be seen in organisms, like – Plants exhibit flowering in a particular season (photoperiodism), Some animals perform breeding in a particular season only (seasonal breeders), and all organisms handle the chemicals entering their bodies, etc.
- When humans are concerned a very high level of consciousness is found in human. Human being is the only organism who is aware of himself, i.e., has self-consciousness because of our well developed nervous system and supreme level of skill of communication which is called **self-consciousness.**
- Human is very fast to respond towards the external stimuli and even it can think or predict about possible changes of surroundings also, so it can prepare itself according to the surrounding situations. Further, human can even change its surrounding situations upto a limit so this **topmost** or climax level of consciousness is regarded as **self-consciousness**, which can not be seen elsewhere.
- The brain dead coma patient, virtually supported by machines which replace heart and lungs also has consciousness. So, it is living. But it does not has self consciousness as it has lost the co-ordination of organs of different body parts.
- All the living phenomena are due to underlying interactions. (Important events/reactions which occurs due to interactions in its constituents).
- Properties of tissues are not present in the constituents cells, but arise as a result of interactions among the constituents cells. Similarly, properties of cellular organelle are not present in the molecular constituents of the organelle but arise as a results of interactions among the molecular components comprising the organelle. These result in emergent properties (apparent properties which develop by interactions in its constituents) at a higher level of organisation.
- Living organisms are **self replicating**, **evolving**, and **self regulating** interactive system capable of responding to external stimuli. Adaptations and homeostasis are also very important characters of livings.
- All the organisms have been evolved by a very long and complex process of **evolution**. All living organism are related to each other by sharing of the **common genetic material** but upto varying degrees because all living organisms have ds DNA as genetic material but in different organism this sharing may be less or more.



- When human came to know this fact then he humbled and led to cultural movements for conservation of **biodiversity**.
- Sharing of common characters was also proved when human studied the similarities among living organisms both **horizontally** and **vertically**.

(2) DIVERSITY IN THE LIVING WORLD

(A) Taxonomy

Taxis = arrangement, *nomos* = law

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

Branch of biology dealing with identification, nomenclature and classification of organisms is called taxonomy.

Taxonomy includes study of following points

(i) **Identification** : A process by which an organism is correctly recognised and described from the other already known organisms.

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

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

- To study all above points, characters of organisms are necessary to be used, so use of characters for description of organisms is called **characterisation**.

Systematics :-

- The term systematics was given by Linnaeus. The word systematics is derived from Latin word "Systema" which means "systematic arrangement of organisms". Linnaeus used "*Systema Naturae*" as a title of his publication.
- Systematics was later enlarged to include identification, nomenclature and classification with study of evolutionary relationships between organisms.

Note : External and internal structure, along with the structure of cell, development process and ecological information of organisms are essential and form the basis of modern taxonomic studies.

(B) Types of taxonomy

(i) **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 behaviour.

(ii) **Chemotaxonomy :** It is based on the chemical constituents of plants in solving taxonomic problems.

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

Some Informations :

- Biodiversity :- The number and types of organisms present on earth.
- The number of species that are known and described range between 1.7 – 1.8 million.
- Practical significance of taxonomy is → Identification of unknown organism.

(C) Nomenclature

The plants and animals in own area are recognised by their local name. These local names vary from place to place.

There is a need to standardise the naming of living organisms, so that a particular organism is known by same name all over the word.

Binomial System -

- **Carolus Linnaeus** :- Linnaeus used this nomenclature system for the first time on large scale and proposed scientific nomenclature for all the plants and animals.
- **Linnaeus** is the founder of binomial system.
- Linnaeus proposed scientific nomenclature of plants in his book "***Species Plantarum***". It was published on **1 May, 1753**, hence 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 nomenclature of animals in his book "***Systema Naturae***" (10^{th} edition).
- This 10^{th} edition of *Systema Naturae* was published on **1 August, 1758**. So initiation of binomial system for animals is believed to be started on 1 August, 1758.

ICBN : "International Code of Botanical Nomenclature"

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

Main Rules of ICBN :-

(i) According to binomial system name of any species or scientific name or biological name consists of two words -

(a) Generic name - Name of genus

(b) Specific epithet -

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

↓ ↓ ↓ ↓

Generic name Specific epithet Generic name Specific epithet

(ii) In plant nomenclature (ICBN) tautonyms are not valid, but tautonyms are valid in animal nomenclature (ICZN- International Code of Zoological Nomenclature)

(Tautonyms - The name in which generic name and specific epithet are same)

e.g. ***Mangifera mangifera*** – **Not valid name**

e.g. ***Naja naja*** (Indian cobra) } **Valid name**
Rattus rattus (Rat)

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

e.g. ***Mangifera indica***

(iv) When handwritten or typed, then generic name and specific epithet should be separately underlined or printed in italics to the indicate their Latin origin.

(v) Name of the author appears after the specific epithet, i.e., at the end of the biological name and is written in an abbreviated form, e.g., *Mangifera indica* Linn. It indicates that this species was first described by Linnaeus.

(vi) Name of scientist is neither underlined nor italicized, but written in Roman letters (simple alphabets).

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

(viii) Type specimen (herbarium sheet) of newly discovered plant should be placed in herbarium.

Note :

- The scientific name ensure that each organism has only one name.
- Description of any organism should enable the people to arrive at the same name.
- They also ensured that such a name has not been used for any other organism.

(D) Biological Classification :

Since it is nearly impossible to study all the living organism, so classification is required.

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.

Types of Biological Classification

(i) Practical classification :

In this type of classification, plants are classified on the basis of their economic importance or uses of various organisms. This classification system is the earliest system.

e.g.
- Oil yielding plants → Coconut, Groundnut (Peanut), Soyabean
- Fibre yielding plants → Jute, Cotton
- Medicinal plants → *Rauwolfia, Cinchona,* Clove, Ginger, Turmeric
- Spices yielding plants → Ginger, Turmeric, Clove, Coriander, Chilli.

Note :- In this classification, one plant can be a member of more than one group.

e.g. **Turmeric** : have multiple uses, 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/**Few morphological characters i.e. over all morphological characters are not considered.

e.g. - Classification proposed by **Linnaeus** is Artificial classification.

Note :

- In the book "***Genera Plantarum***" Linnaeus classified the plant kingdom into 24 classes on the basis of stamen (structure of androecium) so, classification of Linnaeus is also called **sexual classification**.
- 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.**
- 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 or gross morphology**. In this system the characters of whole plant are included (root, shoot etc.)
- Natural classification is based on natural affinities among the organisms and consider not only the external features but also internal features like ultra structure, anatomy, embryology and phytochemistry.

Note:

- In natural classifications more weightage is given to reproductive or floral or sexual characters, so the natural classification is believed to be the **best classification**.

Natural classification is of two types

(a) **Natural Non-phylogenetic (formal)** → In this classification, the phylogeny of the plant is not considered i.e. only the gross morphology of the plant is considered.

(b) **Natural phylogenetic** → In this classification both gross morphology and phylogeny are considered. This classification is based on evolutionary relationship between the various organism. This assumes that organisms belonging to same taxa have common ancestors.

- **Phylogeny** → History of evolution of organism.

Primitive → Advanced

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

- **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. This book impressed very much the opinion of taxonomists.

  Note : A Phylogenetic classification is also known as **Cladistic classification,** because its presentation is like a tree (evolutionary tree).

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

In this system 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. Number and codes are assigned to all the characters and the data are prepared and then processed. Those organisms 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.

Golden Key Points

- Increase in mass and increase in number of individuals are twin characters of growth.
- For unicellular organisms like bacteria, unicellular algae or *Amoeba*, reproduction is synonymous with growth, i.e., increase in number of cells.
- In majority of higher plants and animals, growth and reproduction are mutually exclusive events.
- Cellular organisation of the body is the defining feature of life forms.
- The most obvious and technically complicated feature of all living organisms is this ability to sense their surroundings or environment and respond to these environmental stimuli which could be physical, chemical or biological.
- Human being is the only organism who is aware of himself, i.e., has self-consciousness.
- The first word in a biological name represents the genus while the second component denotes the specific epithet.
- Classification is the process by which anything is grouped into convenient categories based on some easily observable characters.
- Based on characteristics, all living organism can be classified into different taxa.
- The scope of systematics was later enlarged to include identification, nomenclature and classification. Systematics takes into account evolutionary relationships between organisms.
- Artificial system separated the closely related species since they were based on a few characteristics. Also, the artificial systems gave equal weightage to vegetative and sexual characteristics.
- Natural classification systems developed, which were based on natural affinities among the organisms and consider, not only the external features, but also internal features, like ultrastructure, anatomy, embryology and phytochemistry.
- In numerical taxonomy, each character is given equal importance and at the same time hundreds of characters can be considered.

BEGINNER'S BOX — THE LIVING WORLD TO CLASSIFICATION

1. Term 'systematics' was derived from word "*Systema*" which means _____ :-
(1) Evolutionary relationship
(2) Systematic arrangement of organisms
(3) Naming of organisms
(4) Classification of organisms

2. Taxonomically known number of species is :-
(1) 1.7 billion (2) 1.7 million
(3) 5-30 million (4) 17 million

3. Defining characters of all livings is/are :-
(1) Metabolism (2) Consciousness
(3) Cellular organization (4) All of the above

4. Which of the folloiwng 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. All livings show :-
(1) Growth (2) Reproduction
(3) Metabolism (4) Both (1) & (3)

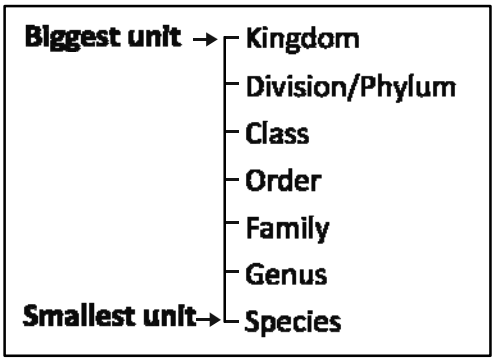
7. Binomial system of nomenclature given by :
(1) A.P. de Candolle (2) Linnaeus
(3) E. Mayr (4) Whittaker

8. Classification based on use of various organisms is called :-
(1) Artificial classification
(2) Practical classification
(3) Natural classification
(4) Phenetic classification

9. Classification system in which computers are used, is :
(1) Natural (2) Practical (3) Numerical (4) Artificial

10. Linnaeus' classification of plants is mainly based on :
(1) Stamen (2) Carpel (3) Petals (4) Sepals

(3) TAXONOMIC CATEGORIES



There are **7 main** taxonomic categories. They are **obligate** or **broad categories** i.e. they are essentially used at the time of any plant classification. However, taxonomists have also developed sub categories or extra categories to facilitate more sound placement of various taxa, like **sub division**, **sub order,** etc. They are not regularly used. They are used only when they are needed.

- **Taxonomic hierarchy -** Descending or ascending arrangement of taxonomic categories is known as taxonomic hierarchy.

Classification of Mango and Human :-

←Taxonomic Categories →

Categories	Mango
Kingdom	Plantae
Division	Angiospermae
Class	Dicotyledonae
Order	Sapindales
Family	Anacardiaceae
Genus	*Mangifera*
Species	*Mangifera indica*

←Taxa (Sign. Taxon)→

←Taxonomic Categories →

Categories	Human
Kingdom	Animalia
Phylum	Chordata
Class	Mammalia
Order	Primata
Family	Hominidae
Genus	*Homo*
Species	*Homo sapiens*

←Taxa (Sign. Taxon)→

- **Taxon (singular) / Taxa (plural)** – Plant group or animal groups included in category are called Taxon/Taxa.
- 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, in fact, represents a rank and is commonly termed as taxon (Pl. : taxa)
- Remember, groups represent category, Category further denotes rank. Each rank or taxon, in fact, represents a unit of classification.
- Wheat, rice, plants, animals and mammals are convenient categories or taxa we use to study organism. Animals, mammals and dogs are different taxa at different level.

Suffix for taxa (Taxon)

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

- There is no suffix for Genus, Species and Kingdom

Note :-

- All living organism including those in plant and animal kingdom have species as lowest category. It is basic unit of classification.
- Taxonomic groups/categories are distinct biological entities and are not merely morphological aggregates.

(A) Species :

Taxonomic studies consider a group of individual organisms 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. For example, ***Mangifera indica*** can easily be identified from any another species on the basis of morphological differences.

(B) Genus :

Genus comprises a group of related species which has more characters in common in comparison to species of other genera. We can say that genera are aggregates of closely related species. Each genus may have one or more than one specific epithets 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*.

(C) 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.

For example three different genera ***Solanum, Petunia*** and ***Datura*** are placed in the family **Solanaceae**.

(D) Order :

Order being a higher category is the assemblage of related families which exhibit a few similar character. For example **convolvulaceae** and **solanaceae** are related and included in the order **polymoniales** and are mainly characterised by floral characters. Order has less number of similarities as compared to family, genus and species. **Order and other higher taxonomic categories are identified on the basis of aggregates of characters.**

(E) Class :

A class includes organisms of related orders having less similarities than orders. For example **Sapindales** and **Polymoniales** are related, so they are included in one class **Dicotyledonae**.

(F) Division :

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

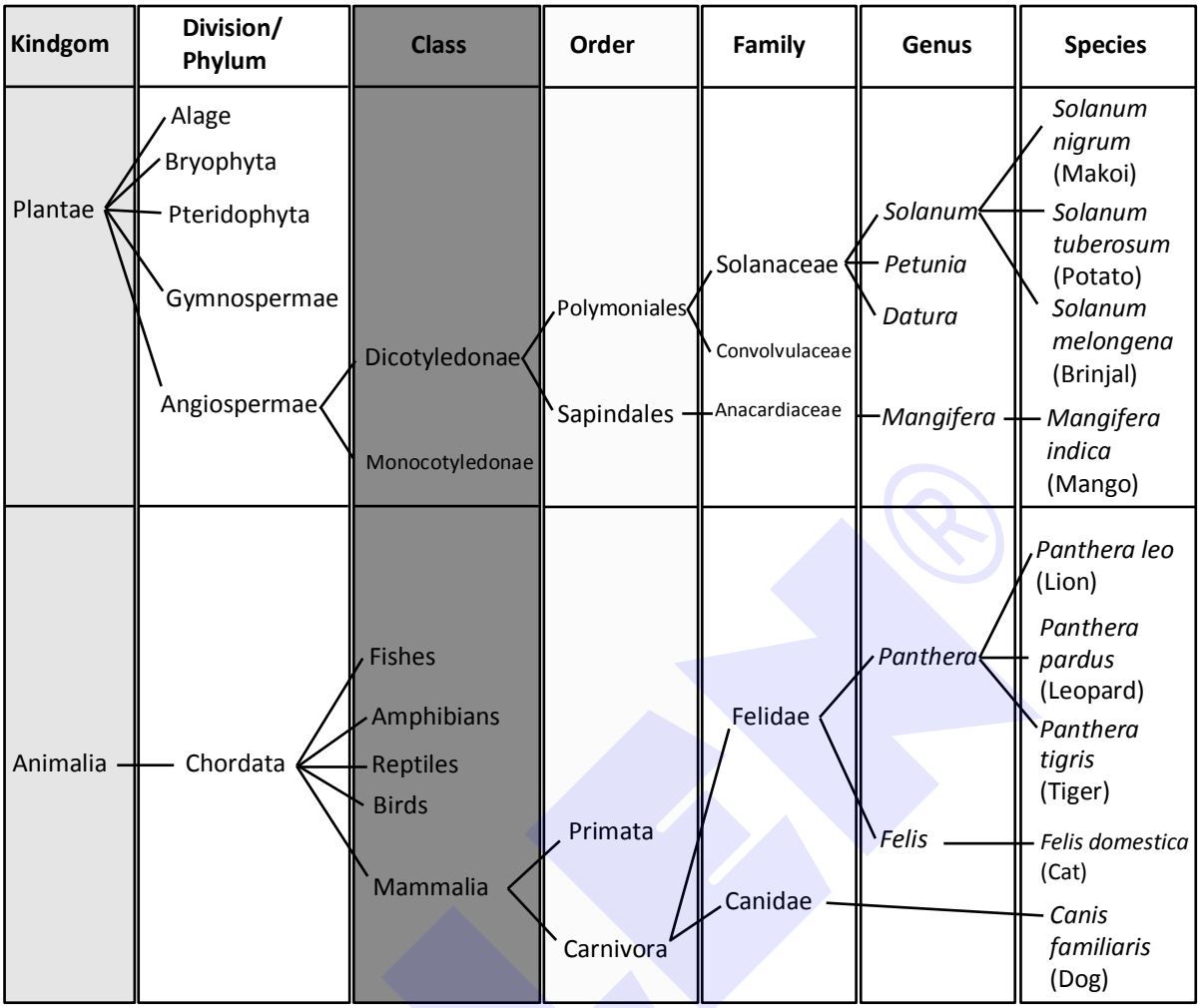
(G) Kingdom :

The kingdom plantae is distinct and comprises all plants from various divisions.

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

Common Name	Biological Name	Genus	Family	Order	Class	Phylum/ Division
Man	*Homo sapiens*	*Homo*	Hominidae	Primata	Mammalia	Chordata
Housefly	*Musca domestica*	*Musca*	Muscidae	Diptera	Insecta	Arthropoda
Mango	*Mangifera indica*	*Mangifera*	Anacardiaceae	Sapindales	Dicotyledonae	Angiospermae
Wheat	*Triticum aestivum*	*Triticum*	Poaceae	Poales	Monocotyledonae	Angiospermae

NCERT XI, PAGE NO. 11, TABLE 1.1



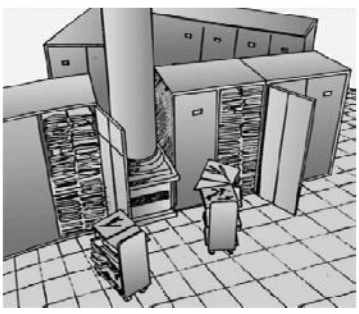
(4) TAXONOMICAL AIDS

- Taxonomic studies of various species of plants and animals are useful in agriculture, in forestry, in industry and in knowing our bio resources & their diversity.
- Taxonomic studies require intensive laboratory and field work for correct identification.
- The collection of actual specimens of animal and plant species are essential and is the prime source of taxonomic studies.
- Biologists have established certain procedures and techniques to store and preserve the information as well as the specimens. Some of these are explained here to help you understand the usage of these aids. Taxonomical aids are also fundamental and essential for training in systematics.

(A) Herbarium :-

Herbarium is a store house or repository or dry garden of collected plant specimens that are dried, pressed and preserved on sheets.

These sheets are arranged according to universally accepted system of classification these specimens along with their description on herbarium sheets become store house or repository for future use.



Herbarium showing stored specimens

NCERT XI Page No. 12, Figure No. 1.2

Standard size of herbarium sheet is 11.5 × 16.5 inches. 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. Herbarium is also known as **dry garden.** Herbarium is used as **quick referral system.**

(B) Botanical Gardens :-

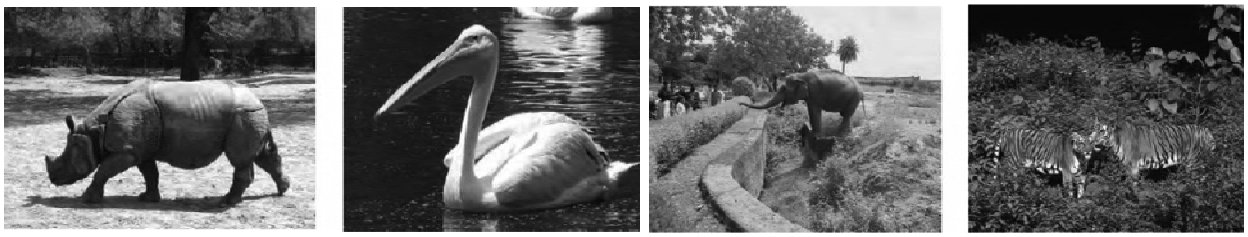
Plant species in these gardens are grown for identification purposes and each plant is labelled indicating its botanical/scientific name and its family. The famous botanical garden are at Kew, Indian botanical garden, Howrah and at national botanical research institute, Lucknow.

(C) Biological Museum :-

Museum have collections of preserved plant and animal specimens for study and reference. Specimens are preserved in the containers or jars in preservative solutions. In the museums dried specimens of plants and animals are also kept. 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.

Biological Museum

(D) Zoological Parks :- These are the places where wild animals are kept in protected environments under human care and they enable us to learn about their food habits and behaviour. All animals in a zoo are provided, as far as possible, the conditions similar to their natural habitats.



Pictures showing animals in different zoological parks of India

NCERT XI Page No. 13, Figure No. 1.3

(E) Key :-

- Key is another taxonomical aid used for identification of plants and animals based on the similarities and dissimilarities
- The keys are based on the contrasting characters, generally in a pair called **couplet.**
- It represents the choice made between two opposite options.
- Each statement in the key is called a **lead.** Keys are analytical in nature.
- Separate keys are required for each taxonomic category, such as family, genus and species for identification purposes.
- Flora, manuals, monographs and catalogues are same other means of recording descriptions. They also helps in correct identification.

(F) Flora - It contains actual account of habitat and distribution of plants of a particular area. These provide the index to the plant species found in a particular area.

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

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

(I) Monographs - They contain information on any one taxon.

(5) SPECIES CONCEPT

John Ray :- Proposed the **term** and **concept of species**

To explain the species different concepts were proposed.

(A) Biological concept of species :-

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

(ii) Group of members which can interbreed naturally and produce fertile progeny is called **biological species**.

(iii) When species is determined on the basis of interbreeding, then it is called "biological species".

(iv) This concept cannot be applied in case of prokaryotes because they do not reproduce by sexual reproduction.

(B) Taxonomic concept of species :-

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

(ii) A group of individuals having fundamental morphological similarities is known as taxonomic species.

Note : Since conventional taxonomic methods are not suitable to describe species in case of microbes like prokaryotes hence many biochemical and biomolecular studies are used to identify them as species.

ESSENCE

Characters of living organism

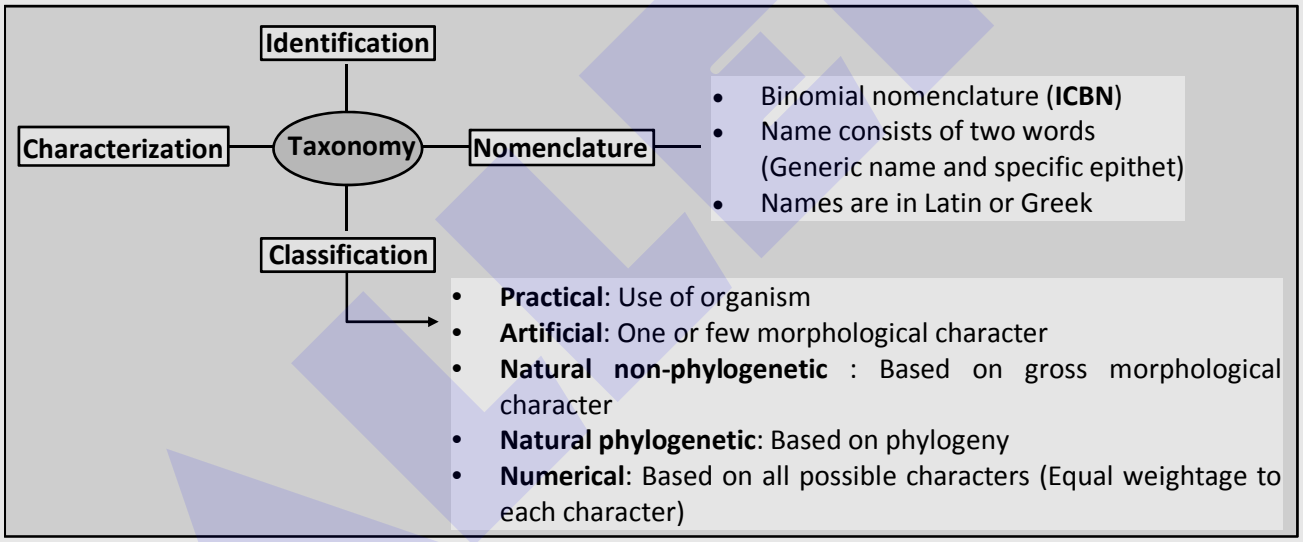
- **Growth**
- **Reproduction**
- **Metabolism**
- **Cellular organisation**
- **Consciousness**

} Defining characters of living (Present in all living but not present in non living)

Growth can be shown by non-living also

Reproduction is an exclusive character of living organisms. Certain living organisms do not show reproduction. No nonliving object show the reproduction

Taxonomy: Branch of biology deals with **Identification, Nomenclature and Classification** organisms.



Taxonomic Categories :

Kingdom
Division
Class
Order
Family
Genus
Species

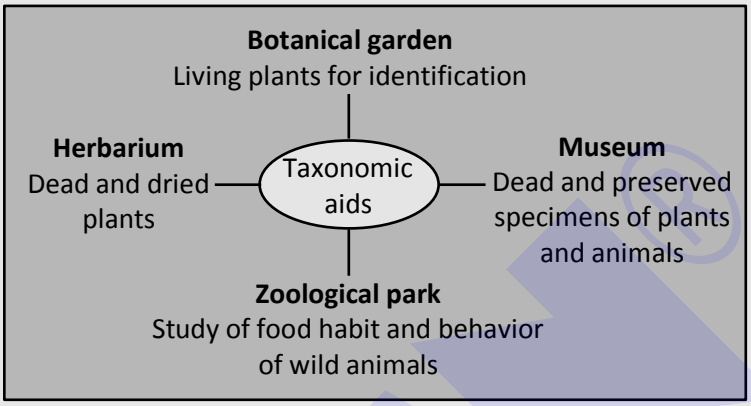
From species to kingdom

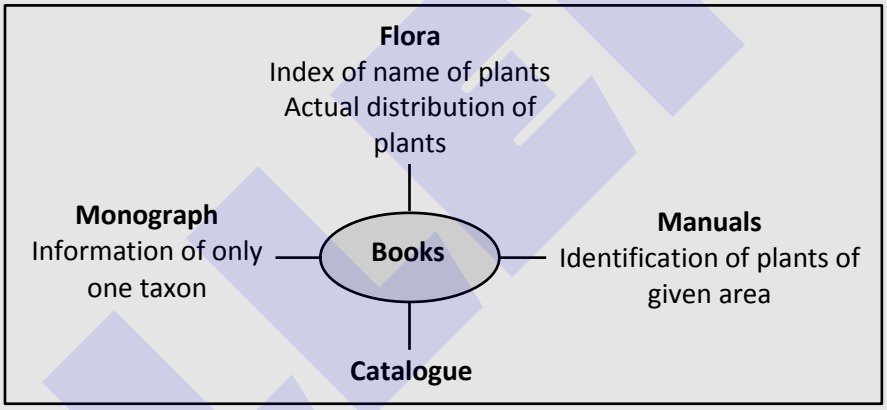
- Diversity: Increases
- Common character: Decreases
- Difficulty in classification : Increases

- These all are unit of classification
- These categories represent rank and commonly called as taxa or taxon
- Animals, mammals and dogs are different taxa at different level
- Species is the smallest obligate category and smallest unit of classification

Taxonomic keys:

- Based on pair of contrasting characters (Couplet)
- Each statement is called lead
- Usually analytical in nature
- Used for both animals and plants





- These books are taxonomic aids used for dissemination of taxonomical informations.

Biological concept of species:

- Based on reproductive isolation
- Group of individuals which can naturally interbreed and can produce fertile offsprings
- It is applicable for sexually reproducing organisms only

02. BIOLOGICAL CLASSIFICATION

- **Kingdom : Monera**
- **Kingdom : Protista**
- **Kingdom : Fungi**
- **Kingdom : Plantae**
- **Kingdom : Animalia**
- **Virus, Viroids, Lichens and Mycorrhiza**

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

(1) HISTORY OF TAXONOMY

(A) Aristotle :- Father of Biology & Father of Zoology.

Aristotle used simple morphological character (Growth habit) to classify plants into Herb, Shrub and Trees.

(B) Theophrastus :-

(i) He is known as Father of ancient plant taxonomy and Father of Botany.

(ii) He classified plants into **four groups** on the basis of growth habit -

(a) Trees (b) Shrubs (c) Under shrubs (d) Herbs

(C) Carolus Linnaeus :-

(i) His real name was -**Carl Von Linne**

(ii) On the basis of work in Latin language he changed his name as **Carolus Linnaeus**.

(iii) He is known as **Father of taxonomy**, Father of plant taxonomy and Father of animal taxonomy, binomial system and classification science.

(iv) Linnaeus gave the **Two kingdom classification,** with kingdom **Plantae** and kingdom **Animalia** which included all plants and all animals, respectively, on the basis of cell wall only.

Demerits of two kingdom classification :-

- In two kingdom classification prokaryotes (bacteria, blue green algae) and eukaryotes (fungi, mosses/bryophytes, fern/pteridophytes, gymnosprem and angiosperm) are placed in the same group plants/plantae.

  The character that unified this whole kingdom was that all the organisms included in it had a **cell wall** around their cell.

- It grouped together the unicellular organism (***Chlamydomonas*** and ***Chlorella)*** and the multicellular organism, (***Spirogyra***) under algae/plantae.
- 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.
- Large number of organisms did not fall into either category (Plantae/Animalia). Hence the two kingdom classification used for a long time was found inadequate.
- In two kingdom system *Paramoecium* and *Amoeba* were placed in animalia kingdom, because cell wall is absent.
- This placed together group which widely differed in other characteristics.

(D) George Bentham and Joseph Dalton Hooker :-

(i) Both Bentham and Hooker are related to **Royal botanical garden**.

(ii) Scientists working in botanical garden are known as **curator**.

(iii) They wrote the book **"*Genera plantarum*"**.

(iv) In this book, Bentham and Hooker gave the **natural classification** of spermatophytes (seeded plants)

Division – **Spermatophyta** (202 families)
3 Classes

Dicotyledonae	**Gymnospermae**	**Monocotyledonae**
(165 families)	(3 families)	(34 families)

Merits of Bentham and Hooker classification :-

- The classification of Bentham and Hooker was mainly based on the **floral characters**.
- The classification of Bentham and Hooker was **natural**.
- It is simple classification because 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.

(E) R. H. Whittaker :-

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

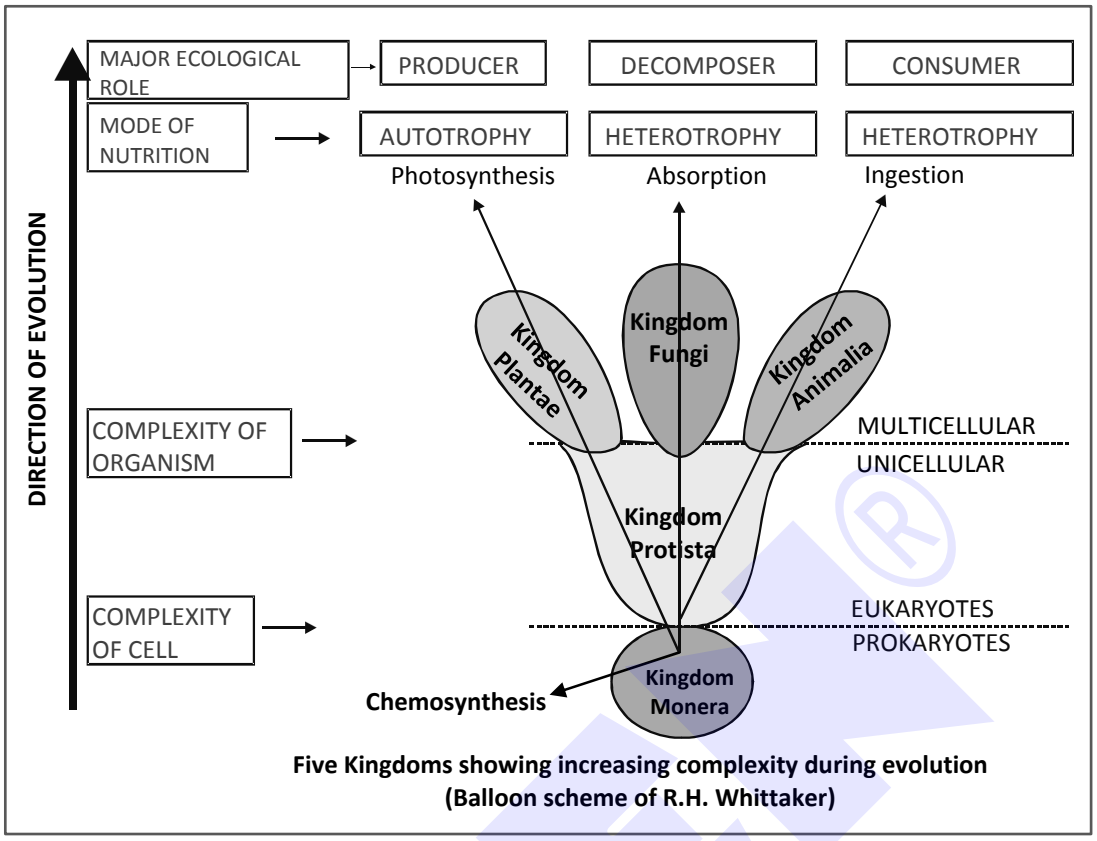
(i) Cell structure (Complexity of cell)

(ii) Thallus organisation/Body organisation (complexity of organism)

(iii) Mode of nutrition

(iv) Reproduction

(v) Phylogenetic relationships



Five Kingdoms showing increasing complexity during evolution (Balloon scheme of R.H. Whittaker)

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)	Present (cellulose)	Absent
Nuclear membrane	Absent	Present	Present	Present	Present
Body organisation	Cellular	Cellular	Multicellular/ loose tissue	Tissue/ organ	Tissue/organ/ organ system
Mode of nutrition	Autotrophic (chemosynthetic, photosynthetic) and Heterotrophic (saprophyte/parasite	Autotrophic (Photosynthetic) and Heterotrophic	Heterotrophic (Saprophytic /Parasitic)	Autotrophic (Photosynthetic)	Heterotrophic (Holozoic/ Saprophytic etc.)

NCERT XI, PAGE NO. 17, TABLE 2.1

FIVE KINGDOM

(i) Monera :- All the prokaryotic organisms (Eubacteria, Rickettsia, Actinomycetes, BGA, Archaebacteria, *Mycoplasma*)

(ii) Protista :- All the Unicellular eukaryotes (Dinoflagellates, Diatoms, Euglenoids, Slime moulds (false fungi) and Protozoans)

(iii) **Fungi :-** True fungi

(iv) **Plantae :-** All the multicellular plants – Algae, Bryophyta, Pteridophyta, Gymnosperms, Angiosperms.

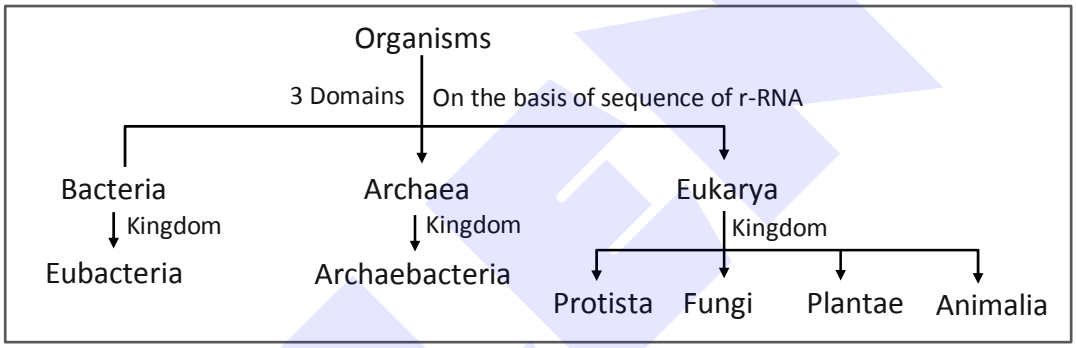
(v) **Animalia :-** All the multicellular animals

Note :

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

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

(F) **Carl Woese :-** The three-domain system has also been proposed that divides the Kingdom Monera into two domains, leaving the remaining eukaryotic kingdoms in the third domain and thereby a six kingdom classification.



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

Golden Key Points

- Species is smallest taxonomic category and basic unit of classification.
- 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.
- Each genus may have one or more than one specific epithets representing different organisms, but having morphological similarities.
- Genus comprises a group of related species which has more characters in common in comparison to species of other genera.
- In museum insects are preserved in insect box after collecting, killing and pinning.
- Keys are generally analytical in nature.
- Taxonomists prepare and disseminate information through manual and monographs for taxonomic studies.
- Classification proposed by Bentham and Hooker is natural non-phylogenetic.
- Whittaker gave the five kingdom (Monera, Protista, Fungi, Plantae and Animalia) Classification.
- Carl Woese gave three domain theory. In these three domain 6 kingdoms are included. He suggested separate kingdom for Archaebacteria.

BEGINNER'S BOX TAXONOMIC CATEGORIES TO CARL WOESE

1. Family is placed between :-

(1) Genus and species (2) Order and class

(3) Class and genus (4) Order and genus

2. Chemosynthesis is mode of nutrition is found in kingdom :-

(1) Monera (2) Protista

(3) Fungi (4) Plantae

3. Monograph 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 particular areas

(4) Habitat and distribution of plants

4. Smallest unit of classification is :-

(1) Genus (2) Species (3) Order (4) Kingdom

5. Biological concept of species is based on :-

(1) Morphology (2) Interbreeding

(3) Physiology (4) All

6. According to five kingdom classification, multicellular heterotrophs are included in :

(1) Three kingdom (2) One kingdom

(3) Two kingdom (4) Three domain

7. According to Carl Woese, archaebacteria belong to domain :-

(1) Monera (2) Protista (3) Plantae (4) Archaea

8. According to R.H. Whittaker which kingdom includes producer, decomposer and consumer is :

(1) Plantae (2) Fungi (3) Protista (4) Animalia

9. Basis of two kingdom system was :-

(1) Cell wall (2) Nucleus

(3) Cell membrane (4) Pigments

10. Three domain system was given by :-

(1) Carl Woese (2) Bentham and Hooker

(3) Theophrastus (4) Linnaeus

(2) KINGDOM-MONERA (PROKARYOTES)

- Bacteria are the sole members of Monera Kingdom.
- They are the most abundant micro-organism.
- They also live in extreme habitats such as hot springs, deserts, snow and deep ocean. Where very few live form can survive. Many of them live in or on other organism as parasites.

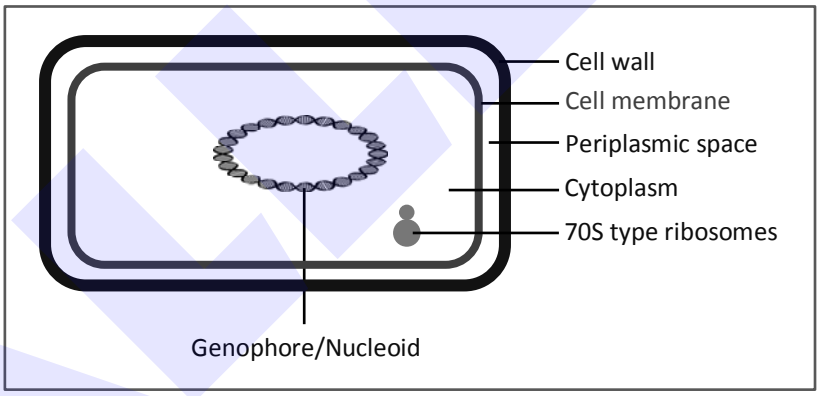
Main characteristic of prokaryotes :-

Cell wall :-

- Cell wall of prokaryotes is made up of peptidoglycan or murein or polysaccharides and amino acids which is a type of mucopeptide.

Cell membrane :-

- Like eukaryotes the cell membrane of prokaryotes is made up of lipoprotein [lipid + protein]
- The space between cell wall and cell membrane is known as periplasmic space. This space, is **analogous** (functionally same) to lysosome because in this space the digestion of complex substances is done.



Cytoplasm :-

- The cytoplasm of prokaryotes lacks membrane bound cell organelles.
- In Prokaryotic cell, the nucleus is primitive. 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 and polyamines. This false chromosome coils and forms the chromosomal region, which is known as nucleoid.
- In prokaryotes ribosomes are of 70S type. Ribosome are the site of protein synthesis.

Example of Prokaryotes :-

(A)	**Eubacteria (True bacteria)**
(B)	**Blue Green Algae**
(C)	**Archaebacteria**
(D)	**Mycoplasma**
(E)	**Actinomycetes**
(F)	**Rickettsia**
(G)	**Chlamydia**

(A) Eubacteria

There are thousands of different eubacteria or true bacteria. They are characterized by the presence of a rigid cell wall, and if motile, a flagellum.

(i) History

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

(b) **F.J. Cohn** and **Ehrenberg** first of all coined the name "**Bacteria**".

(ii) Shape

Bacteria have variations in their shape. Bacteria are grouped under four categories based on of their shape.

(a) Coccus (sing.)/Cocci (plu.) –

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

e.g. *Micrococcus*

(b) Bacillus (sing.)/Bacilli (plu.) –

- This group includes most of the bacteria
- These are rod shaped

e.g. *Escherichia coli [E. coli]*

(c) Spirillum (sing.)/Spirilla (plu.)

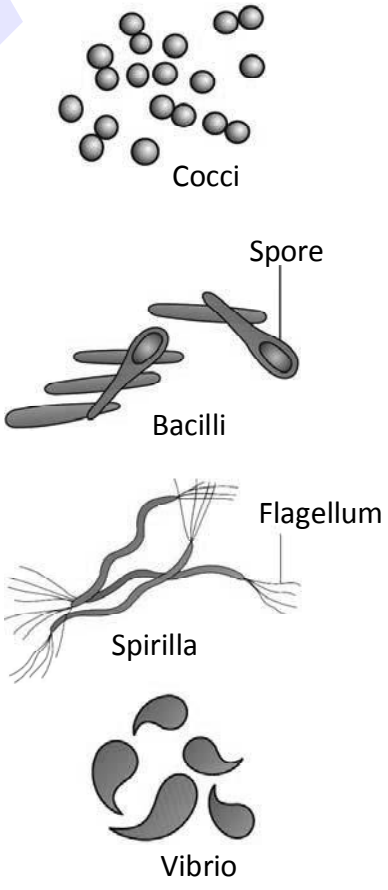
- These are spiral shaped bacteria

e.g. *Spirillum volutans, Treponema*

(d) Vibrium (sing.)/Vibrio (plu.) –

- These are comma shaped bacteria

e.g. *Vibrio cholerae*



NCERT XI Page No. 18, Figure No. 2.1

(iii) Motility in Bacteria

Bacterial cells are motile as well as non motile. If motile they have thin filamentous extensions from their cell wall called flagella. Movement in bacteria takes place by means of flagella.

Bacteria show a range in number and arrangement of flagella (flagellation) for example

Peritrichous – When flagella are found on the whole body of bacterium

e.g. *Escherichia coli*

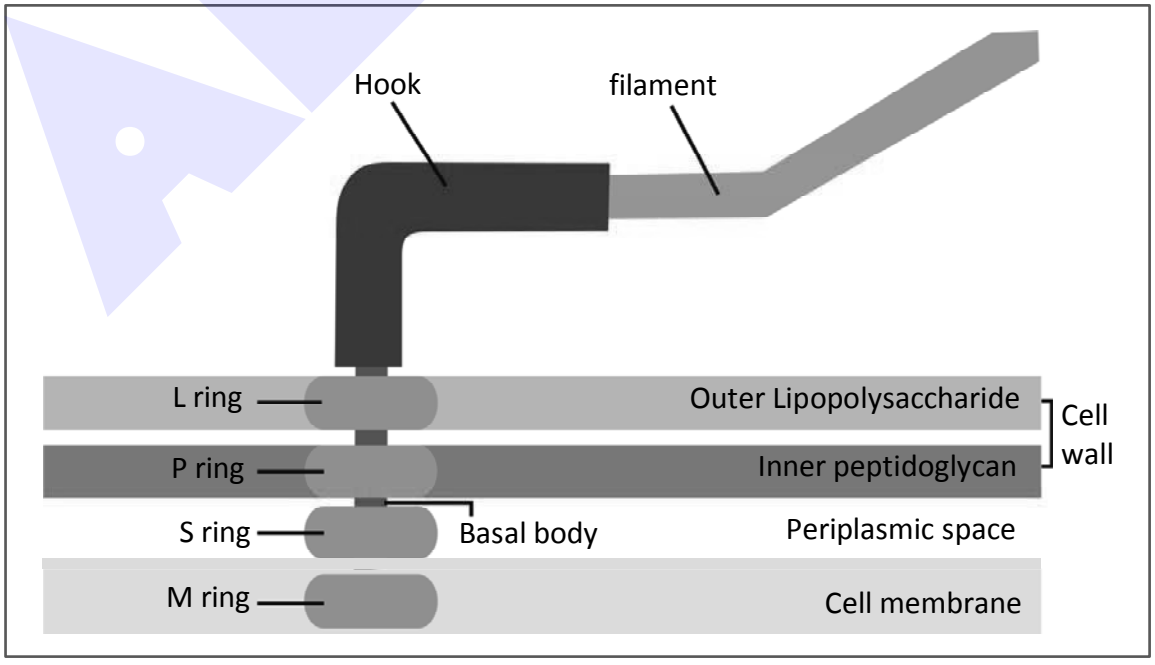
(iv) Structure of bacterial flagellum

Bacterial flagellum is made up of three parts

(a) Basal body (b) Hook (c) Filament

(a) Basal body –

- It is the basal part of flagellum and rod shaped in structure.
- It lies with in the cell wall and cell membrane
- This proteinaceous rod shaped structure is surrounded by two pairs of rings
  - ❖ **Outer pair** ❖ **Inner pair**
- Outer pair of ring lies with in the cell wall. One ring of this pair is called **L** and the another called **P**.
- Inner ring of inner pair lies with in the cell membrane. One ring of this pair is called **S** and the another is **M**.
- In Gram positive bacteria only one pair of rings (inner pair) is found.



(b) Hook –

- It connects the basal body to filament
- It is the middle part of flagellum

(c) Filament –

- It is the longest portion and extends from the cell surface to the outside
- It is cylindrical hollow structure made up of protein monomers.
- Each monomer is made up of **Flagellin** protein. Monomers are arranged in spiral manner. Flagellin is a contractile protein.

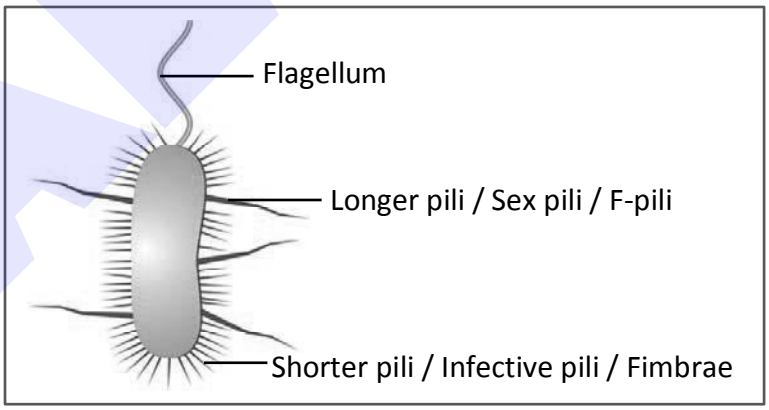
(v) Pili and Fimbriae

Pili and fimbriae are also surface structures of the bacteria but do not play a role in motility.

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

(b) Longer pili are also known as **'F' pili** or **'sex' pili.** The pili are elongated tubular structure. Longer pili occur in only donor (F^+ or male) bacteria and help in conjugation. These are absent in recipient bacteria or female.

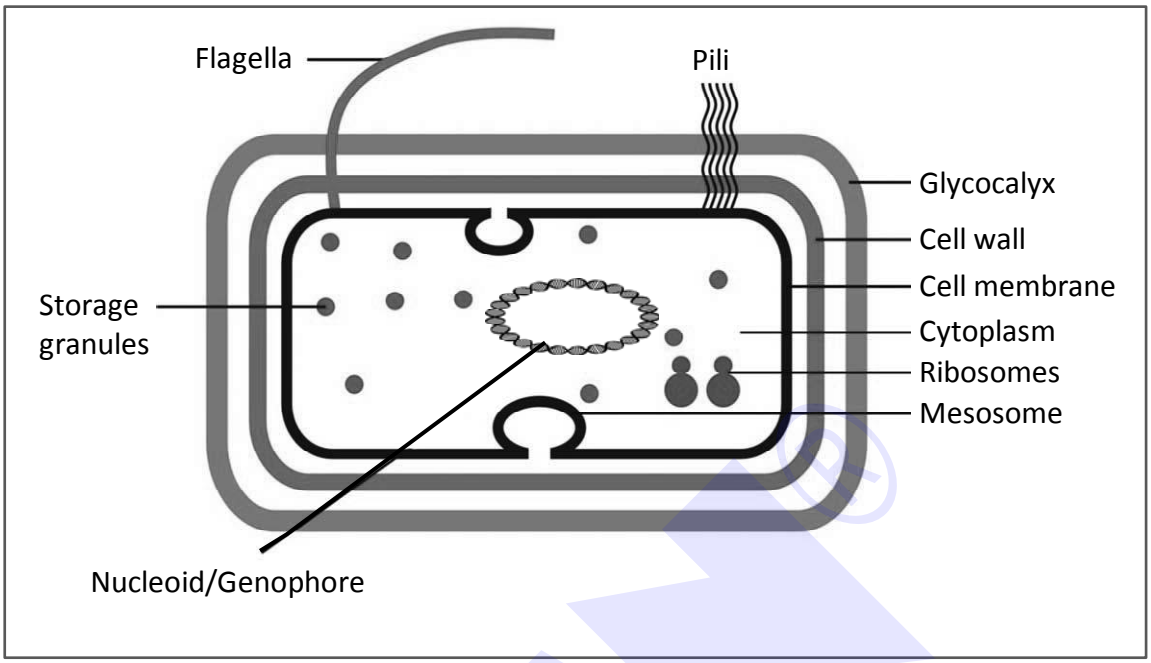
(c) The fimbriae (shorter pili) are small bristle like fibres sprouting out of the call and take part in attachment to rocks in streams and to the host tissue.



Structure

- Every pilus is cylindrical hollow structure and composed of protein monomers.
- Each monomer is made up of '**pilin**' protein. Pilin is non-contractile protein.

(vi) Structure of Eubacterial cell



Though the bacterial structure is very simple, they are very complex in behaviour.

The organisation of prokaryotic cell is fundamentally similar even through prokaryotes exhibits a wide variety in shape and function.

Bacterial cell has a chemically complex **cell envelope**. The cell envelope consists of a tightly bound three layered structure.

(a) Glycocalyx **(b) Cell wall** **(c) Cell membrane**

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

(a) Glycocalyx — **Capsule -** Thick, tough, regular and smooth layer.
Slime layer - Thin, loose, irregular and rough layer.

- Glycocalyx differs in composition and thickness among bacteria.
- When bacteria are surrounded by capsule, called capsulated bacteria. Formation of capsule is perfomed by cell membrane. Mostly pathogenic bacteria are capsulated.
- Capsule is made up of **polysaccharides** and **polypeptides**.
- When the molecules of polysaccharides are very loosely arranged they form a thin and sticky layer, known as slime layer.
- Glycocalyx protects the bacteria from W.B.C. and also helps in colony formation.

(b) Cell Wall –

- Bacterial cell wall is rigid and made up of mainly **peptidoglycan.**
- **In Gram positive** 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 negative** bacteria cell wall is double layered. Inner layer is thin and composed of **peptidoglycan** while outer layer is thick and made up of **lipopolysaccharide**.
- The cell wall determines the shape of the cell and provides strong structural support to prevent the bacterium from bursting or collapsing.

(c) Cell membrane or Plasma lemma or Plasma membrane

- The plasma membrane is selectively permeable in nature.
- Bacterial cell membrane is made up of **lipoprotein.** This membrane is structurally similar of that eukaryotes.
- It interacts with the outside world.

(d) Cytoplasm –

- The fluid matrix filling the cell is cytoplasm
- No organelle, like the ones in eukaryotes, are found in prokaryotic cells except for ribosomes.
- Bacterial cytoplasm does not show streaming or cyclosis.

(e) Cytoplasmic structures –

Mesosomes –

- Mesosome is a special membranous structure formed by the extension or infoldings or invaginations of plasma membrane into the cell. These extensions are in the form of vesicles, tubules and lamellae.
- These are functionally mitochondria like structures. Oxidative enzyme are found in mesosome.
- They help in cell respiration and cell wall secretion processes to increase surface area of the plasma membrane and enzymatic content.
- Help in DNA replication and distribution to daughter cells during cell division.

Storage granules/Inclusion bodies –

- Reserve material in prokaryotic cells are stored in the form of inclusion body. These are not bound by any membrane and lie free in cytoplasm.
- **Glycogen granules** – They store carbohydrate
- **Phosphate granules** (Volutin granules) – These are also known as metachromatic granules. These are phosphate polymers and fuction as storage reservoir for phosphate.

Photosynthetic structure –

- Some eubacteria (purple bacteria and green sulphur bacteria) have capacity of photosynthesis.
- In bacterial cytoplasm many photosynthetic pigments are present.

  In purple bacteria (sulphur & non-sulphur) : Bacteriochlorophyll a & b

  In green sulphur bacteria : Bacteriochlorophyll a, Bacterioviridin

Chromatin material (Nucleoid) –

- There is no well defined nucleus.
- Nucleus of bacterial cell is called Nucleoid or Genophore or Incipient nucleus or fibrilar nucleus. Nuclear membrane and nucleolus are absent.
- The genetic material is double stranded circular DNA which is basically naked, (without histone and Non-histone proteins) and not surrounded by a nuclear membrane.
- In addition to genomic DNA many bacteria have small circular DNA outside the genomic DNA. These DNA are known as plasmid.
- It is also known as **extra chromosomal** or **extranuclear** or **extragenomic** genetic material. (The term 'plasmid' was given by **Lederberg**).
- Plasmids have the ability to replicate independently.
- The plasmid DNA confers certain unique phenotypic characters to bacteria. e.g. Antibiotic resistance.
- **Plasmids are of many types on the basis of their function or phenotypic character**

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

(a) F^+ – Cells, carrying 'F' plasmid, act as donor and are called F^+ or male.

(b) F^- – Cells, lacking 'F' plasmid, act 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 cell. (Hfr – High frequency recombinant) cell

R-factor - Resistance to certain antibiotics.

(vii) Staining of bacteria

(a) First of all **H.C. Gram** differentiated bacteria on the basis of staining.

(b) In the first step of this method bacteria are stained with **Crystal violet** and then **KI solution**.

(c) After staining bacteria are washed with **Acetone** or **Ethyl alcohol**. After washing some bacteria retain the stain and some bacteria are decolourised.

(d) Bacteria which retain stain (violet or purple) are called **Gram(+)** and bacteria which decolourise are known as **Gram(–)**. Gram(-) bacteria are counter stained by **Safranin**.

(viii) Nutrition in Bacteria

Bacteria as a group show the most extensive metabolic diversity. The vast majority of the bacteria are heterotrophic i.e., they depend on other organisms or on dead organic matter for food, but some are autotrophic. Autotrophic bacteria synthesize their own food from inorganic substances. On the basis of nutrition bacteria are classified into following three catagories :-

(a) Autotrophs

These bacteria use light or chemical energy for their own food synthesis.

They may be photosynthetic autotrophic or chemosynthetic autotrophic.

- **Photosynthetic autotrophs = Photoautotrophs = Phototrophs**
  - ❖ These bacteria use light energy for food synthesis.
  - ❖ In bacterial photosynthesis H-donor is not water, so they do not release oxygen during photosynthesis hence this is called **Non-oxygenic photosynthesis.**
    – Purple sulphur bacteria – e.g. *Chromatium*
    – Green sulphur bacteria – e.g. *Chlorobium, Thiothrix*
    – Purple non sulphur bacteria – e.g. *Rhodospirillum, Rhodopseudomonas*
- **Chemosynthetic autotrophs = Chemoautotrophs = Chemotrophs**
  - ❖ They use energy released by oxidation of chemical to synthesize their food.
  - ❖ These bacteria oxidize various inorganic substances such as nitrites, and ammonia and use the released energy for their ATP production.

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

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

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

(b) Heterotrophs

- Most of the bacteria are heterotrophic i.e., they can not manufacture their own food. The majority of heterotrophic bacteria are important decomposers. They are useful in making curd from milk, production of antibiotics, 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

- **Saprotrophic bacteria –**

❖ These bacteria obtain food from dead and decaying organic matter.

e.g. *Bacillus vulgaris, Clostridium botulinum*, *Pseudomonas, Staphylococcus*

- **Parasitic bacteria –**

❖ They obtain their food from living organism.

e.g. *Mycobacterium leprae*, *Mycobacterium tuberculosis.*

(c) Symbiotic bacteria

- They form symbiotic relation with other organisms.
- These bacteria convert atmospheric nitrogen into ammonia and then into nitrogenous compounds like Amino acids, NO_3^- or salts of ammonia.

e.g. *Rhizobium*

(ix) Respiration

On the basis of respiration bacteria are of two types

- **Aerobic bacteria :-**They use oxygen in respiration.

e.g. *Azotobacter, Acetobacter aceti* (it causes souring of wine), *Clostridium tetani*

- **Anaerobic bacteria :-** They do not use oxygen in respiration.

e.g. *Clostridium botulinum*, Fermentation bacteria (*Lactobacillus*) except *Acetobacter aceti.*

Lactobacillus causes souring of milk.

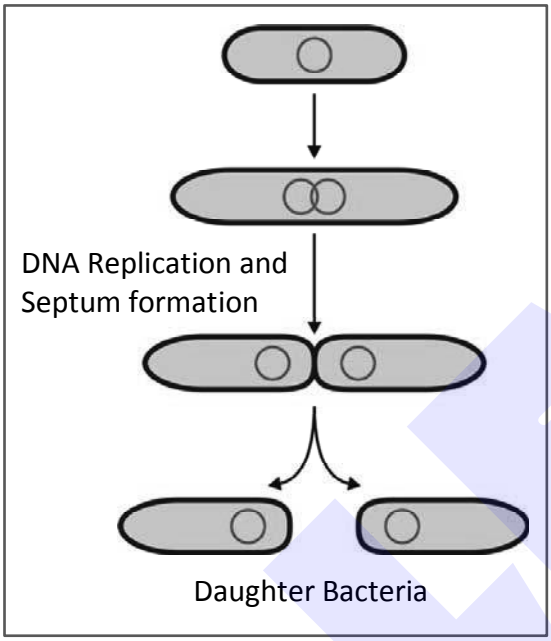
(x) Reproduction

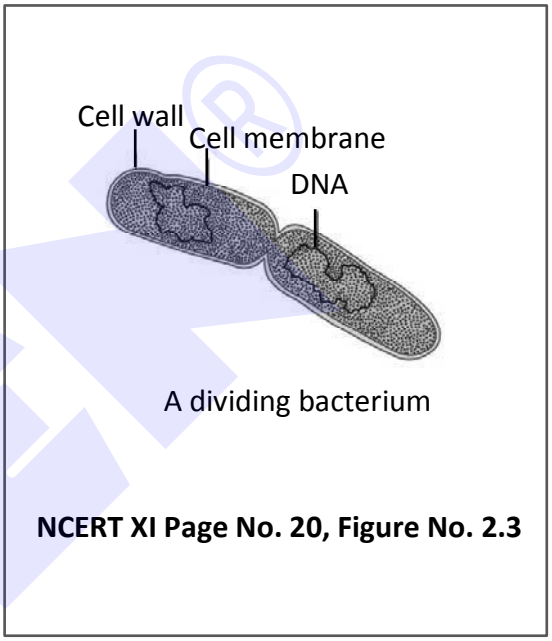
Bacteria reproduce only by asexual reproduction but they also perform a primitive type of gene transfer from one bacterial cell to the other which is called genetic recombination.

(a) Asexual reproduction

Following methods of asexual reproduction are found in bacteria.

- **Binary fission –** Bacteria mainly reproduce by fission.





NCERT XI Page No. 20, Figure No. 2.3

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

- **By Endospore –**

- ❖ Endospore formation occurs under unfavourable conditions.
- ❖ It is a highly resistant structure. It is resistant to high temperature, radiations, antibiotics and chemicals.
- ❖ Endospore is highly resistant structure due to presence of **Ca-dipicolinate** in its thick wall.
- ❖ Endospore formation usually seen in bacillus type of bacteria.

(b) Genetic Recombination :

Bacteria also reproduces by a sort of sexual reproduction by adopting primitive type of DNA transfer from one bacterium to another.

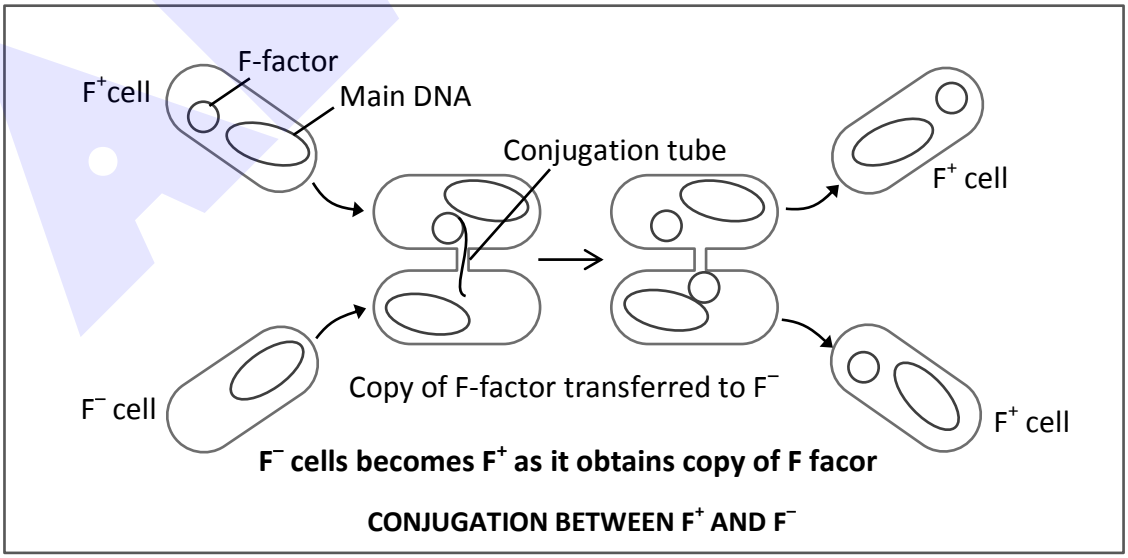
There are three methods of Genetic Recombination.

- **Transformation :** Uptake of DNA by bacterial cell from surrounding. It was discovered by Griffith.
- **Transduction :** Transfer of genetic material from one bacterium to another with the help of bacteriophage (virus).
- **Conjugation :** Transfer of genetic material from one bacterium to another with the help of conjugation tube. It is direct transfer method.

Conjugation – Gene transfer by conjugation tube between two bacterial cells.

Conjugation between F^+ and F^-

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



CONJUGATION BETWEEN F^+ AND F^-

(xi) Economic Importance of Bacteria

Harmful Activities

a. Disease in Human beings :

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

b. Disease in Animals –

Anthrax	–	***Bacillus anthracis***
Black leg	–	***Clostridium chauvoei***

c. Disease in plants –

Citrus canker	–	***Xanthomonas citri***
Crown gall in many plants	–	***Agrobacterium tumefaciens***
Black leg and soft rot of potato	–	***Erwinia caratovora atroseptica***
Bacterial leaf blight of rice	–	***Xanthomonas oryzae***
Black rot of crucifers	–	***Xanthomanas campestris***

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

d. 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

e. Food poisoning –

Botulism – *Clostridium botulinum* – It is most lethal type of food poisoing. These bacteria survive in absence of O_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.

f. Water pollution –

Several bacterial forms cause water pollution. These bacteria spoil the water.

e.g. Vibrio cholerae, Salmonella typhi.

g. Biological Weapons – Some bacteria are used as bio weapons such as **Anthrax, Botulism, Cholera causing bacteria.**

Useful Activities

a. Ammonification - Ammonifying bacteria –

Some bacteria convert Protein (present in decaying plants & animals) into Ammonia.

e.g. Bacillus vulgaris

b. Nitrification - Nitrifying bacteria –

These bacteria convert Ammonia in to Nitrite and later into Nitrate.

$NH_3 \xrightarrow{\textbf{\textit{Nitrosomonas}}} NO_2$ (Nitrite) $\xrightarrow{\textbf{\textit{Nitrobacter}}} NO_3$ (Nitrate)

c. Nitrogen fixation - Nitrogen fixing bacteria –

These bacteria convert the atmospheric nitrogen into ammonia and then into nitrogenous compounds like amino acids, nitrate or ammonium salts.

Nitrogen fixation is done by two methods –

- **Symbiotically –** Some bacteria live symbiotically and exhibit nitrogen fixation.
  - *Rhizobium* – found in the root nodules of legumes
  - *Azorhizobium* – found in the stem nodules of *Sesbania* plant
  - *Azospirillum* – Found on root surface of cereals (eg. Wheat, Rice, Maize, etc.) i.e., superficial symbiosis.
  - *Frankia (Filamentous bacteria or actinomycetes)* - It is found In root nodules of non leguminous plant *Casuarina* and *Alnus*.
- **Asymbiotically –** Some bacteria are found freely in soil and perform nitrogen fixation.

  e.g. *Clostridium, Chromatium, Azotobacter, Azospirillum, Beijernickia Rhodomicrobium, Rhodospirillum, Rhodopseudomonas*

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

d. 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.

e. Antibiotics –

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

f. Industries –

Many bacteria are used in industries

- Vinegar formation (Acetic acid) –

  $$\text{Ethanol} \xrightarrow{\textbf{\textit{Acetobacter aceti}}} \text{Acetic acid}$$
- Retting of fibres – Separation of plant fibres by the help of bacteria

  e.g. Clostridium, Butyric acid bacteria
- Flavouring /curing of tea leaves and processing of tobacco leaves –

  e.g. Bacillus megatherium, Micrococcus condiscend
- Production of Vitamins –
- *Clostridium butylicum produces* $\rightarrow$ Riboflavin (Vit. B_2) and Butyric acid
- *Propionibacterium and Bacillus megatherium produce* – Vit. B_{12}
- *E.coli* (coliform bacteria) *produces* $\rightarrow$ Vit. E, Vit. K.
- ***E. coli*** bacteria is found in alimentary canal of human beings.

g. Purity of Ganga water – In Gangatic water a bacteria ***Bdellovibrio bacteriovorus*** is found, they kill the other water polluting bacteria.

h. 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 number the water will be highly polluted. So, the *E. coli* is known as pollution indicating bacteria.

i. Bacteria for genetic engineering -

e.g. E. coli and *Agrobacterium* $\longrightarrow$ These are Gram(–) bacteria

(B) Blue Green Algae (BGA)

(i) According to **Two kingdom** system BGA were included in class **Cyanophyceae, Myxophyceae or Cyanophyta.** But now they are included in Kingdom Monera, because blue green algae are prokaryote.

(ii) BGA are now known as **cyanobacteria**.

(iii) BGA are fresh water (mostly), marine water and terrestrial algae.

(iv) Cyanobacteria were the first organism that produced O_2 on our earth.

(v) Cyanobacteria are photosynthetic prokaryotes.

(vi) Cyanobacteria have following pigments :-

- ❖ Chlorophyll 'a' – green → similar to green plant
- ❖ Carotenoids – yellow
- ❖ C - Phycocyanin - blue
- ❖ C - Phycoerythrin – red

Note : BGA are not always of blue-green colour. *e.g. Trichodesmium* is red coloured. The red colour of red sea is due to this alga.

Different forms of BGA or Cyanobacteria :

The cyanobacteria are unicellular, colonial or filamentous

(a) **Unicellular :-** Some BGA are unicellular. *e.g. Spirulina*

Note : *Spirulina* is an edible BGA because it has large amount of proteins. It can be grown artificially in water tanks. It is a **fodder** for cattle.

(b) **Colonial :-** Some BGA are found in colony. i.e. cell colonies.

The colonies are usually surrounded by gelatinous sheath.

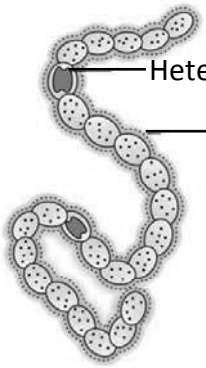
eg. Anabaena, Microcystis

(c) **Filamentous :-** Some BGA are filamentous. There are many cells arranged in a row to form a filamentous body.

Note : The filament of BGA is known as **trichome**.

e.g. Oscillatoria, Nostoc

Structure of B.G.A. :-



A filamentous blue-green algae – *Nostoc*

NCERT XI Page No. 19, Figure No. 2.2

(a) The structure of BGA is similar to Gram (-ve) eubacteria.

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

(c) The cell membrane of BGA is also made up of lipoproteins.

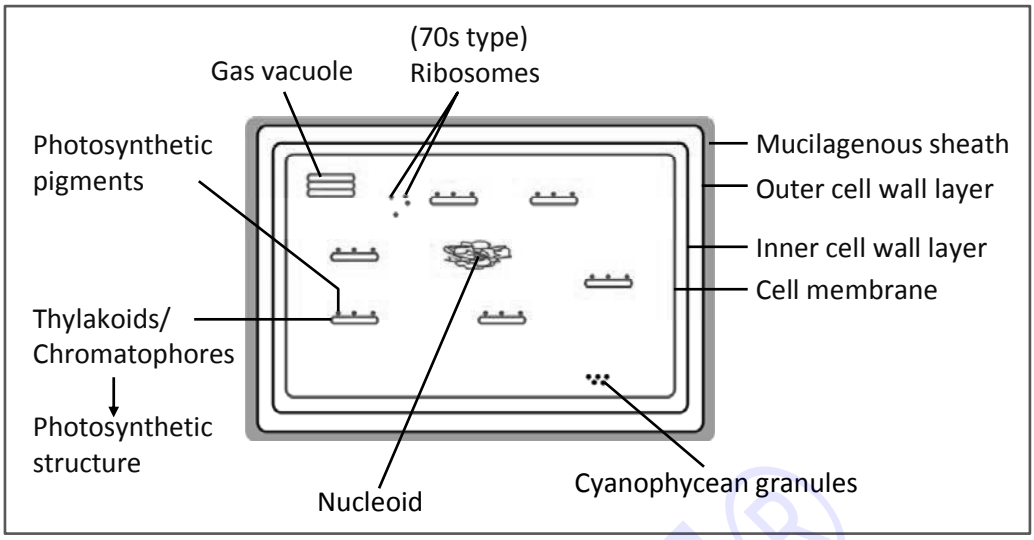
(d) **Cytoplasm of BGA contains following structures :-**

- Thylakoids or chromatophores : These are membrane bound structures which contain photosynthetic pigments. They are present in form of vesicles lamellae.
- Inclusion bodies : α-granules and gas vacuole
- BGA store its food in the form of α-granules.
- α- granules - They are made up of cyanophycean starch. It is not actually strach, it is structurally similar to glycogen.

  They are also known as cyanophycean granules.
- **Gas vacuole –** it is found in blue green algae, purple and green photosynthetic eubacteria.

  Note : Inclusion bodies are non membranous structures.

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



Nitrogen fixation :-

(a) Some of the BGA, fix atmospheric nitrogen in specialized cells called heterocyst. They convert atmospheric nitrogen in to ammonia and then nitrogenous compounds like amino acids and nitrates. These nitrates increase the fertility of soil. Hence BGA improves the fertility of soil by nitrogen fixation.

Note :- Heterocyst is a thick walled, non green cell.

Heterocyst does not perform photosynthesis like other vegetative cells.

(b) BGA fix nitrogen in **two forms** :-

Symbiotic form and Asymbiotic or free living form

Symbiotic form	Free living form
e.g. ***Anabaena*** & ***Nostoc*** These BGA form symbiotic association with many plants and performs nitrogen fixation. ***e.g.* :-** ☛ 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***]	*e.g.* ***Anabaena, Nostoc*** Some BGA are found free living in water and soil and perform nitrogen fixation. ***Aulosira*** → This BGA is found in plenty in paddy fields. This BGA performs nitrogen fixation due to which the production of rice is increased. ***Oscillatoria*** = also fix N_2 in paddy fields.

Reproduction

In BGA reproduction is done by two main processes

(a) Vegetative

(b) Asexual

(a) Vegetative Reproduction :-

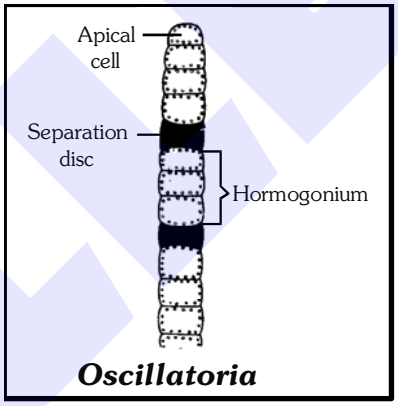
- **Binary fission :-**

  This is the most common method of reproduction in prokaryotes.

  e.g. Spirulina

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

  eg. Oscillatoria



(b) Asexual Reproduction :-

It is method of protection to overcome unfavourable conditions

e.g. - Akinete formation in *Nostoc*

Water bloom :

BGA Often from bloom in polluted water bodies.

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

(C) Archaebacteria : "Group of Ancient bacteria"

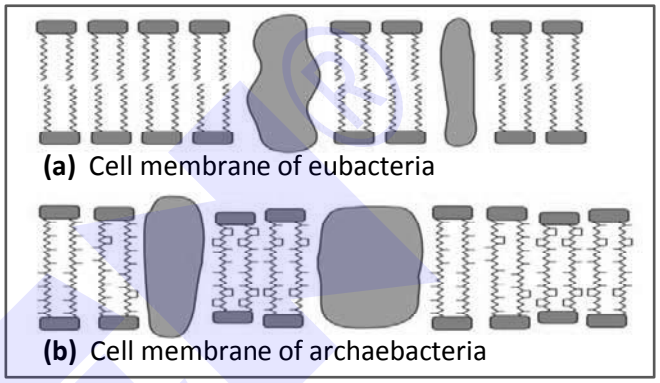
(i) Evolutionarily they are primitive. They were the first to be born on our planet and they are present now a days with their primitive characters. They are the **"Oldest living fossils".**

(ii) Mostly archaebacteria are **anaerobes**.

(iii) *Thermococcus, Methanococcus* and *Methanobacterium* exemplify *archaebacteria* that contain proteins homologous to eukaryotic core histones.

(iv) Their cell wall is not made up of peptidoglycans like that of eubacteria. Their cell wall is made up of complex polysaccharides and complex polypeptide.

(v) Cell membrane of archaebacteria consist of monolayer of branched chain lipids **(fig. b)** while in other bacteria bilayer **(fig. a)** of unbranched fatty acid is present. Due to branched chain lipid archaebacteria have more resistant capability as compared to eubacteria.


(a) Cell membrane of eubacteria

(b) Cell membrane of archaebacteria

Note : Archaebacteria live in some of the most harsh habitat such as extreme salty areas, hot springs and marshy area because archaebacteria have a different cell wall and cell membrane structure.

Archaebacteria group includes following types of bacteria

(a) Methanogens :-

"Methane producing archaebacteria"

- These bacteria convert CO_2 of swampy areas (marshy) into methane (CH_4).
  e.g. *Methanococcus, Methanomicrobium*
- These bacteria convert the organic substance (cellulose) present in cow dung into methane by fermentation.
- Methanogens are present in the rumen or gut of several reminants animals/cattles as a symbiotic organisms and they are responsible for the production of methan gas (biogas).

(b) Halophiles :-

- These archaebacteria are found in highly saline areas.

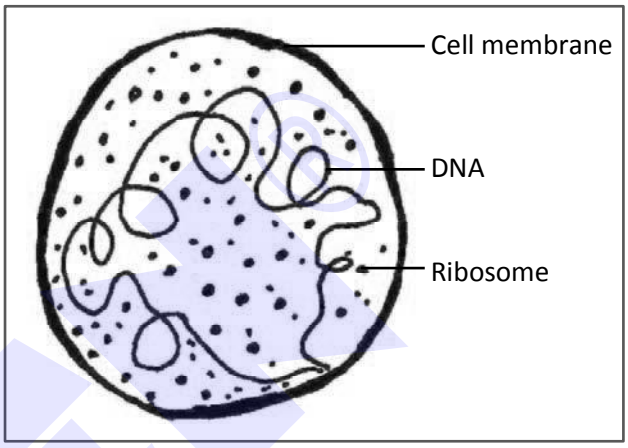
(c) Thermoacidophiles :-

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

(D) Mycoplasma

- In 1898, two **French** scientists **E. Nocard** and **R. Roux** while studying pleural fluids of cattle suffering from **Bovine pleuropneumonia** disease, discovered the organisms which are known as mycoplasma and were designated as **PPLO** (i.e. Pleuropneumonia like organism).
- **Nowak** (1929) Placed these organisms under the genus *Mycoplasma*.

General Characters :-



(i) Mycoplasmas are unicellular, smallest prokaryotic organisms. They are smallest living cells known.

(ii) They completely lack cell wall, so the outermost covering is only cell membrane. Cell membrane is and made up of lipoprotein. Both DNA (ds DNA, **circular mainly**) and RNA are present.

(iii) They are cell wall less hence, they exhibit pleomorphism and thus called as Joker of microbiology.

(iv) **Osmotrophic mode of nutrition** (absorption of nutrients by osmosis) is found in *Mycoplasma*.

(v) They are resistant to antibiotics like **penicillin** which act on cell wall.

(vi) They are sensitive to **tetracycline** and **chloramphenicol** that act on metabolic activities.

(vii) *Mycoplasma* can survive without oxygen.

(viii) Species of *Mycoplasma* are **saprophyte** or **parasite.**

(ix) Many *Mycoplasma* are pathogenic in animals and plants.

Plant Disease :-

(i) Little leaf disease of Brinjal.

(ii) Bunchy top of papaya.

(iii) Witches broom of Ground nut (Legume) / Potato.

(iv) Aster yellow disease of sunflower.

Animal Disease :-

(i) Mycoplasma cause primary atypical Pneumonia

(ii) Bovine Pleuropneumonia

Golden Key Points

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

BEGINNER'S BOX — KINGDOM MONERA

1. The bacteria which are associated with some plant roots and fix atmospheric nitrogen are :-

(1) *Azotobacter* (2) *E.coli*

(3) *Rhizobium* (4) *Pseudomonos*

2. In paddy field blue green algae are grown :-

(1) For medicinal use

(2) To increase soil fertility

(3) To serve as food for fishes

(4) To conserve water

3. The digestive tracts of ruminants contain :-

(1) Halophilic bacteria

(2) Methanogens

(3) Thermoacidophile becteria

(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 unique cell 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. Murein is found in the cell wall of :-

(1) Diatoms (2) Cyanobacteria

(3) Archaea (4) *Mycoplasma*

7. Which of the following are first oxygenic photosynthetic organisms :-

(1) Green algae (2) Red algae

(3) Blue-green algae (4) Golden algae

8. Blue green algae can photosynthesize due to presence of :-

(1) Heterocyst (2) Chloroplast

(3) Chromatophore (4) Leghaemoglobin

9. Which of the following does not have photosynthetic pigment but can synthesize their own food :-

(1) *E.coli* (2) *Lactobacillus lactis*

(3) *Nitrobacter* (4) *Nostoc*

10. Gram negative bacteria can be differentiated from gram positive bacteria in having :-

(1) Liopolysaccharide wall outside to peptidoglycan wall

(2) Selective permeable membrane inside cell wall

(3) 70S Ribosome in cell wall

(4) Murein in cell wall

(3) KINGDOM - PROTISTA

All the single celled (unicellular) eukaryotes (acellular) are placed under protista.

Members of protista are primarily aquatic.

Living organisms included in Protista are as follows

Dinoflagellates, Chrysophytes (Diatoms and Desmids), Euglenoids, Slime moulds, Protozoa.

Main characteristics of Protista :-

- All the organism included in Protista are unicellular eukaryotes. i.e. the structure of all protists is similar to eukaryotic cell. The members of protista have characters of plants, animals and fungi also hence, the boundary of this kingdom are not well defined.
- This kingdom form a link with the other dealing with plants, animals and fungi.
- The protistan cell body contains a well defined nucleus and other membrane bound cell organelle.

Nutrition :-

Mode of nutrition in protists is of different types

(i) Holophytic or Photosynthetic :-

They prepare their own food by photosynthesis.

(ii) Holozoic :-

Some protists have holozoic mode of nutrition, which is similar to animals *i.e.* food is first ingest/intake and then digest.

(iii) Osmotrophic or Absorptive :-

Food is first digested and then ingested in this mode of nutrition.

If food is absorbed from livings, it is parasitic and if from dead organic matter it is saprophytic mode of nutrition.

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

Movement :-

Some protists have flagella (Dinoflagellates, Euglenoids) or cilia (Protozoans).

Reproduction :-

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

(i) Asexual Reproduction :- 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 develops to form a normal organism.

e.g. Dinoflagellates, Chrysophytes, Euglenoids

(b) Spore formation :- Some protists form special structure known as sporangium. Spores are formed in this sporangium. The sporangia burst after sometime and all the spores become free. Each spore forms a new cell of protists. ***e.g.*** Slime moulds

(ii) 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 anisogamy.**

(b) Anisogamy :-

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

(c) Oogamy :-

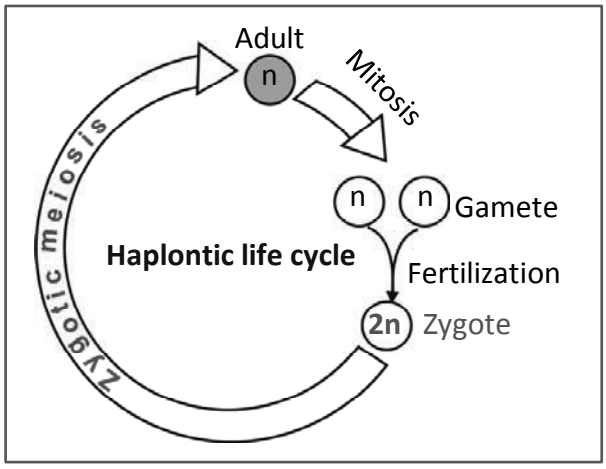
It is the developed form of Anisogamy. Male gamete is small and motile or immotile while female gamete is large and immotile. In oogamy female gamete does not come outside the female reproductive cell and fertilisation takes place in sex organs or female reproductive cell only.

Life cycle of Protist :-

The life cycle of Protists is of two types

(i) Haplontic Life Cycle -

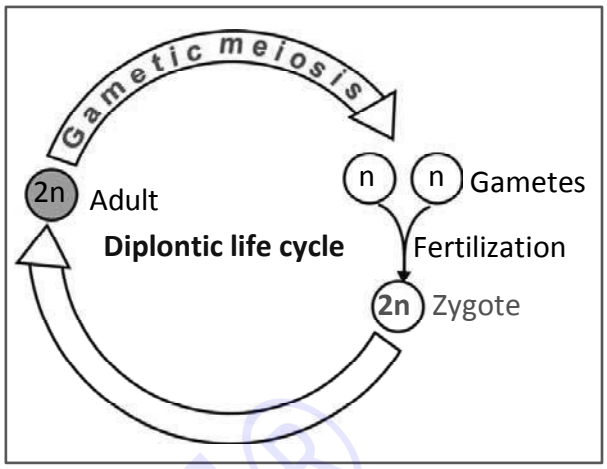
In this type of life cycle, during sexual reproduction gametes are formed by mitosis. These gametes are haploid (n). These gametes fuse to form a diploid (2n) zygote. After that **meiosis** takes place in zygote (**Zygotic meiosis**), as a result of which haploid cells or organisms are formed again.



In this type of life cycle the zygotic phase is only diploid (2n) and remaining all the phases are haploid (n) so this type of life cycle is known as **Haplontic life cycle**.

(ii) Diplontic Life cycle -

In this type of life cycle during sexual reproduction, **meiosis** takes place in diploid (2n) cell (**Gametic meiosis**), due to which haploid gametes are formed. Now haploid gametes fuse to form diploid zygote. And after that mitosis takes place in zygote, which again form diploid cells.



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.**

(A) Division - Pyrrophyta - Class Dinophyceae - DINOFLAGELLATES

"Protists with two flagella"

- Dinoflagellates are mainly marine and photosynthetic. They are found on the surface of water.

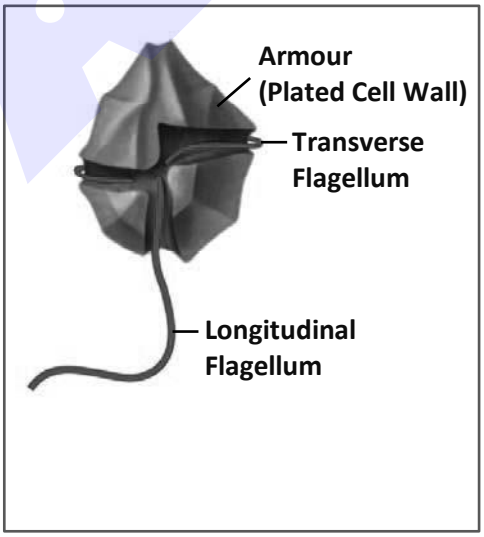
  They appear yellow, green, brown, blue or red depending on the main pigments present in their cells.

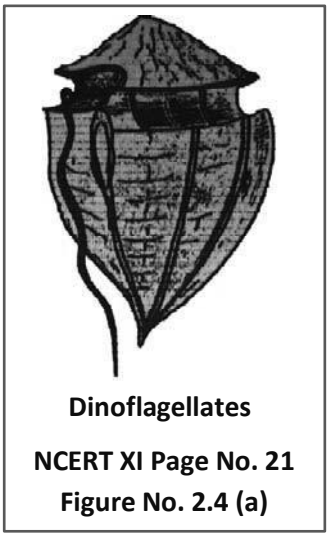
- In Dinoflagellates, the nutrition is mainly holophytic.

Structure :-

(i) Their cell wall is divided in to stiff plates, which is made up of cellulose. Therefore the covering of Dinoflagellates is seen as armoured so they are called **armoured algae.**

(ii) Dinoflagellates have two flagella - one is ***transverse*** and other is ***longitudinal,*** between the wall plates. Dinoflagellates show a special type of movement which is like whirling whips, therefore they are called **"whirling whips".**





Dinoflagellates

NCERT XI Page No. 21
Figure No. 2.4 (a)

(iii) Dinoflagellates are yellow-brown or golden brown in colour. These colours of Dinoflagellates are due to the pigments present in them - **Chlorophyll 'a', Chl. 'c' and Xanthophylls** (Dinoxanthin & Didinoxanthin)**.**

(iv) Histone protein is absent in chromosome of dinoflagellates.

(v) They have **starch** as stored food.

Reproduction :- Mainly Asexual – Binary fission.

Some informations of Dinoflagellates -

(i) Dinoflagellates (***e.g.*** - ***Noctiluca, Gonyaulax*** show **'bioluminescence'** due to presence of photogenic granules in cytoplasm, so these dinoflagellates are also known as **'night light'**.

(ii) Red dinoflagellates ***(Gonyaulax)*** undergo rapid multiplication and spreads on the surface of sea water, that makes the sea water appears red. It is called **red tide**. It is also responsible for water bloom.

(iii) Both ***Gymnodinium & Gonyaulax*** secrete toxins, which can cause paralysis in human beings. Humans acquire these toxins through food chain. These toxins release by dinoflagellates may even kill other marine animals such as fishes.

(iv) Dinoflagellates are also called **"fire algae"**. Because they appear as glowing light due to bioluminescence.

(B) Division - Chrysophyta

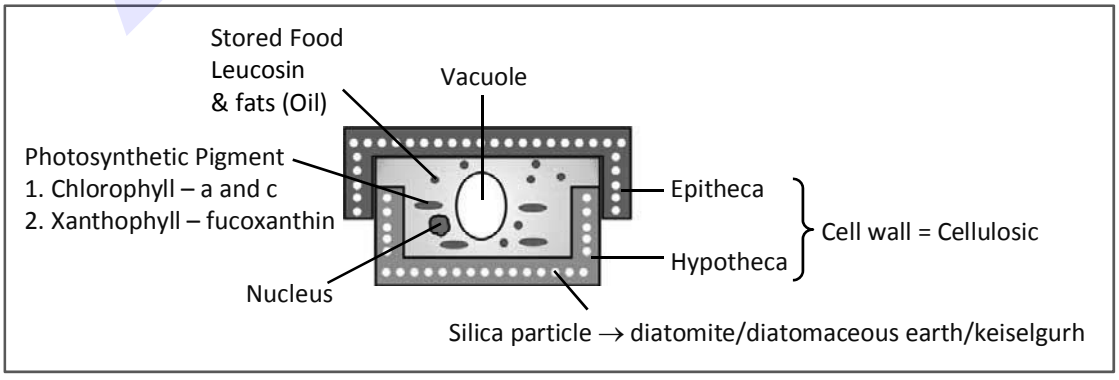
This group includes diatoms and golden algae (desmids). They are found in fresh water as well as in marine environment.

Diatoms are also known as **pearls of oceans.**

Diatoms Structure :–

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

(ii) In diatoms the cell wall form two thin overlapping shells, made up of cellulose which fit together as in a soap box. The walls are embedded with silica and thus the walls are indestructible. Diatoms have left behind large amount of cell wall deposits in their habitat. This accumulation over billions of years is referred as diatomaceous earth or keiselgurh.



(iii) Diploid nucleus is present in Diatom.

(iv) Diatoms have pigments **Chlorophyll 'a', 'c', and xanthophyll (fucoxanthin)**. Due to these pigments they appear golden coloured.

(v) They are chief, producers in the ocean due to very high number of them in oceans.

(vi) They have Leucosin (Chrysolaminarin) & fats (Oil) as stored food.

- **Movement** – They are immotile, because flagella are absent in them. They float passively on the surface of water (Plankton) due to low molecular weight **stored fats**.

Reproduction :- Mainly Asexual – Binary fission.

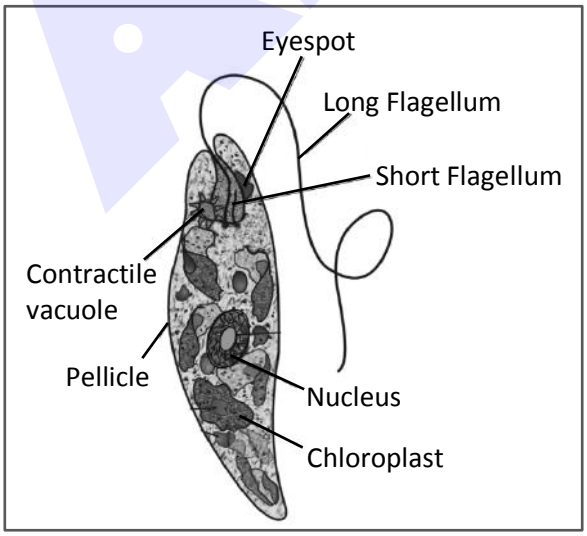
Use of keiselgurh / Diatomaceous earth :-

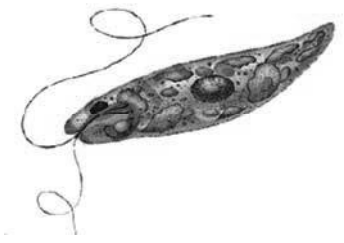
- Sound proofing
- Filteration of oils and syrups
- Stone polishing
- As "Heat insulator" in steam boilers because silica is bad conductor of heat.

(C) 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.
- Majority of them are fresh water organism. They are found in stagnant water, lakes, ponds, 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.

e.g. Euglena





Euglena

NCERT XI Page No. 21
Figure No. 2.4 (b)

Structure :-

(i) Cell wall is absent around them. Instead of a cell wall, they have protein rich layer pellicle which makes their body flexible.

(ii) 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 two flagella a short and a long one. Eye spot is present at anterior position.

(iii) They have a contractile vacuole. These contractile vacuoles help in osmoregulation.

(iv) Euglenoids have a haploid nucleus and chloroplast. Chloroplast has following pigments -

Chl. 'a' , Chl. 'b' and Xanthophyll (Zeaxanthin) –

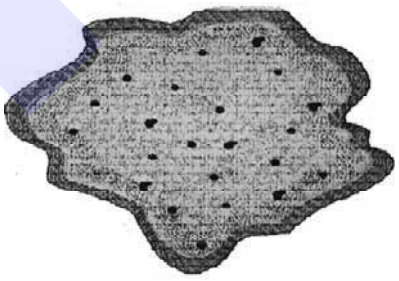
These pigments are identical to higher plants

(v) They have Paramylum and fat as stored food.

Reproduction - Asexual reproduction by longitudinal binary fission.

(D) Slime Moulds/Myxomycetes (Consumer – Decomposer)

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



Slime mould

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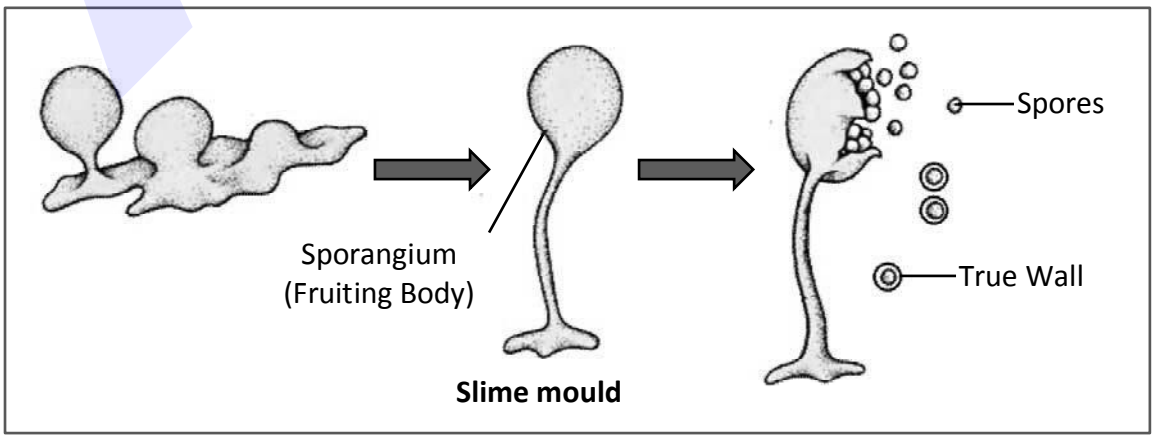
Figure No. 2.4 (c)

(ii) Slime moulds are saprophytic protists found on decaying twigs and leaves engulfing organic material.

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



Slime mould

(4) KINGDOM – FUNGI

General characters

(i) The fungi constitute unique kingdom of heterotrophic organisms. Members of this kingdom are called fungi. They show great diversity in their morphology and habitat. They can be seen on moist bread, butter, leather, wood, pickle, rotten fruits (orange rotting) and vegetables or as parasites on plants (white spot on mustard leaves) and animals.

(ii) Fungi are cosmopolitan and occur in air, water, soil, and on animals & plants. Fungi prefer to grow in warm and humid places so, we keep food in refrigerator, which prevents food from going bad due to bacterial or fungal infections. Fungi do not have chlorophyll and chloroplasts.

(iii) Most of fungi are heterotrophs. On the basis of source of food, fungi are of two types

(a) **Saprophytic :-** These fungi obtain their own food from dead substrate or organic matter (absorb soluble organic matter) such as bread, rotting fruits, vegetables and dung.

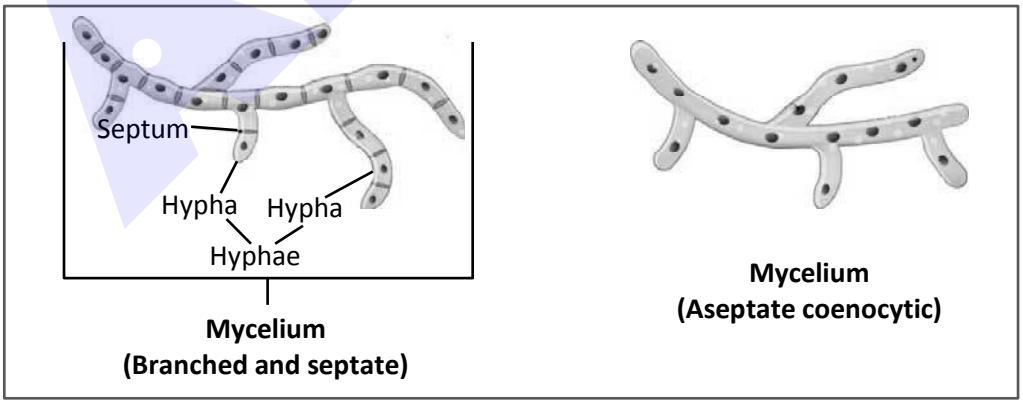
- Nutrition is of absorptive type in saprophytic fungi

(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.**

(iv) 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**.

(v) With the exception of yeasts which are unicellular, fungi are filamentous. Their body consist of long, slender thread-like structures called hyphae. The network of hyphae is known as mycelium. Some hyphae are continuous filled with multinucleated cytoplasm (coenocytic hyphae), other have septae or cross walls in their hyphae.



(vi) Cell wall composed of **chitin** (fungal cellulose) and **polysaccharides**, but cell wall of the members of Class-Oomycetes is mainly made up of **cellulose**.

(vii) In fungi, the stored food is present 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 (rotting orange) sexually by itself without the aid of another thallus.

e.g. ***Albugo candida***

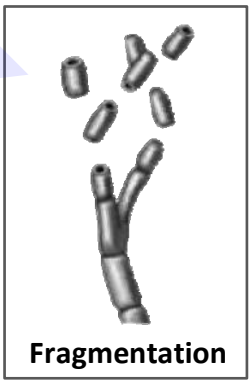
Heterothallic fungi :-

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*** **& Majority of fungi**

Reproduction

Reproduction in fungi can take place by vegetative means – fragmentation, budding or fission. Asexual reproduction is by spores called conidia or sporangiospores (zoospores, aplanospores) and sexual reproduction by oospore, zygospore, ascospores and basidiospores.


Fragmentation

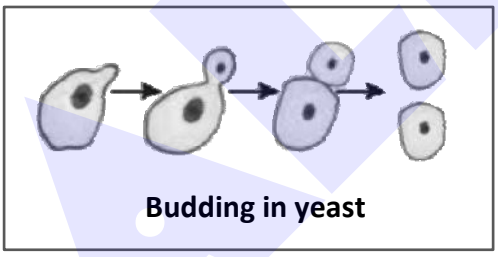
(i) Vegetative reproduction -

(a) Fragmentation –

Sometimes the fungal filament (mycelium) breaks into small pieces due to any reason. Now each piece forms a new fungal filament and start working like normal filament.

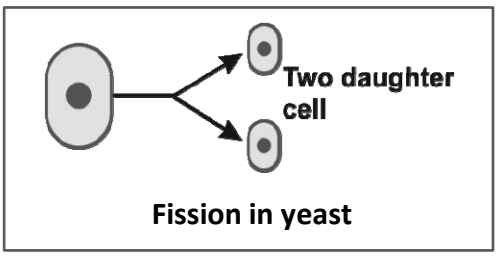
(b) Budding –

e.g. Saccharomyces (*Yeast*)


Budding in yeast

(c) Fission –

e.g. Schizosaccharomyces (*Yeast*)



Fission in yeast

Note : Reproduction by bud formation and fission is found only in nonmycelial forms.

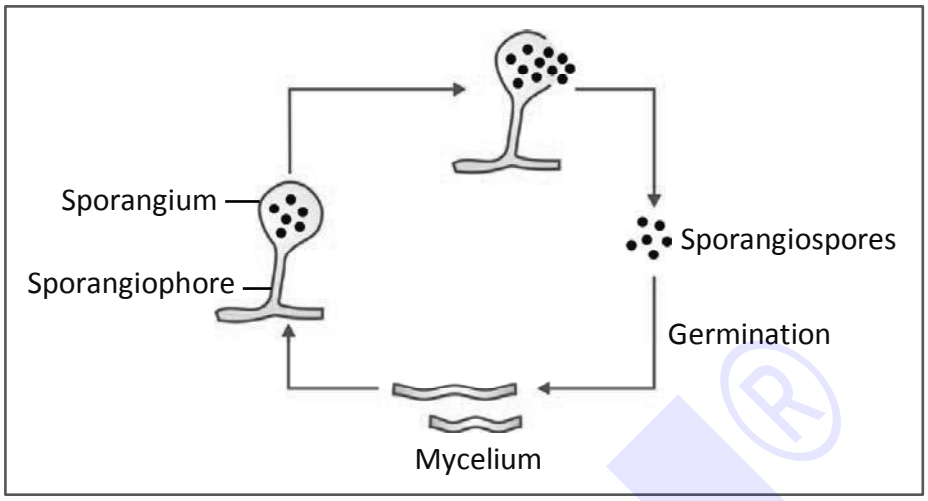
(ii) Asexual reproduction -

Asexual reproduction takes place by the formation of different types of spores (Conidia/sporangiospores). These spores are formed by mitotic division.

Spores are of following types :-

(a) Sporangiospores - They are formed in sporangia. Sporangium is formed at the tip of fungal filament. The fungal filament on which sporangium is formed is called as sporangiophore. Numerous spores (sporangiospores) are present in the sporangium,

they come out by rupturing of sporangia and germinate to form fungal filaments. The formation of sporangiospores takes place **endogenously**.

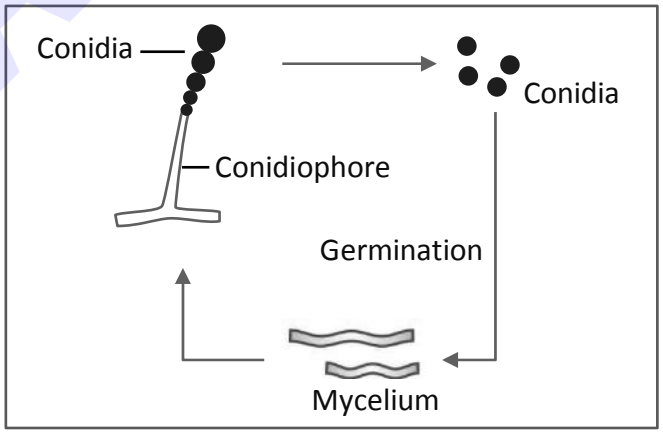


Sporangiospores are of two types :-

- **Zoospore :–** When the sporangiospores formed in sporangia are flagellated and motile, then they are called as zoospores.
- **Aplanospore :–** When sporangiospores are non flagellated and non motile then they are called aplanospores.

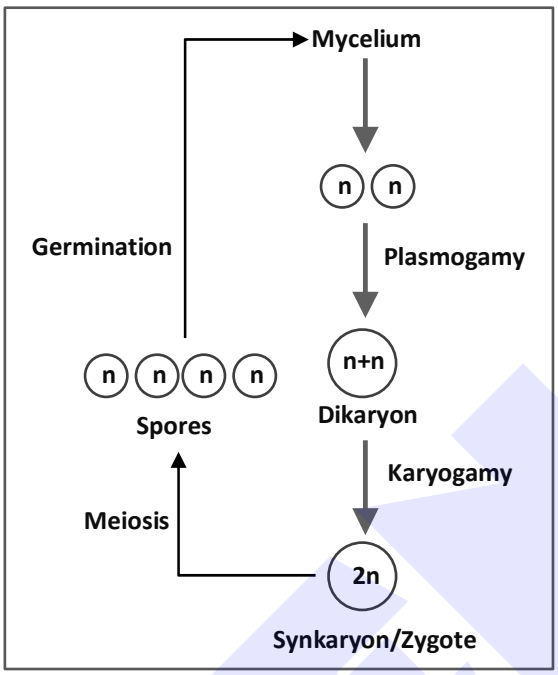
(b) **Conidia** - The formation of conidia takes place **exogenously**. These conidia are formed at the tip of conidiophores.

- **Conidiophore** - Erect fungal filament on which conidia are formed is called conidiophore.
- **Conidia** - Conidia are formed in chain. Each conidium forms new fungal filament (mycelium) by germination.



(iii) Sexual Reproduction :-

The structure in which gametes are formed is called **gametangium**.



Sexual reproduction in fungi completes in three steps :-

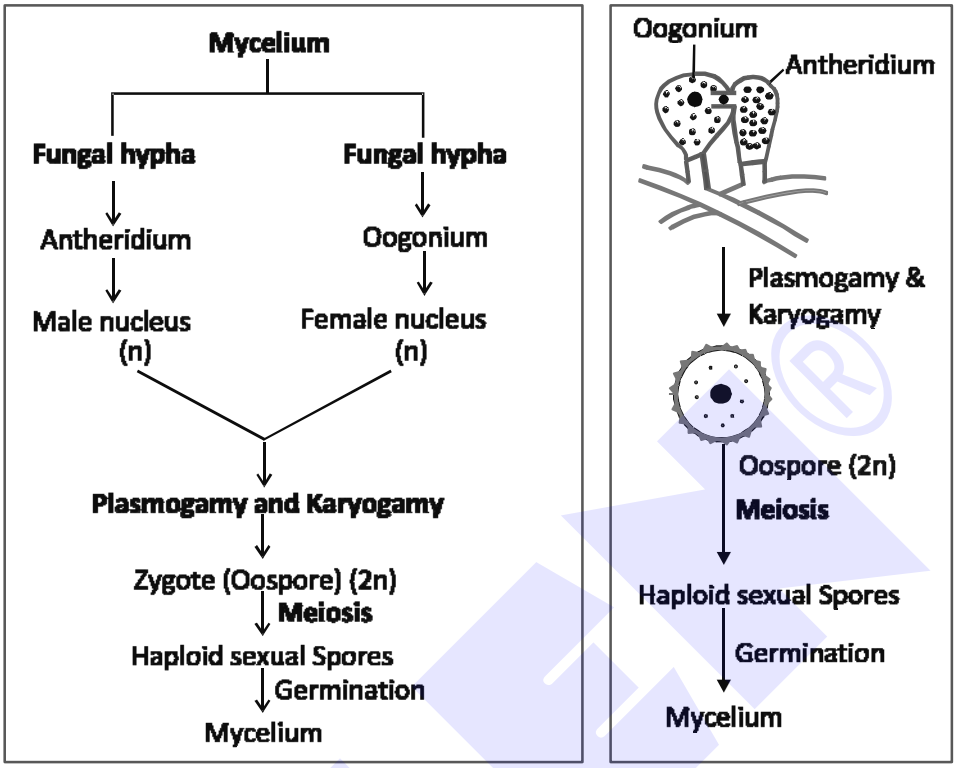
(a) **Plasmogamy** – Fusion of protoplasm of two motile or non motile gametes. In this stage two sex cells or two haploid hyphae of compatible mating types come togather and fuse. In phycomycetes the fusion of two haploid cells immediately result in diploid cells (2n). However, in other fungi (Ascomycetes and Basidiomycetes), an intervening dikaryotic stage (n + n, i.e., two nuclei per cell) occurs. Such a condition is called a dikaryon and phase is called dikaryophase of fungus.

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

(c) **Meiosis (Reduction division)** - In this stage, meiosis takes place. Meiosis in zygote/synkaryon/diploid nucleus resulting in haploid nuclei or haploid spores.

In fungi, sexual fusion is of many types

(i) Gametangial contact -



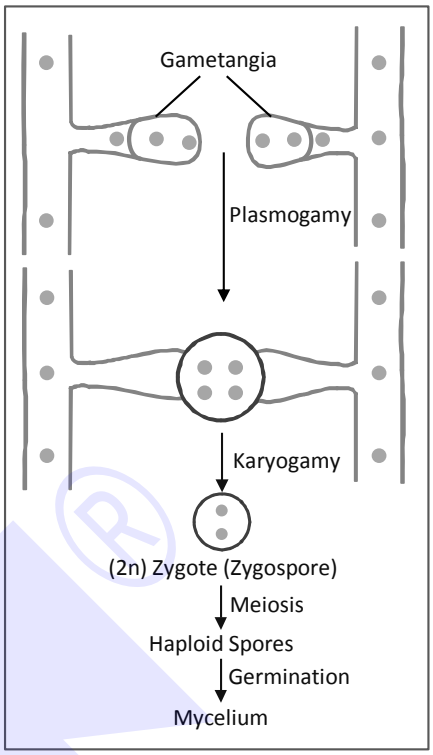
(a) In this process, first of all male and female sex organs are formed on two different hypha of same mycelium. Male sex organ is called antheridium and female sex organ is called oogonium.

(b) In mature antheridium & oogonium both have one – one nucleus. Antheridium and oogonium come close to each other and perform plasmogamy and karyogamy, then oospore(2n) is formed. Now meiotic division takes place in oospore(2n), as a result of which haploid spores are formed. Now each spore germinates and gives rise to a new mycelium.

(ii) Gametangial copulation :-

(a) In this process, two identical gametangia directly fuse to perform plasmogamy and karyogamy resulting in formation of diploid zygospore.

(b) Now meiotic division takes place in zygospore(2n), as a result of which haploid spores are formed. Now each spore germinates and gives rise to a new mycelium.



(iii) Somatogamy -

In it sex organs are not formed. Only two hyphae come close to each other and their cells fused.

Fungi are divided into following classes on the basis of morphology of mycelium, mode of spore formation and fruiting bodies formed during sexual reproduction :-

(A) Phycomycetes
(B) Ascomycetes
(C) Basidiomycetes
(D) Deuteromycetes

(A) Phycomycetes

Habitat :

All the fungi included in this class are called lower fungi.

Members of phycomycetes are found in aquatic habitat (members of this class are 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 all 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 is further classified into some classes like Oomycetes, Zygomycetes

Note : The mycelium of oomycetes and zygomycetes classes is same in structure i.e. coenocytic & aseptate. But they are dissimilar on the basis of sexual reproduction.

Oomycetes :

Asexual reproduction - By sporangiospores (Zoospores) & Conidia.

Sexual reproduction - By Gametangial contact, Oogamous.

Examples :-

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

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

(c) ***Pythium*** **species -** Causes ‘‘Damping off’’ disease in tobacco & vegetable crops.

(d) ***Sclerospora graminicola*** causes ‘‘Green ear disease of bajra’’

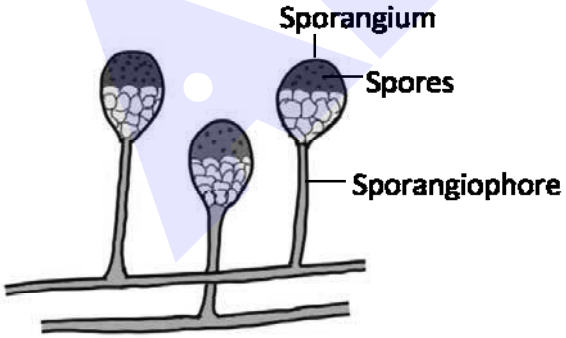
Zygomycetes -

Asexual reproduction - By sporangiospores (aplanospores)

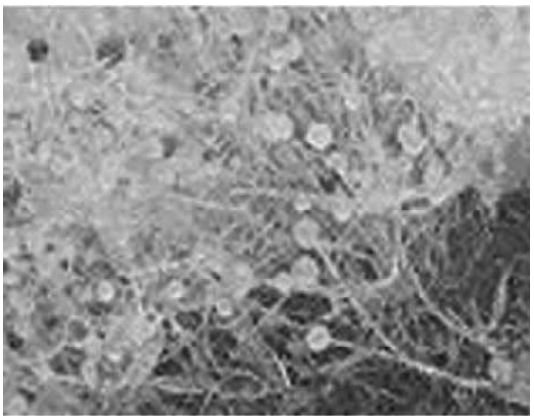
Sexual reproduction - By Gametangial copulation, Isogamous

Examples :-

Rhizopus & Mucor - These are known as **Bread mould** - They prefer to grow on bread.



Mucor



Mucor

NCERT XI Page No.
Figure No. 2.5 (a)

(B) Ascomycetes : "The sac fungi"

Habitat :

They are saprophytic, decomposers, parasitic or coprophilous (growing on dung).

Members of ascomycetes are multicellular but rarely unicellular, like yeasts.

Mycelium :

Uninucleate branched and septate. Pores are present in septum.

Asexual reproduction - by **conidia**

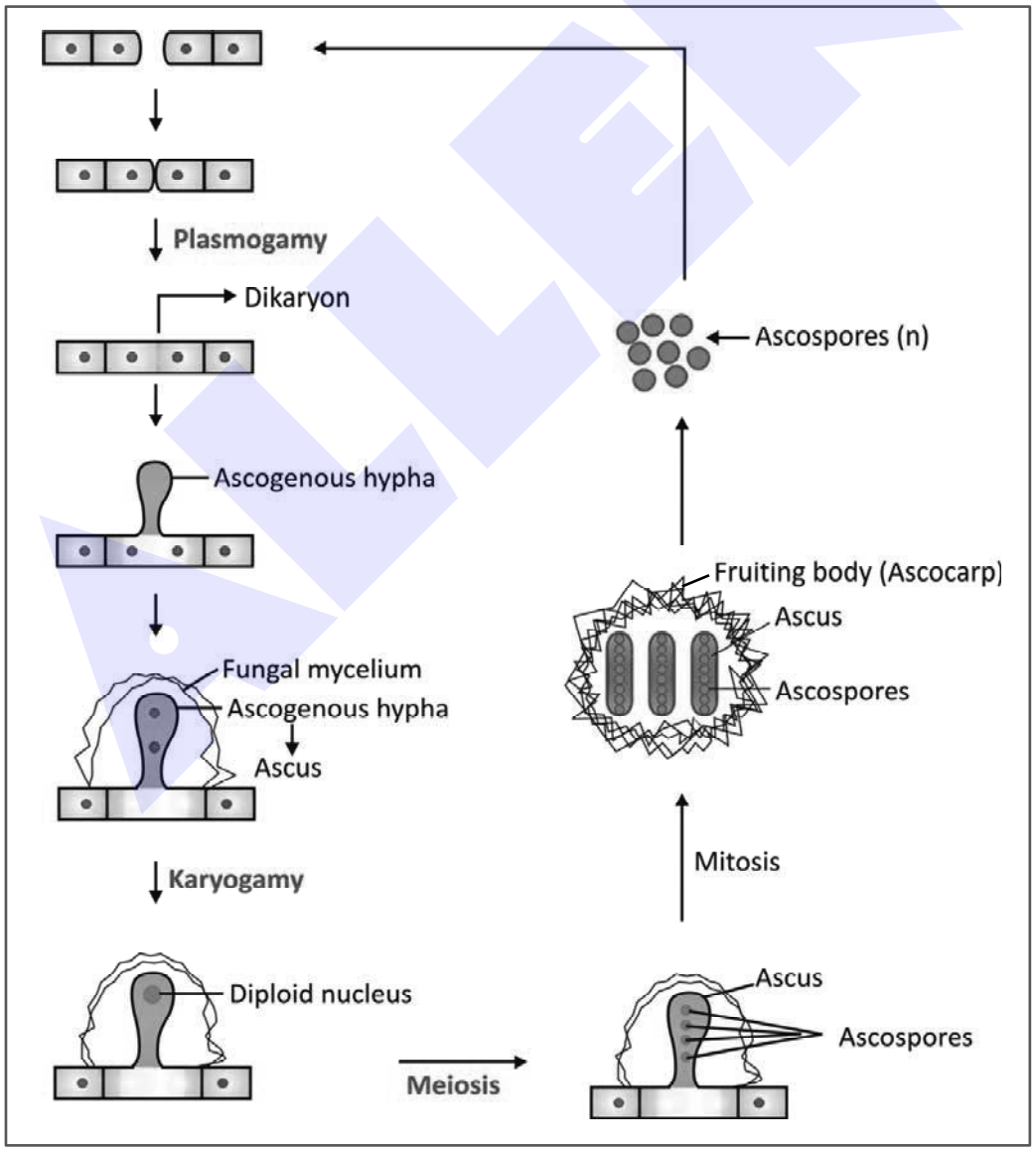
Sexual reproduction – by "Somatogamy"

Sexual spores are called ascospores which are produced endogenously in saclike asci so they are named as **Ascomycetes**.

SOMATOGAMY

(i) There are three stages in sexual reproduction

- **Plasmogamy**
- **Karyogamy**
- **Meiosis.**



Types of Ascocarp

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

(ii) In it two fungal hyphae come close to each other and fuse to form **dikaryon**.

Dikaryon - A cell in which two nuclei are present.

(iii) After this an outgrowth originates from dikaryon which is called **ascogenous hypha**. Ascogenous hypha develops in to a sac like structure called as **ascus**. Due to this sac like ascus, ascomycetes are also called **sac fungi**.

(iv) Now both the nuclei reach in ascus and fuse. As a result **diploid** nucleus is formed. Now **meiosis** takes place in the diploid nucleus of ascus, due to which four haploid spores are formed, which are called **ascospores**.

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

(v) During the formation of ascus and ascospores, the mycelium grows around the ascus and forms a covering which is called **fruiting body** or **ascocarp**. Asci are arranged in different types of fruiting body or ascocarp.

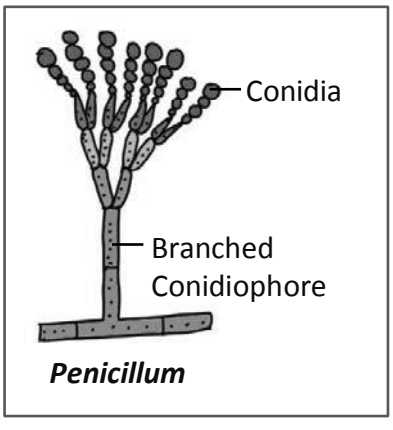
(vi) By rupturing of ascocarp & ascus, ascospores become free and each ascospore forms a new mycelium.

Examples :-

(a) ***Penicillium*** **:-**

Penicillin antibiotic was obtained from *Penicillium notatum*.

First discovered antibiotic was Penicillin it was obtained from fungi *Penicillium*.



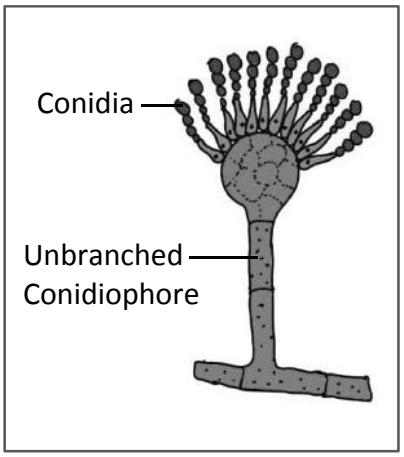
Penicillum

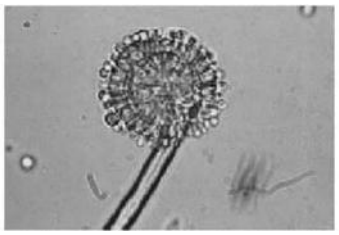
(b) ***Aspergillus*** **:-**

Different species of *Aspergillus* are related to **"aspergillosis"** disease.

Secrete **"aflatoxins"** (carcinogenic) in stored crop plants.

Aspergillus niger – Known as weed of laboratory and produce citric acid.





Aspergillus

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Figure No. 2.5(b)

(c) ***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.

(d) ***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.

(e) ***Morchella*** :- The species of *Morchella* are commonly called as morels.

(f) **Truffles** :- Some members of Ascomycetes are known as Truffles.

Morels and **truffles** are edible and considered as delicacies.

YEAST

Yeast are **unicellular fungi.**

Yeast grow on ripened fruits like grapes, sugarcane, date palm and flowers. Mycelium is absent in yeast. If yeast 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 :-

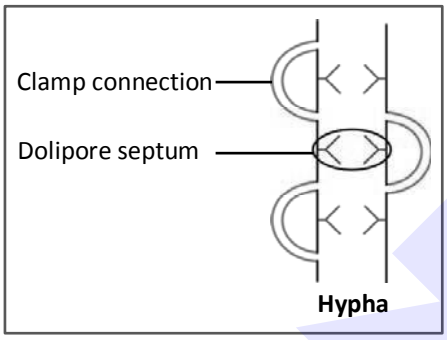
It is used as fermentation agent in bakery (bread industry) and brewery (wine industry). So ***Saccharomyces cerevisiae*** is also called **"Baker's yeast"** or **Brewing yeast.**

(C) Basidiomycetes "Club fungi"

Habitat :

They grow in soil, **on logs** (thick wooden pieces), **tree stumps** and in living plant bodies as **parasites e.g. rusts and smuts.**

Mycelium :



Branched, Septate and uni or binucleate

In basidiomycetes, septa are of special type and they are called **dolipore septa**.

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.

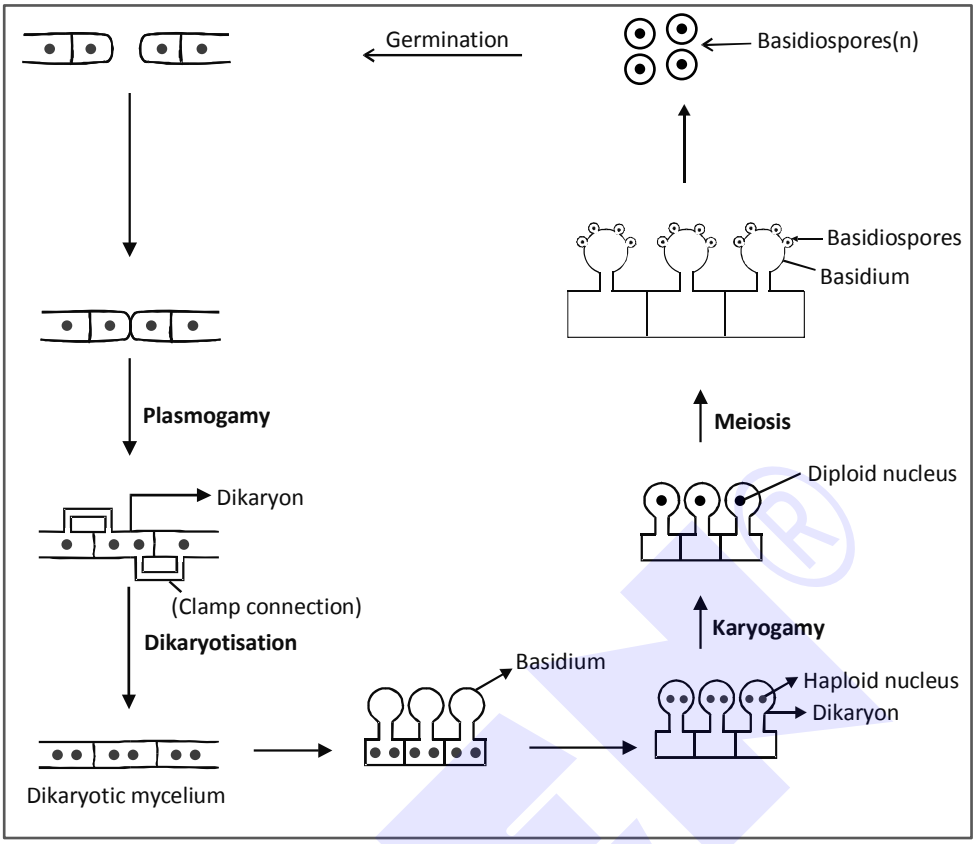
Sexual reproduction :-

Sexual reproduction is performed by Somatogamy.

Somatogamy -

This is the most common method of reproduction among the members of Basidiomycetes. The sex organs are absent but plasmogamy is brought about by fusion of two vegetative or somatic cells of different strains or genotype.

e.g. ***Ustilago, Agaricus***



(a) First of all, the two mycelium come close to each other.

(b) Now their cells fuse with each other (Plasmogamy), as a result of **dikaryon** is formed. (Dikaryon - The cell in which two nuclei are present)

(c) Dikaryon is ultimately gives rise to basidium which is club shaped.

(d) Karyogamy & meiosis takes place in the basidium producing four basidiospores exogenously.

(e) The basidia are arranged in fruiting body called basidiocarp.

(f) Now the Basidiospores become free from basidium and produce a new monokaryotic mycelium on germination.

Example :-

Commonly known form are mushroom, bracket fungi and puff ball.

(a) **Rust fungi : *Puccinia* :** It cause rust disease in wheat.

(b) **Bracket or Shelf fungi :-**

Their fruiting body is similar to bracket therefore they are called as bracket fungi.

(c) **Puff balls** – Fruiting body of some fungi are puff like so these fungi are called puff ball.

(d) **Mushrooms–** 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)

Agaricus

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Figure No. 2.5(c)

(e) **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.

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

(g) **Stink horn fungi :** *Phallus*. They are known for their foul smelling sticky spore.

(D) Deuteromycetes

Habitat :

Some members are saprophytic or parasitic, while a large number of members of this class are decomposers of litter and help in mineral cycling. ***e.g.*** *Trichoderma*

Mycelium : Septate and branched

Asexual reproduction : Takes place with the help of conidia.

It is also called "**fungi Imperfecti**", because only the asexual or vegetative phase of these fungi are known. When the sexual forms of this class of fungi were discovered they were moved into right class ascomycetes or basidiomycetes from deuteromycetes. e.g. *Alternaria, Colletotrichum* and *Trichoderma*.

Trichoderma is used as biocontrol agent.

The fungi included in this class cause many diseases		
	Fungi	**Disease**
(a)	***Alternaria solani***	Early blight of Potato
(b)	***Colletotrichum falcatum***	Red rot of sugarcane

Golden Key Points

- Mode of nutrition is absorptive in fungi
- All the unicellular eukaryotes are placed in Kingdom Protista.

  Pigments present in dinoflagellates are Chl 'a' and Chl 'c'.
- Stored food of dinoflagellates is starch.
- Cell wall of diatoms is made up of cellulose + silica.
- Pigments present in diatoms are Chl 'a' and Chl '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.
- 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.
- Deuteromycetes is known as Fungi Imperfecti.
- ***Trichophyton, Microsporum*** **and** ***Epidermophyton*** cause "**Ringworm**" in human.

  Tinea pedis (Athelete foot disease) is also known as "Ringworm of foot".

BEGINNER'S BOX — KINGDOM PROTISTA & FUNGI

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

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 *Gonyaulax* meiosis occurs in :-
(1) Gamete (2) Zygote (3) Sporangium (4) Zoospores

4. The famous Irish (Ireland) 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) *Albugo* (2) *Puccinia* (3) *Morchella* (4) *Saccharomyces*

6. Among rust, smut and mushroom all the three :-
(1) are pathogen (2) are saprobes (3) bear ascocarp (4) are basidiomycetes

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) Diploid (3) Haplodiplontic (4) Diplohaplontic

9. Taxonomy of fungi is mainly 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) *Morchella* and *Aspergillus*
(4) Shelf fungi and puffball

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

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

(5) VIRUSES

(A) History

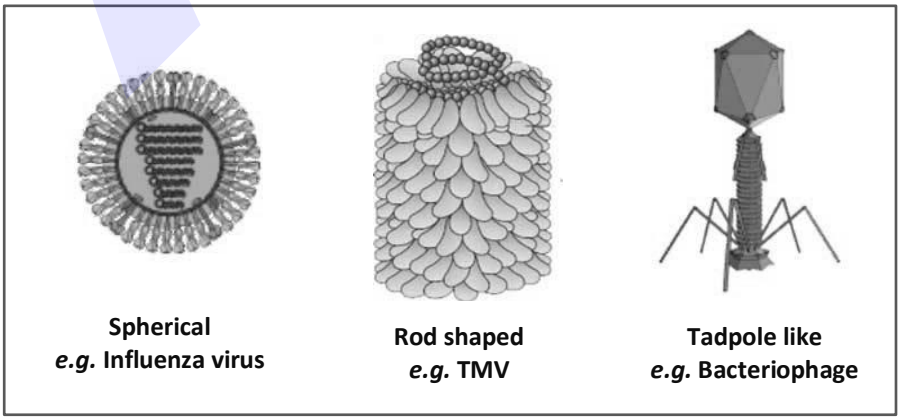
- **Virus** : **The name virus**, which means "**poisonous fluid**" or "**venom**" or "**secretion**" was given by **Pasteur**.
- **D.J. Ivanowsky** recognised certain micro organism as causal agent of mosaic disease of tobacco. He reported that viruses are smaller than bacteria and they can pass through the bacteria proof filters.
- **Beijerineck** demonstrated that the extract of the infected plants of tobacco could cause infection in healthy plants and called the fluid as "***contagium vivum fluidum*** (Infectious living fluid)".
- **W.M. Stanley** (1935) showed that viruses could be crystallized and crystals consist largely of protein.
- Viruses did not find a place in classification since they are not considered truly living.

(B) Characteristic features of viruses

- These are **submicroscopic** & **non-cellular** organisms.
- They are obligate intracellular parasites.
- They have either RNA or DNA. No virus contains both DNA and RNA.
- They are **inert** out side their specific host cell in crystalline form.
- Once they infect a cell, they take over the machinery of the host cell to replicate themselves.
- They contain nucleic acid so they are capable of protein synthesis by the help of ribosomes of host cell.

(C) Morphology and structure of viruses

Shape :



Spherical
e.g. **Influenza virus**

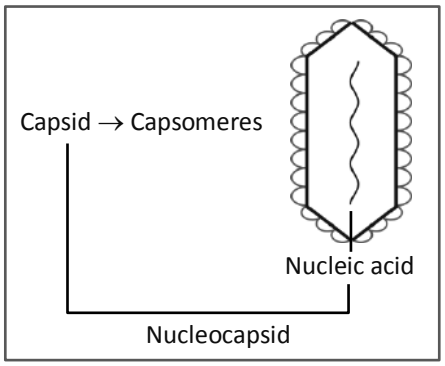
Rod shaped
e.g. **TMV**

Tadpole like
e.g. **Bacteriophage**

(D) Chemical composition :

(i) Nucleic acid : Either RNA or DNA

- Generally viruses that infect plants have ssRNA, but in **Cauliflower mosaic virus** dsDNA is present and in **Gemini virus** ss-DNA is present.
- Viruses that infect animals have generally double stranded DNA or ss or dsRNA



(ii) Protein coat :

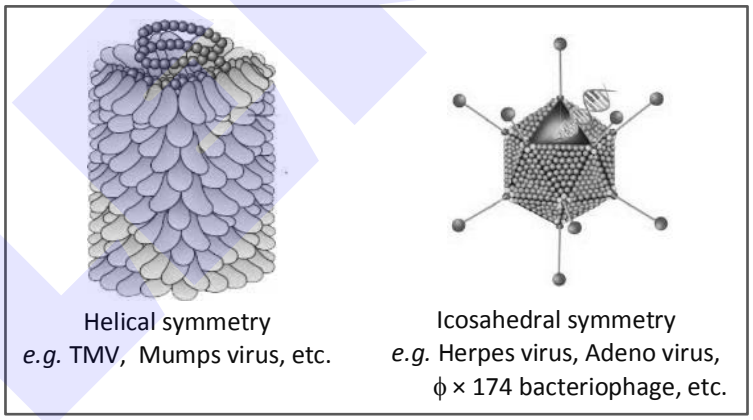
- It is known as **capsid** and made up of small sub units called **capsomeres**, protecting the nucleic acid.
- Central core & Capsid are collectively known as **nucleoprotein**.

(E) Symmetry of viruses :

(i) Helical symmetry :

Capsomeres are arranged in helical manner in the capsid

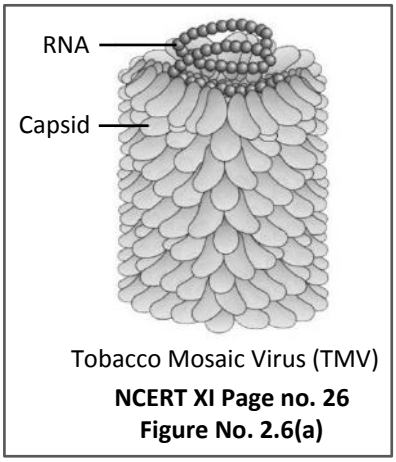
e.g. TMV and *Mumps virus* etc.



(ii) Icosahedral : It is a type of polyhedral ***e.g.*** Herpes virus, Adeno virus, ϕ × 174 bacteriophage

TMV (Tobacco Mosaic Virus)

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



Tobacco Mosaic Virus (TMV)

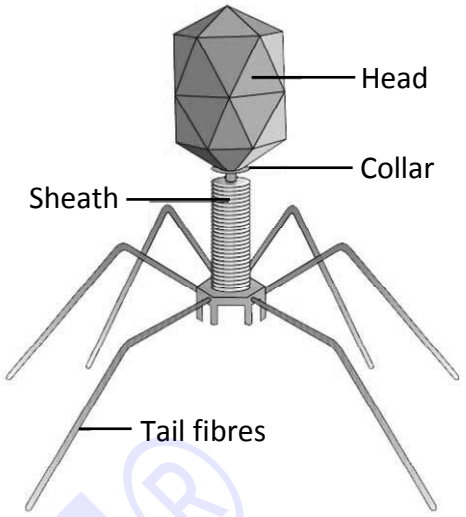
NCERT XI Page no. 26
Figure No. 2.6(a)

Bacteriophage

The Virus which infect the bacteria are called bacteriophage.

- Bacteriophages are generally double stranded DNA virus.
- **Transduction :**

  Transfer of genetic material from one bacterium to another by bacteriophage is known as transduction.



Bacteriophage

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Figure No. 2.6(b)

Plant Diseases caused by viruses :-

- Tobacco mosaic disease.
- Leaf curl of **papaya**

Note : In plants, the symptoms can be mosaic formation, leaf rolling and curling, yellowing and vein clearing, dwarfing and stunted growth.

Human disease caused by virus :-

- **Influenza**
- **Mumps**
- **Small pox**
- **Herpes disease**
- **AIDS**

Viroids (Free infectious RNA) :

- **T.O. Diener** (1971) discovered some new infectious agents, which are smaller than viruses, called **viroids**. It was found to be free RNA.
- Viroids contain only very low molecular weight RNA (ss RNA) and not the protein coat.
- **Viroids cause Potato spindle tuber disease**.

Prions or Slow viruses (Smallest proteinaceous infectious agent) :

In modern medicine certain infections neurological diseases were found to be transmitted by an agent consisted of abnormally folded protein. The agent was similar in size to viruses. These agents were called prions. The most notable diseases caused by prions are **bovine spongiform encephalopathy (BSE)** commonly called **mad cow disease** in cattle and its analogous variant **Cr-Jacob disease (CJD)** in humans.

(6) LICHENS

- Lichens are distinct group of organism having two components.
- Algal component of lichen is known as phycobiont and prepare food for algae and fungi. Fungal component is known as mycobiont and provides shelter and absorbs mineral nutrients and water for its partner. Hence lichen is an example of **symbiosis.**
- **Crombie** - Gave the **master-slave hypothesis** for this association. It is also called **helotism** (Most accepted association now a days).
- Major part of lichen's thallus is composed of fungal component.

Importance of Lichens :

Indicator of air pollution :

- Lichens are very good pollution indicator they do not grow in polluted area.
- Lichens are very sensitive to SO_2 and die at higher level of SO_2. So lichens are not found in industrial areas where atmosphere is polluted by smoke (specially SO_2), So lichens are **biological indicator** of air pollution.
- Lichens are pioneer species during the process of succession on rocks.

(7) MYCORRHIZA

- Mycorrhiza is the symbiotic association between roots of higher plants and fungus. Mycorrhiza is an example of **symbiosis**. Fungus obtain food and shelter from root and it helps to root in **absorption of water** & **minerals**.
- Mycorrhiza are of two types

(A) Ectomycorrhiza/Ectotrophic mycorrhiza :

- Ectomycorrhizal fungi occurs in the roots of ***Pinus, Oak, Eucalyptus*** etc.
- Ectomycorrhizal fungi are mainly members of class **basidiomycetes** *e.g.* ***Clavatia, Amanita*** and some ascomycetes.

(B) Endomycorrhiza/Endotrophic mycorrhiza :

- Endomycorrhiza is also called **Vesicular arbuscular mycorrhiza** (VAM). Arbuscule acts as haustorium.
- **VAM** is useful for **phosphate absorption.**
- Endomycorrhizal fungi are mainly member of class **Zygomycetes (*e.g. Glomus*)** but some members of Endomycorrhizal fungi belongs to basidiomycetes also.

ESSENCE

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

Living organism

Plantae	**Animalia**
Cell wall present	Cell wall Absent

Basis:

1. Cell structure
2. Body organisation
3. Mode of nutrition
4. Reproduction
5. Phylogeny

- Monera: All prokaryotes
- Protista: Unicellular eukaryotes
- Fungi: Heterotrophic, cell walled multicellular eukaryotes
- Plantae: Autotrophic, cell walled multicellular eukaryotes
- Animalia: Heterotrophic, cell wall less multicellular eukaryotes

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

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

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

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

Characters	Dinoflagellates	Diatoms	Euglenoids	Slime Moulds
	Producer protists	Producer protists	Producer, consumer protists	Consumer, decomposer protists
Cell wall	Made up of stiff cellulosic plate	Cellulosic embedded with silica	Absent Pellicle is present	Cellulosic, present in spore only
Nutrition	Holophytic	Holophytic	Mixotrophic	Osmotrophic
Special characters	Red tide Bioluminescence	Diatomaceous earth or keiselgurh	Pigments similar to higher plants	

Fungi :

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

Characters	Phycomycetes	Ascomycetes	Basidiomycetes	Deuteromycetes
Mycelium	Branched aseptate	Branched and septate	Branched and septate	Branched and septate
Asexual spores	Sporangiospore (Zoospore and aplanospore)	Conidia	Usually, no spore formation	conidia
Sexual spores	Oospore (2n) or zygospore (2n)	4 or 8 Ascospore (n) Endogenous	4 basidiospore(n) Exogenous	Sexual reproduction is not discovered
Fruiting body		Ascocarp	Basidiocarp	

Viruses

- Non-cellular
- Obligate intra cellular parasites
- Nucleoprotein particles (Nucleic acid and proteins)
- Protein capsid is made up of capsomeres
- Cause infection in plants, animals and prokaryotes

Viroids are low molecular infectious RNA particles cause disease in plants (PSTD)

Prions are infectious protein particles cause disease in animals and humans (CJD disease, mad cow disease)

03. PLANT KINGDOM

- **Algae**
- **Bryophytes**
- **Pteridophytes**
- **Gymnosperms**

- Our understanding of the plant kingdom has changed over time.
- Members of Fungi, Monera and Protista having cell wall is now excluded from plantae.
- The cyanobacteria or blue green algae are not algae any more.
- The earliest classification of plants was based on gross superficial morphological characters.

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

Following plant groups are included in Kingdom-Plantae

(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 :-

(i) Algae are largely aquatic (fresh and marine water). They occur in a variety of other habitat : Moist stones, soils and wood. Some of them also occurs in association with fungi (lichens) and animals (e.g. on sloth bear).

- The form and size of algae is highly variable. Algae are found in many forms like filamentous, colonial.
- A few of the marine forms such as kelp form massive plant body.

(ii) 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**.

(iii) 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.

(iv) 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. **Chl-a** and **β carotene** are **universal pigment** of algae.

Reproduction :-

(i) Vegetative **(ii) Asexual** **(iii) Sexual**

(i) Vegetative reproduction :- By Fragmentation - Filaments break down into small pieces and each fragment develops into a thallus.

(ii) Asexual reproduction :- Asexual reproduction is by the production of different types of spores. The most common being is the zoospores. They are flagellated and on germination gives rise to new plants. Zoospores are formed in favourable conditions and aplanospores, hypnospores and akinetes etc. are formed in unfavourable condition.

(iii) Sexual reproduction :-

(a) 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 ***Chara*** (***Chara*** - 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**.
- Sexual reproduction takes place by fusion of two gametes.

(b) Plant body of algae is haploid, so sexual reproduction take place through **zygotic meiosis**. Therefore, their life cycle is **haplontic**. But exceptionally brown algae are **diploid**. [***e.g.*** In ***Fucus*****,** life cycle is diplontic]

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

Sexual reproduction is of three types

- **Isogamous** – *Chlamydomonas debaryanum, Ulothrix, Ectocarpus, Spirogyra, Cladophora*
- **Anisogamous** – *Chlamydomonas braunii, Eudorina*
- **Oogamous** – *Chlamydomonas coccifera, Sargassum, Volvox, Fucus* and *Chara*

Some important points about algae :-

- At least half of the CO_2 fixation on earth is carried out by algae. They perform oxygenic photosynthesis, so they increase the level of dissolved oxygen in their immediate (nearby) environment.
- As the producers, algae are of paramount (very much) importance as primary producer of energy rich compounds which form the basis of food cycles.
- About 70 species of marine algae are used as food. *Porphyra*, *Laminaria* and *Sargassum* algae are used as food.

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 are divided into following divisions

(A)	Chlorophyta	-	Green Algae
(B)	Phaeophyta	-	Brown Algae
(C)	Rhodophyta	-	Red Algae

(A) Class : Chlorophyceae – Division : Chlorophyta

Green Algae

- Green algae are the **most advanced** algae.

Habitat : Green algae are cosmopolitan in nature.

Different body forms of green algae :- The plant body may be unicellular, colonial or filamentous.

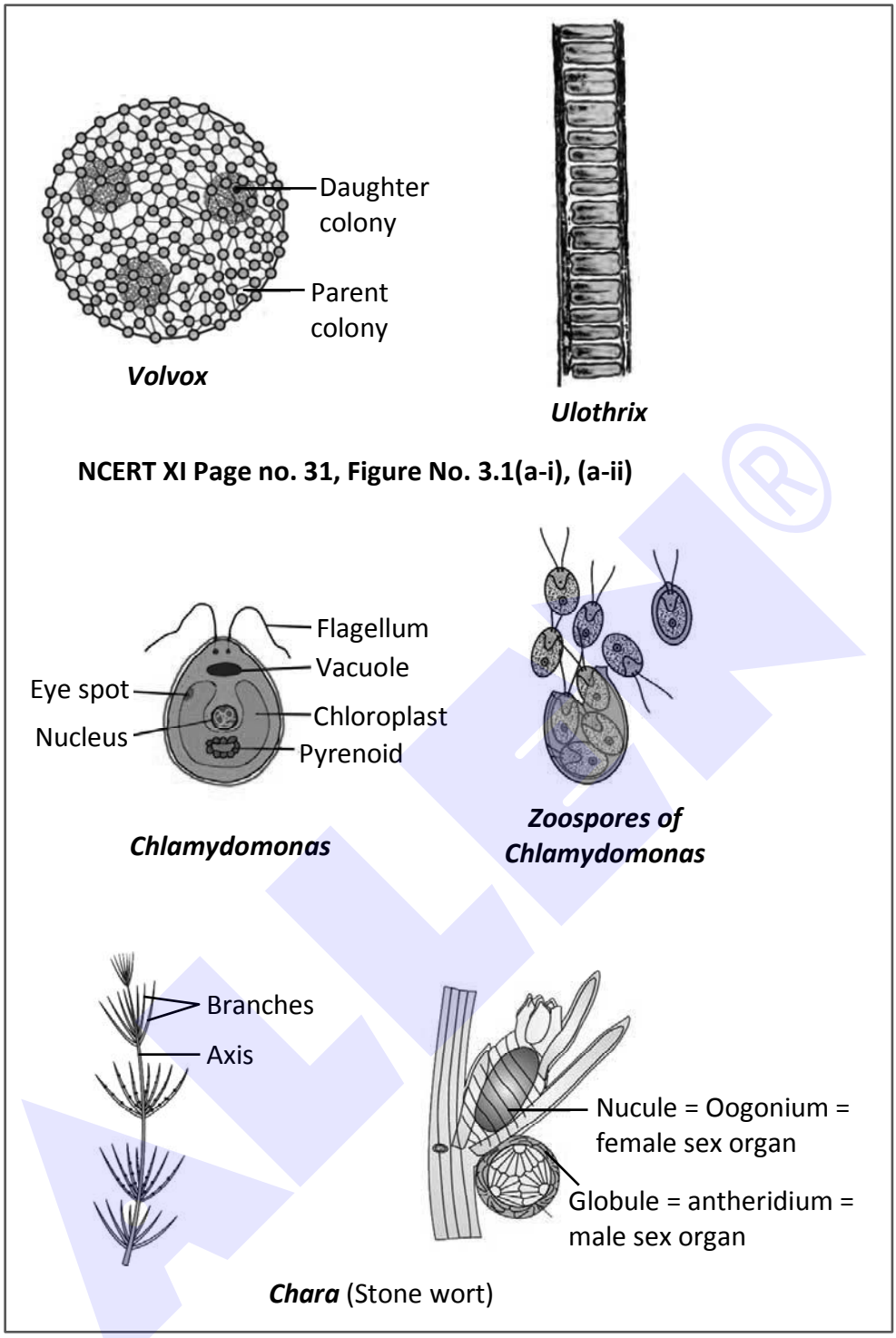
(i) Unicellular :-

(a) ***Chlamydomonas*** - Motile unicellular algae. These algae move with the help of flagella.

(b) ***Chlorella*** **-** Non motile unicellular alga.

(c) ***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 so they are studied in **Plantae**.



(ii) **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 is called **coenobium**.

eg. *Volvox* - Motile colony

(iii) **Multicellular filamentous -** Mostly the green algae are multicellular and filamentous.

eg. *Ulothrix, Spirogyra*

(iv) **Multicellular thalloid or Parenchymatous -** Some algae are multicellular in length and width. *eg.* *Ulva*

- Green algae usually have a rigid cell wall, made up of inner layer of cellulose and outer layer of pectose.

Pigments :

Chlorophyll	-	Chl 'a' and Chl 'b'
Carotene	-	β carotene
Xanthophyll	-	Yellow coloured

- They are usually grass green due to the dominance of pigments chlorophyll a and b. Pigments are localised in definite chloroplasts

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

Vegetative reproduction – Usually takes place by fragmentation.

Asexual reproduction – Asexual reproduction is by flagellated zoospores which 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.

Note :

- On the basis of pigments (Chl 'a', Chl 'b', Carotenoids), stored food (starch) & cell wall (made up of cellulose and pectose), green algae are considered similar to higher plants.
- One or more **pyrenoids** are also present in chloroplast as storage bodies. Pyrenoids contain protein besides starch.

Economic Importance :

Food - *Chlorella* is used as food, *Chlorella* has large amount of protein.

Antibiotics - Chlorellin antibiotic is obtained from *Chlorella*.

Space research - In space, *Chlorella* is used as a source of food and O_2 by space travellers.

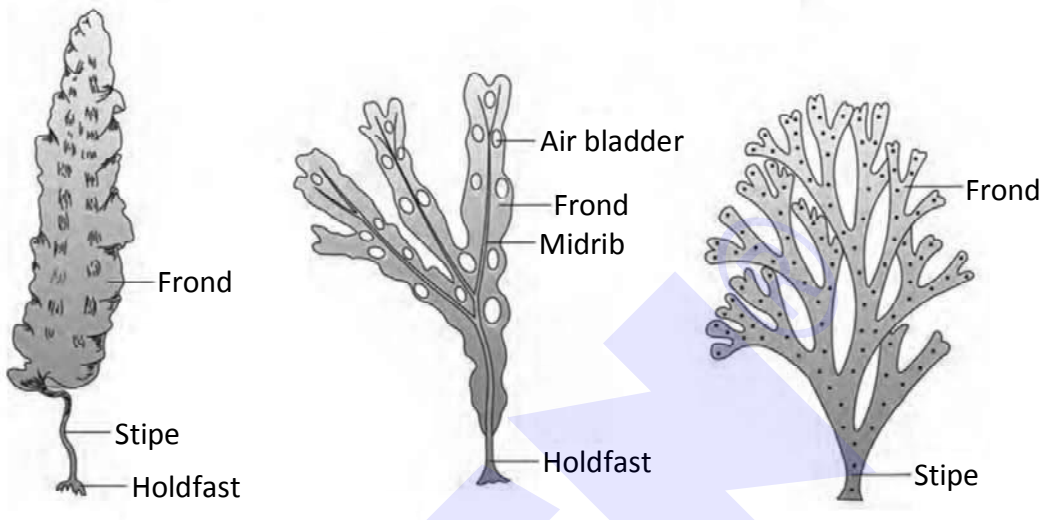
Parasitic algae - *Cephaleuros* is present parasitically in the leaves of tea plant and causes **'red rust'** disease.

(B) Class : Phaeophyceae – Division : Phaeophyta

Brown algae

"Sea weeds" or "Kelps"

Habitat : Brown algae are found primarily in marine habitats.



Laminaria ***Fucus*** ***Dictyota***

NCERT XI Page No. 31, Figure No. 3.1(b-i), (b-ii), (b-iii)

Structure :-

- Brown algae are multicellular filamentous. They show great variation in size and form. They range from simple branched filamentous forms (*Ectocarpus*) to profusely branched forms as represented by Kelps which may reach a height of 100 meters.
- 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***)
- The vegetative cells have a cellulosic wall usually covered on the outside by a **gelatinous coating of algin.** In brown algae protoplast contains plastid, centrally located vacuole and nucleus.

  e.g. *Fucus, Dictyota, Ectocarpus*

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** or **Alginate salts** is used for dentury measurement.
- Algin is 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

They vary in colour from olive green to various shade of brown depending upon the xanthophyll pigment 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 : Laminarin and mannitol - both are complex carbohydrates.

Vegetative reproduction : Takes place by fragmentation.

Asexual reproduction : By biflagellated Zoospores that are pear shaped and have two unequal laterally attached flagella.

Sexual reproduction : Sexual reproduction in brown algae may be isogamous, anisogamous or oogamons. Union of gametes may takes place in water or within the Oogonium.

- Gametes are pyriform and have two unequal laterally attached flagella.
- Life cycle of *Ectocarpus* and kelps are haplodiplontic, life cycle of *Fucus* is diplontic.

Note : In *Ectocarpus* and kelp life cycle pattern is haplodiplontic, but diploid phase is dominant. So can be termed as diplohaplontic.

Examples :

Sargassum **-** used as food

Kelps : Profusely branched and giant algae are known as **kelps.**

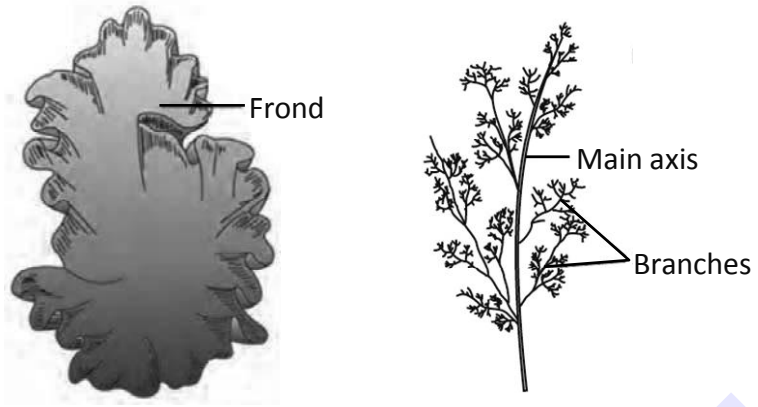
Laminaria **-**

(1) Used as food

(2) Iodine and Bromine - Obtained from *Laminaria*

(C) Class : Rhodophyceae – Division : Rhodophyta

Red Algae



Porphyra ***Polysiphonia***

NCERT XI Page No. 31, Figure No. 3.1(c-i), (c-ii)

Red algae are **ancient (Primitive) algae**. 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. They occur in both well lighted regions close to surface of water, and also at great depth in ocean, where relatively little light penetrate. But exceptionally ***Batrachospermum*** is found in fresh water (river).

Structure :

- The red thalli of red algae are usually multicellular. Some of them have complex body organisation.
- Cell wall of red algae is complex because it is made up of cellulose & pectin with **polysulphate esters.**
- Some red algae may secrete and deposite **calcium carbonate** and appear like **corals**.

Pigments :

Chlorophyll - Chl 'a' and Chl 'd'

Carotenes - β carotene

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

- The members of rhodophyceae are commonly called red algae because of predominance of the red pigment, r-phycoerythrin in their body.
- On the basis of pigments red algae are similar to blue green algae.

Stored Food :

The food is stored as **floridean starch** which is very similar to **glycogen** and **amylopectin** in structure.

Vegetative reproduction – Fragmentation

Asexual reproduction – Non motile spores

Sexual reproduction – Occurs by non motile gametes

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

(ii) Life cycle of ***Polysiphonia*** is Haplo-diplontic or diplobiontic.

Economic importance :-

Harveyella **-** It is **parasite** on other alga.

Porphyra **-** It is an edible algae and used as a food.

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.

Chondrus crispus **- Carrageen** 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 carrageen.

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	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, R-phycoerythrin	Floridean starch	Cellulose, pectin and polysulphate esters	Absent	Fresh water (Some), brackish water, salt water (most)

NCERT Page No. 33, Table No. 3.1

Note - Algae which are present on animals known as epizoic

e.g. *Cladophora* (present on Mollusca shell)

Cyanoderma (Blue green algae) and *Trichophilus* (Green algae) **(Present on sloth bear)**

S.No.	Type of chloroplast	Present in
1.	Discoid	*Chara*
2.	Plate like	*Fritschiella*
3.	Cup shaped	*Chlamydomonas*
4.	Girdle shaped	*Ulothrix*
5.	Ribon shapped	*Spirogyra*
6.	Reticulate	*Oedogonium*

THALLOPHYTA

(i) According to two kingdom classification, all the **algae, fungi** and **prokaryotes** were placed in thallophyta, because their plant body is thallus.

(ii) 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]

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

(iv) In thallophyta, sexual reproduction takes place through **zygotic meiosis**, therefore embryo is not formed. **Absence of embryo formation is unique character of thallophyta** so they are also known as "**nonembryophytes**"

Note :

(i) The word "**Algae**" refers to those organisms which are usually aquatic, photosynthetic, thalloid body and having chlorophyll-**a**.

(ii) **Cryptogams** do not produce seed, they include thallophyta, bryophyta and pteridophyta.

(iii) **Phanerogams** produce seeds, they include gymnosperms and angiosperms.

Golden Key Points

- The viruses are non-cellular organisms that are characterised by having an inert crystalline structure outside the living cell.
- Viruses are obligate parasites.
- A virus is a nucleoprotein and the genetic material is infectious.
- The protein coat called capsid made of small subunits called capsomeres, protects the nucleic acid.
- In general, viruses that infect plants have single stranded RNA and viruses that infect animals have either single or double stranded RNA or double stranded DNA.
- Bacterial viruses or bacteriophages (viruses that infect the bacteria) are usually double stranded DNA viruses.
- T.O. Diener discovered a new infectious agent - Viroids that was smaller than viruses and caused potato spindle tuber disease.
- The most notable diseases caused by prions are mad cow disease in cattle and its analogous variant Cr–Jacob disease (CJD) in humans.
- Lichens are symbiotic associations i.e. mutually useful associations, between algae and fungi.
- Lichens are very good pollution indicators – they do not grow in polluted areas.
- Mycorrhiza is the symbiotic association between roots of higher plants and fungus.
- Algae are chlorophyll-bearing, simple, thalloid, autotrophic and largely aquatic (both fresh water and marine) organisms.
- *Chlorella* a unicellular alga rich in proteins is used as food supplement even by space travellers.
- The plant body is usually attached to the substratum by a holdfast, and has a stalk – the stipe and leaf like photosynthetic organ – the frond.
- The gametes or zoospores are pyriform (pear-shaped) and bear two laterally attached flagella.
- The members of Rhodophyceae are commonly called red algae because of the predominance of the red pigment, R-phycoerythrin in their body.
- Sexual reproduction is oogamous and accompanied by complex post fertilisation developments.
- Agar, one of the commercial products obtained from *Gelidium* and *Gracilaria* are used to grow microbes and in preparations of ice-creams and jellies.
- Gaidukov's effect is found in both red algae and blue green algae.

BEGINNER'S BOX
VIRUS, LICHEN, MYCORRHIZA AND ALGAE

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) Pyrenoids
(2) Zoospore
(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 *Spirogyra* isogametes are :-
(1) Non flagellated
(2) Single flagellated
(3) Biflagellated
(4) Multiflagellated

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

6. Globule and nucule are sex organs of
(1) *Chlorella*
(2) *Acetabularia*
(3) *Chara*
(4) *Ulva*

7. Red algae is used to obtain :-
(1) Agar
(2) Carrageen
(3) Citric acid
(4) Both 1 & 2

8. Viruses are made up of
(1) Only nucleic acid
(2) Only proteins
(3) Proteins and nucleic acid
(4) Lipid and Proteins

9. Lichens are association of :-
(1) Algae & Virus
(2) Algae & Bryophytes
(3) Algae & Fungi
(4) Fungi & Roots of plants

10. Disease causing abnormally folded poroteins are
(1) Viroids
(2) Prions
(3) Viruses
(4) Bacteriophages

(2) BRYOPHYTA

- The term **"Bryophyta"** 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 : Bryophytes includes the various mosses and liverwort that are found growing in moist, shady area in the hills.

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

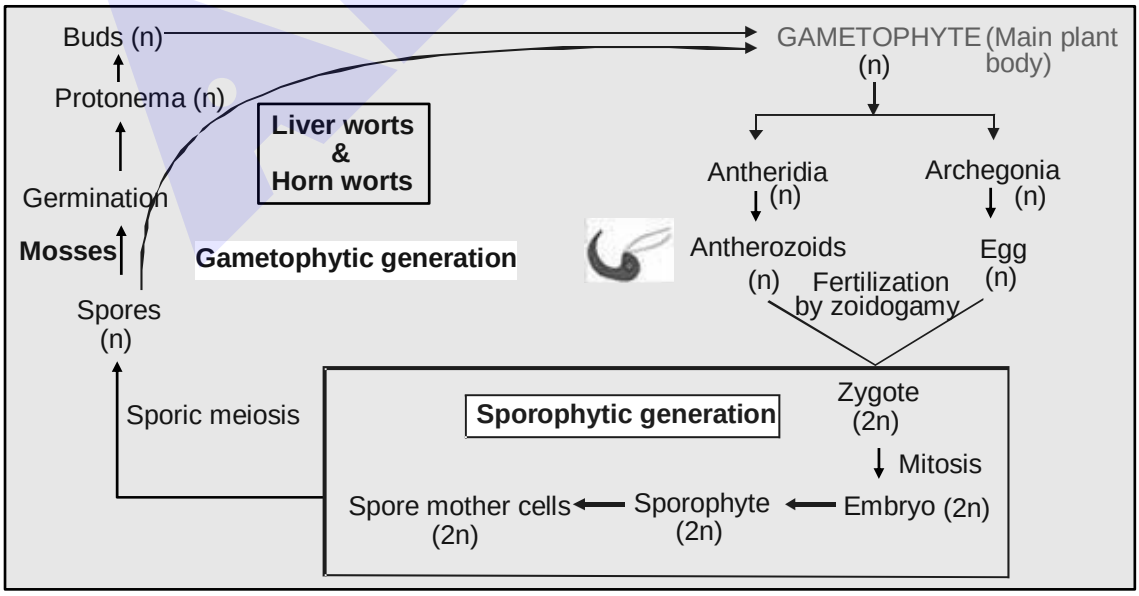
ii. Bryophytes are known as amphibians of the plant kingdom, because these plants can live in soil but are dependent on water for fertilization.

iii. 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.

iv. The plant body of bryophytes is more differentiated than that of algae. It is thallus like prostrate or erect and attached to substratum by unicellular or multicellular rhizoids. They lack true root, stem and leaf. They may possess root like, stem like and leaf like structures.

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

Life cycle of Bryophytes :



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

ii. Sex organs are formed on gametophyte. Sex organs are multicellular and jacketed in bryophytes. Male sex organ is called antheridium. They produces biflagellated antherzoids. The female sex organ is called archegonium. Archegonium is flask shaped and produce a single egg.

iii. The antherozoids are released in water where they come in contact with archegonium.

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

v. As a result of the fertilization, a diploid zygote is formed. Zygote does not undergo reduction division (meiosis) immediately. They produce a multicellular body called sporophyte.

vi. The sporophyte of Bryophyta is not free living but attached to photosynthetic gametophyte and derive nourishment from it. It is made of foot, seta and capsule, so it is known as sporogonium.

Some of cells present in capsule of sporophyte function as spore mother cells and undergo reduction divison to produce haploid spores. These spores germinate to produce gametophytes.

vii. The germination of spores is **direct** or **indirect**. In **Liverworts** & **Hornworts**, the germination of spore is direct, i.e. each spore forms a gametophyte after germination means 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 **lateral 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 : (1) Protonema developed from spores is called primary protonema and the protonema developed from parts other than spores are known as secondary protonema.

(2) Protonema is creeping, green, branched and filamentous.

- **The sexual reproduction in bryophytes is of oogamous type and life cycle is of haplodiplontic type.**
- **In Bryophyta the sporophyte is dependent on gametophyte. This is a unique character of bryophytes.**

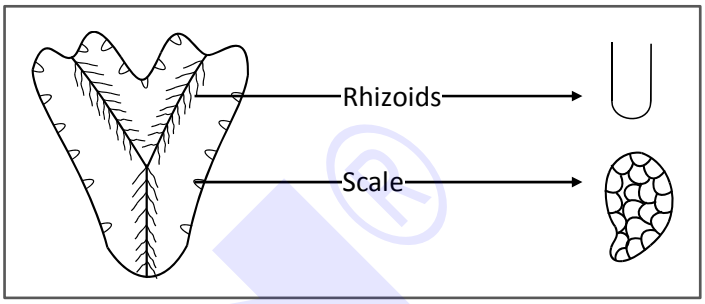
BRYOPHYTA IS DIVIDED INTO THREE CLASSES

(A) Hepaticopsida

(B) Anthocerotopsida

(C) Bryopsida or Musci

(A) Hepaticopsida : Liverworts



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

(ii) The liverworts usually grow in moist, shady habitat, such as banks of streams, marshy ground, damp soil, bark of tree and deep in woods.

(iii) Plant body is dorsiventral thalloid and closely appressed to the substrate. Rhizoids and scales are present on thallus. Rhizoids are unicellular and unbranched. Scales are multicellular.

(iv) The leafy members (eg ***Porella***) have tiny leaf like appendages in two rows on the stem like structures.

(v) 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*

(vi) The sporophyte of Liverworts is differentiated in **foot, seta** and **capsule**. (Exception - In ***Riccia*** **sporophyte is made up of** only capsule).

(vii) The sporophyte of Liverworts is **completely dependent** on gametophyte i.e. it is dependent on gametophyte for food, water and habitat.

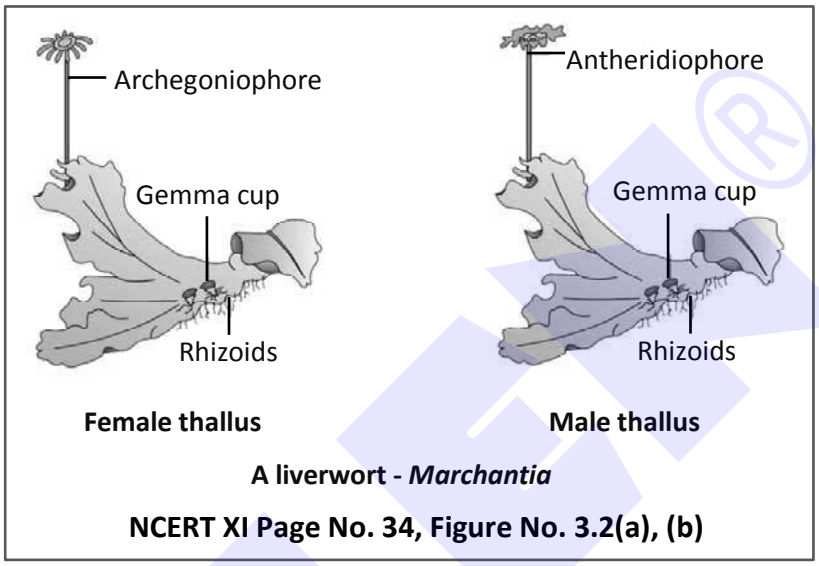
(viii) After meiosis spores are produced within the capsule.

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

e.g. of liverworts – *Riccia, Marchantia, Porella*

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

(2) During sexual reproduction male and female sex organs are produced either on same (eg. *Riccia*) or on different thallus **(e.g. *Marchantia*)**



Female thallus **Male thallus**

A liverwort - *Marchantia*

NCERT XI Page No. 34, Figure No. 3.2(a), (b)

(B) Anthocerotopsida : Horn worts

(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**.

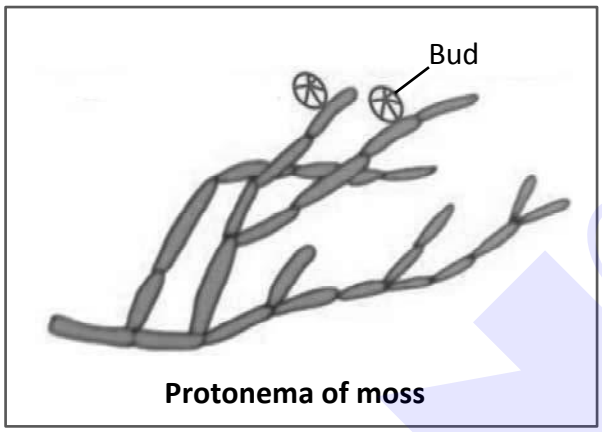
(iii) The sporophyte of Hornworts is not completely dependent on its gametophyte i.e. it is **partially depend** because its sporophyte becomes photosynthetic due to development of chlorenchyma in its capsule therefore it can manufacture its own food. Hence it does not depend on gametophyte for food, 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. *Notothylas, Anthoceros*

(C) Bryopsida : Mosses

(i) The predomiant phase of the life cycle of a moss is the gametophyte which consistst of two stages. The first stage is the protonema stage which directly develops from a spore.



Protonema of moss

- It is a creeping, green, branched and frequently filamentous stage.
- The second stage is the leafy stage which develops from the secondary protonema as a lateral bud.
- It consists of upright, slender axis bearing spirally arranged leaves.
- They are attach to the soil by multicellular and branched and oblique rhizoids.

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.

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

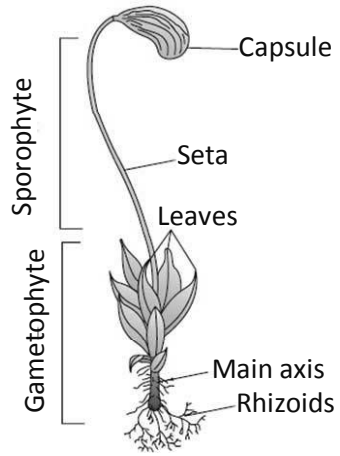
(iii) During sexual reproduction, sex organs are produced at the apex of the leafy shoots.

(iv) After fertilization, zygote develope into sporophyte. The sporophyte in mosses is **more elaborated (developed)** than that in liverworts. The sporophyte of moss is divided into foot, seta and capsule.

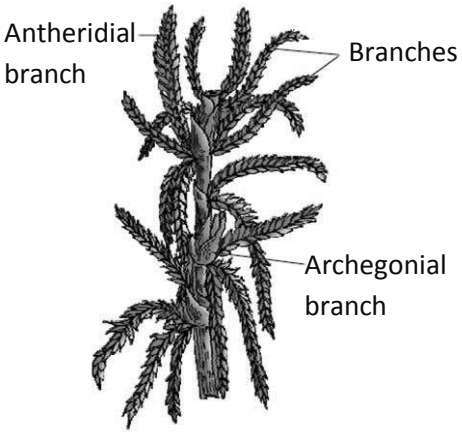
(v) The sporophyte of mosses is also **partially dependent** i.e. it is photosynthetic.

- The moses have an elaborate mechanism of spore disperal.

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



***Funaria,* gametophyte and sporophyte**



***Sphagnum* gametophyte**

Mosses

NCERT XI Page No. 34, Figure No. 3.2(c), (d)

Examples:

- ***Funaria*** - Rope moss
- ***Polytrichum*** - Hair cap moss
- ***Sphagnum*** -

– **Peat moss :** It is a fossil fuel that is obtained from bog. The formation of peat takes place by the fossilization of ***Sphagnum***, which 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 colonise 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

Pteridophytes are known as reptiles of plant kingdom.

i. Pteridophytes are also called as **vascular cryptogames**. Evolutionary Pteridophytes are first terrestrial plant possess **vascular tissues** i.e. xylem and phloem. In pteridophytes, vessels in xylem and companion cells in phloem are absent.

ii. Pteridophytes are used for medicinal purpose and as soil binders. They are also frequently grown as ornamentals.

iii. Pteridophytes are more adapted terrestrial plants as compared to bryophytes. Because -

- **Vascular tissue is present in pteridophytes.**
- They have roots.

iv. Pteridophytes are **not completely successful** terrestrial plants because they need water for fertilization, so pteridophytes grow in **cool, shady and moist places.**

v. Main plant body is sporophyte which is completely differentiated into **root**, **stem** and **leaves.**

- These organ possess well differentiated vascular tissue.
- The primary root remains alive for short period. After some time it is replaced by **adventitious** roots.
- Stem is erect or prostrate. When the stem is underground, it is known as **rhizome**.
- On the basis of leaves, pteridophytes are of two types –
- **First** in which stem is smaller, while leaves are large (Megaphylls). They are known as **megaphyllous** pteridophytes.
  eg. Ferns
- **Second**, in which stem is large and leaves are smaller (Microphylls). They are called as **microphyllous** pteridophytes.
  eg. Selaginella

LIFE CYCLE OF PTERIDOPHYTES :-

i. Plant is **sporophyte**. i.e. diploid and they reproduce by spore formation.

ii. In majority of the pteridophytes all the spores are of similar kinds, such plants are called homosporous.

Exception - Some pteridophytes produce two kinds of spores, macro and microspore, are known as **heterosporous**. e.g. *Selaginella, Salvinia*

iii. Formation of spores takes place in **sporangia**. Sporangia are formed at the abaxial surface of leaves.

iv. The sporophyte bears sporangia that are subtended by leaf like appandeges called sporophyll. 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.

In some cases sporophyll may form distinct compact structure called strobilli or cone.

Note :

In Pteridophyta, sporophylls are also photosynthetic. This is a unique character of Pteridophyta.

v. 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.

vi. In Pteridophyta, the germination of spores is **exosporic**.

vii. The spore germinates to give rise inconspicuous, small but multicellular, free living mostly photosynthetic, thalloid gametophyte called prothallus. 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**.

viii. 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

ix. In homosporus pteridophytes, gametophyte is **monoecious**.

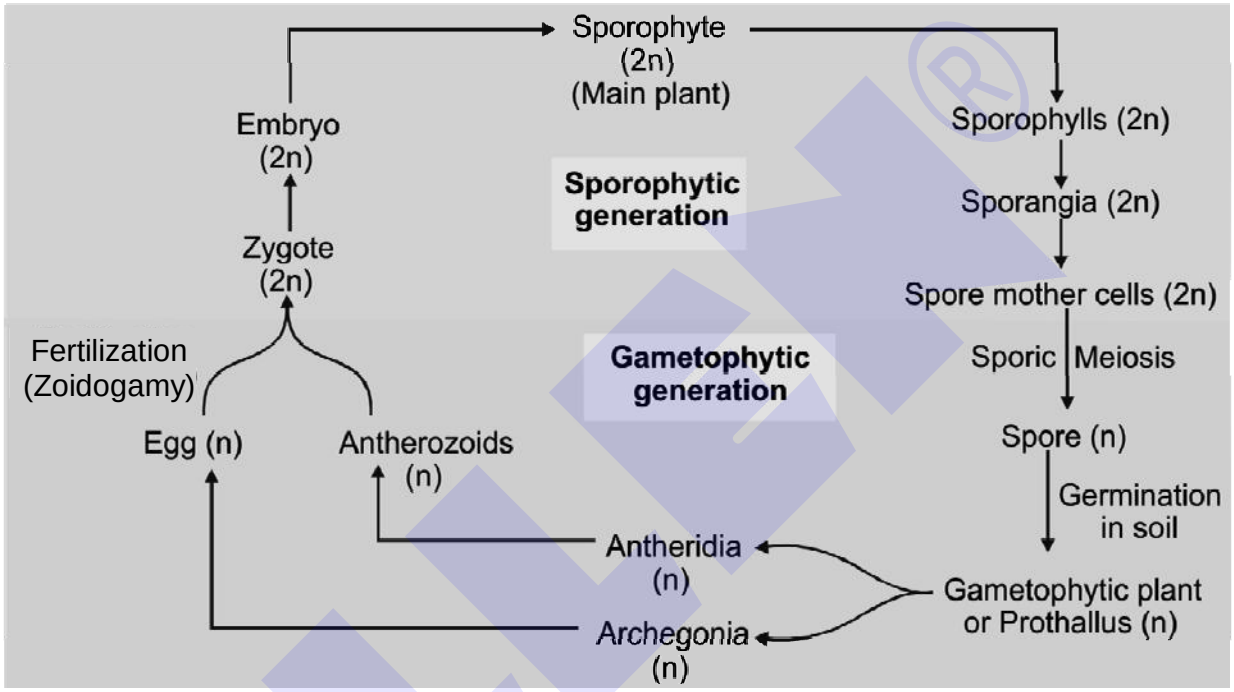
x. The gametophyte bears male and female sex organs called antheridium and archegonium, respectively.

- The formation of male gametes takes place in Antheridia which are called as antherozoids.
- **Antherozoids** are **spiral** and **multiflagellate** but exceptionaly antherozoids of *Selaginella* are spindle shaped and biflagellate.
- Egg is formed in archegonium.

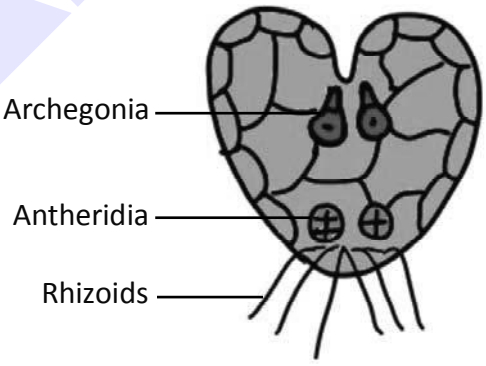
xi. Fertilization takes place by **zoidogamy** and fusion of male gamete with the egg resulting in formation of zygote. Zygote there after produces a multicellular, well differentiated sporophytes which is dominant phase of pteridophytes.

xii. Zygote develops and forms an **embryo**. Now this embryo develops and forms a **sporophytic plant** with **root, stem and leaves.**

- Type of sexual reproduction in Pteridophyta is **oogamous**.
- Their life cycle is **diplo-haplontic** type.
- The unique character of life cycle of Pteridophyte is - **Independent alternation of generation** i.e. sporophyte and gametophyte are independent of each other.



LIFE CYCLE OF PTERIDOPHYTES



VENTRAL SURFACE OF PROTHALLUS (GAMETOPHYTE)

HETEROSPORY IN PTERIDOPHYTES

Occurence of two types of spores, small (Microspores) and large (macrospore = Megaspore) is **heterospory**. A very few genera are heterosporous in pteridophytes e.g. ***Selaginella, Salvinia, Azolla, Marsilea***

- The megaspore and microspores germinate and give rise to female and male gametophytes, respectively.
- In these plants **microspores** form male gametophyte, male sex organ and male gametes which come **outside** the **microsporangium** but the megaspore forms female gametophyte, female sex organ and female gamete **inside** the **megasporangium** on the **parental sporophyte**.
- The female gametophyte in these plants are retained on the parent sporophyte for variable period.
- After the fertilisation the development of zygote into young embryo takes place within the female gametophyte. Embryo essentially comes outside the megasporangium, so **seed could not be formed** in Pteridophyta but the **heterospory** is found in them which is a very important **step in evolution** of **seed habit** in higher plants.
- 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**.

Note : (a) In some pteridophytes prothallus is saprophytic

(b) In heterosporus pteridophytes like *Selaginella* and *Salvinia* gametophytes are not called prothallus because it is very reduced.

Pteridophyta is divided into 4 classes

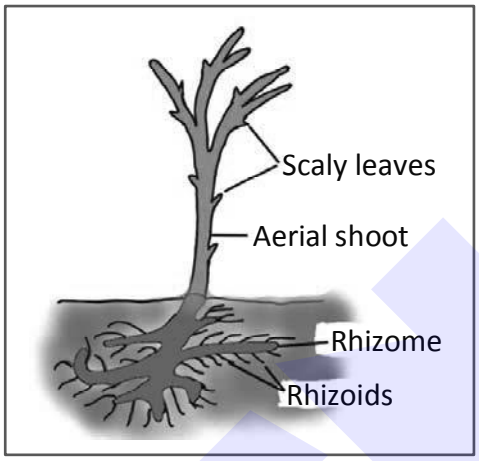
A. Psilopsida	**B. Lycopsida**	**C. Sphenopsida**	**D. Pteropsida**

(A) Psilopsida :

(i) This is the class of most primitive vascular plants and their plant body is differentiated into stem (rhizome), scaly leaves and rhizoids.

(ii) Only one living genus is present in this class - ***Psilotum*** → **A living fossil**

Rhynia → **Fossils**



(B) Lycopsida :

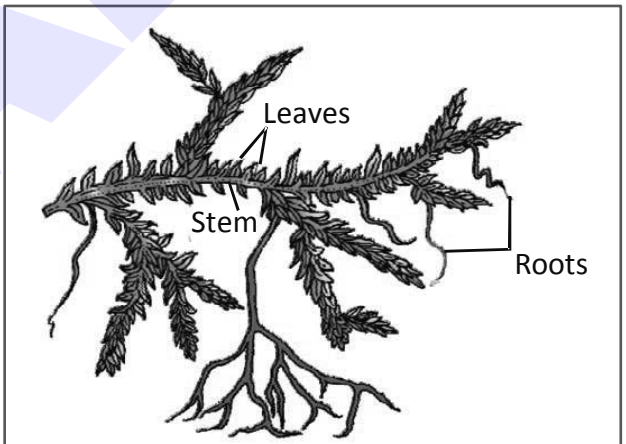
(i) Plants of this class are known as **Club moss**.

(ii) The plant body of club mosses is differentiated into **root, stem and leaves (microphylls)**.

(iii) **Sporangia** are formed on **sporophylls**. These sporophylls are spirally coiled and form a structure known as **strobilus** or **cone**.

e.g. ***Lycopodium*** - Used in making tonic in homeopathy.

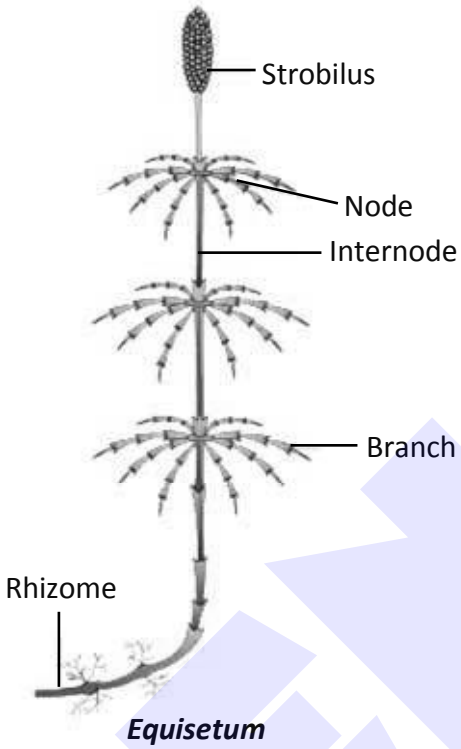
Selaginella



Selaginella

NCERT XI Page No. 37, Figure No. 3.3(a)

(C) Sphenopsida :



Equisetum

NCERT XI Page No. 37, Figure No. 3.3(b)

(i) In this class **Horse tails** are included.

(ii) The plant body of horse tails is differentiated into **root, stem** & **leaves**.

(iii) Their stem is jointed i.e. nodes and internodes are clearly seen on the stem. **Scaly** leaves are present on these **nodes**.

(iv) Cone is formed at the apical part of aerial stem.

eg. ***Equisetum***

(D) Pteropsida = Filicinae

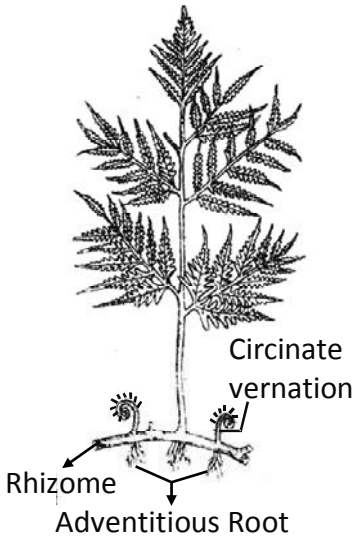
(i) This is the **largest group** of pteridophytes.

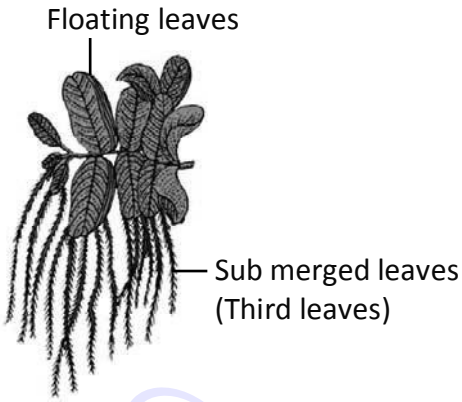
(ii) Plants included in this class are known as "ferns". Their body is made of root, stem, rhizome and leaves.

(iii) Ferns are **megaphyllous** (macrophyllous) i.e. stem is small and leaves are comparatively larger. They are pinnately compound and circinately coiled in young stage.

Fern

NCERT XI Page No. 37,
Figure No. 3.3(c)





Salvinia

NCERT XI Page No. 37,
Figure No. 3.3(d)

Example of Ferns :

Pteridium, *Pteris,* ***Marsilea,*** Dryopteris

Adiantum - **Walking fern** or **Maiden hair 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.

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

BGA, *Anabaena* is found with leaves of ***Azolla*** as symbiont and perform N_2 fixation and increase rice production in paddy fields.

Salvinia - Aquatic in nature

- In pteridophytes, ferns are very beautiful plants so they are grown in gardens for ornamental purposes.
- Pteridophytes are very good soil binding plants and some are used for medicinal purposes.
- In some **aquatic ferns** sporangia are formed in specialized bag like structures called **sporocarp**. e.g *Azolla, Marsilea.*

(4) GYMNOSPERM

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

(ii) Gymnosperms are very limited in distribution. They are mainly found in cold regions. In India, gymnosperms are found on the slope of Himaliayan mountains. As they grow in slopes of mountains so they have to face water scarcity, hence, most of the gymnosperms are **xerophyte**.

(iii) Main plant body (sporophyte) divided into roots, stem and leaves

Roots :

- 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 N_2-fixing cyanobacteria.
- In ***Cycas*** roots are of two types i.e. tap root and coralloid roots.

Stem :

- The stems are unbranched **(*Cycas*)** or branched **(*Pinus*, *Cedrus*).**

Leaves :

- 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.

(iv) Gymnosperm & Angiosperm are collectively included under spermatophyta i.e. seed bearing plants.

(v) All gymnosperms are vascular plants. Therefore vascular tissue are present i.e. xylem & phloem. Xylem lacks **vessels** & phloem lacks sieve tubes and **companion cells**.

Note :-

- Exceptionally in xylem of ***Gnetum, Ephedra, Welwitschia*** true vessels are present.
- Secondary growth takes place in gymnosperm stem, so it becomes woody.

(vi) Most of the gymnosperms are arborescent (woody). Gymnsperms include medium sized tree or tall tree and shrub.

eg. Ephedra

Some gymnosperms are liana or woody climbers.

eg. Gnetum ula

LIFE CYCLE OF GYMNOSPERM -

(i) The gymnosperms are heterosporous plants. They produce two kinds of haploid spores; microspores and megaspores within microsporangium and megasporangium, respectively.

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

(iii) The strobilli (sing. strobilus) bearing microsporophylls and microsporangia are called microsporangiate cones or male strobilli or **male cone**.

(iv) 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.

(v) The microspore develop into male gametophyte (pollen grain) 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)**.

(vi) The development of pollen grains take place within the microsporangium.

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

(viii) The male and female cones are borne 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**.

(ix) In gymnosperms the megasporangium is made of a diploid tissue also called nucellus. The nucellus is protected by envelops and the composite structure is called ovule or integument megasporangium. The ovules are borne on megasporophylls which may be clustered to form the female cone.

(x) The megaspore mother cell is differentiated from one of the cell of nucellus. The megaspore mother cell divide meiotically to produce four haploid megaspores. Three of them degenerate and only one **megaspore** remains functional.

(xi) The functional megaspore enclosed within the megasporangium developes into a multicellular female gametophyte (endosporic germination) also called **endosperm(n).**

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

(xiii) This multicellular female gametophyte is retained within megasporangium (ovule).

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

(xiv) 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.

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

(xvi) One male gamete fuses with female gamete and another male gamete degenerates. The fertilisation is performed. Following fertilization zygote develops into embryo and the ovules into seeds.

(xvii) Now fertilized ovule having embryo is called seed.

(xviii) These seed are not covered with ovary wall or fruit wall so they are called **naked seeds**.

(xix) Means in gymnosperms seeds are formed but ovary or fruits are not formed, so they are called as naked seeded plants.

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

- **Pollinated pollens are stored in pollen chamber of ovule.**

FERTILIZATION

In gymnosperms fertilization is by the process of siphonogamy (siphonogamy = Male gametes are non motile and formation of pollen tube)

In both angiosperms and gymnosperms siphonogamy is present so (Gymnosperm + Angiosperm = Siphonogamous plants)

Fertilization is of two types

(i) **Zoido - siphonogamy -** This type of fertilization occurs in lower gymnosperms. Male gametes are motile in lower gymnosperms.

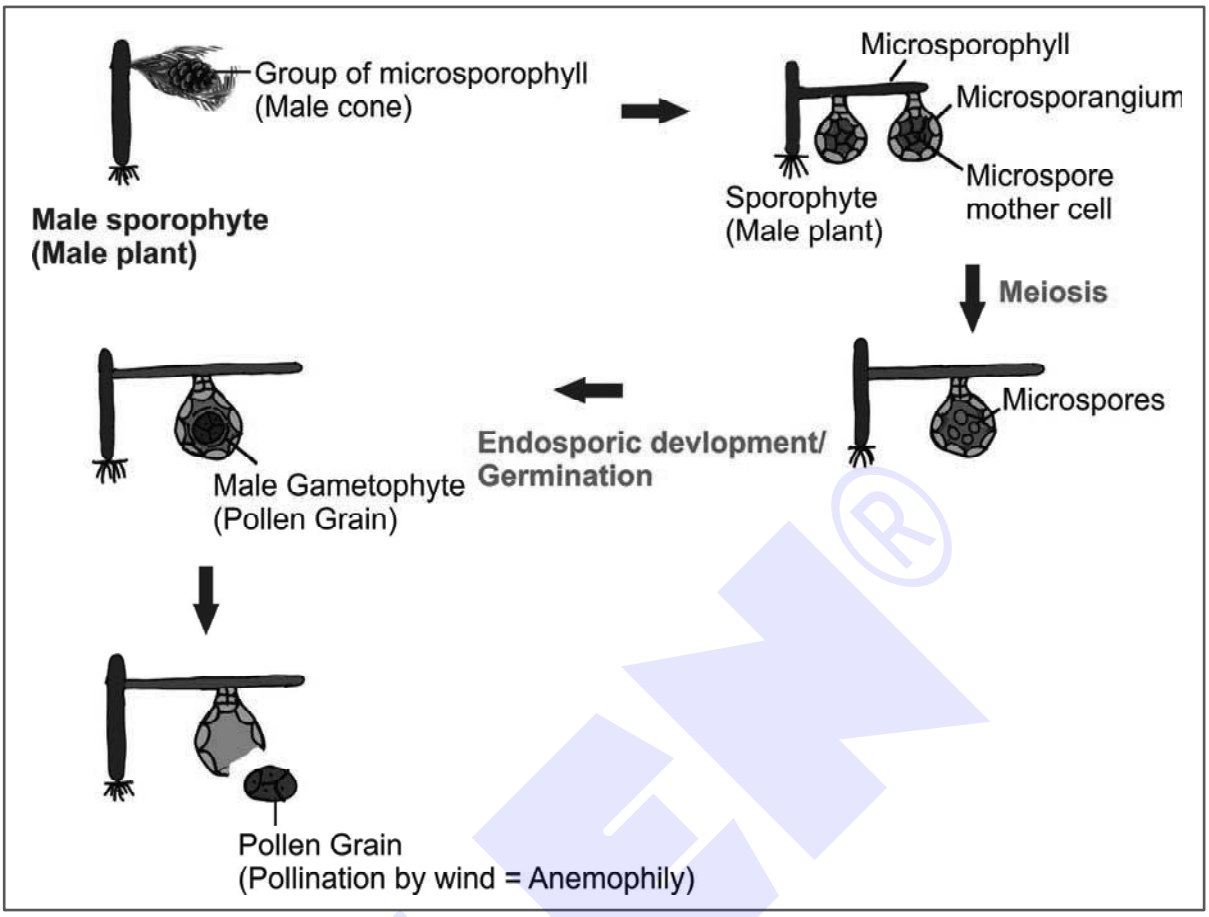
(ii) **Siphonogamy -** This type of fertilization is found in higher gymnosperms. Male gamete is non motile in higher gymnosperm. Male gamete reaches the **egg** with the help of pollen tube.

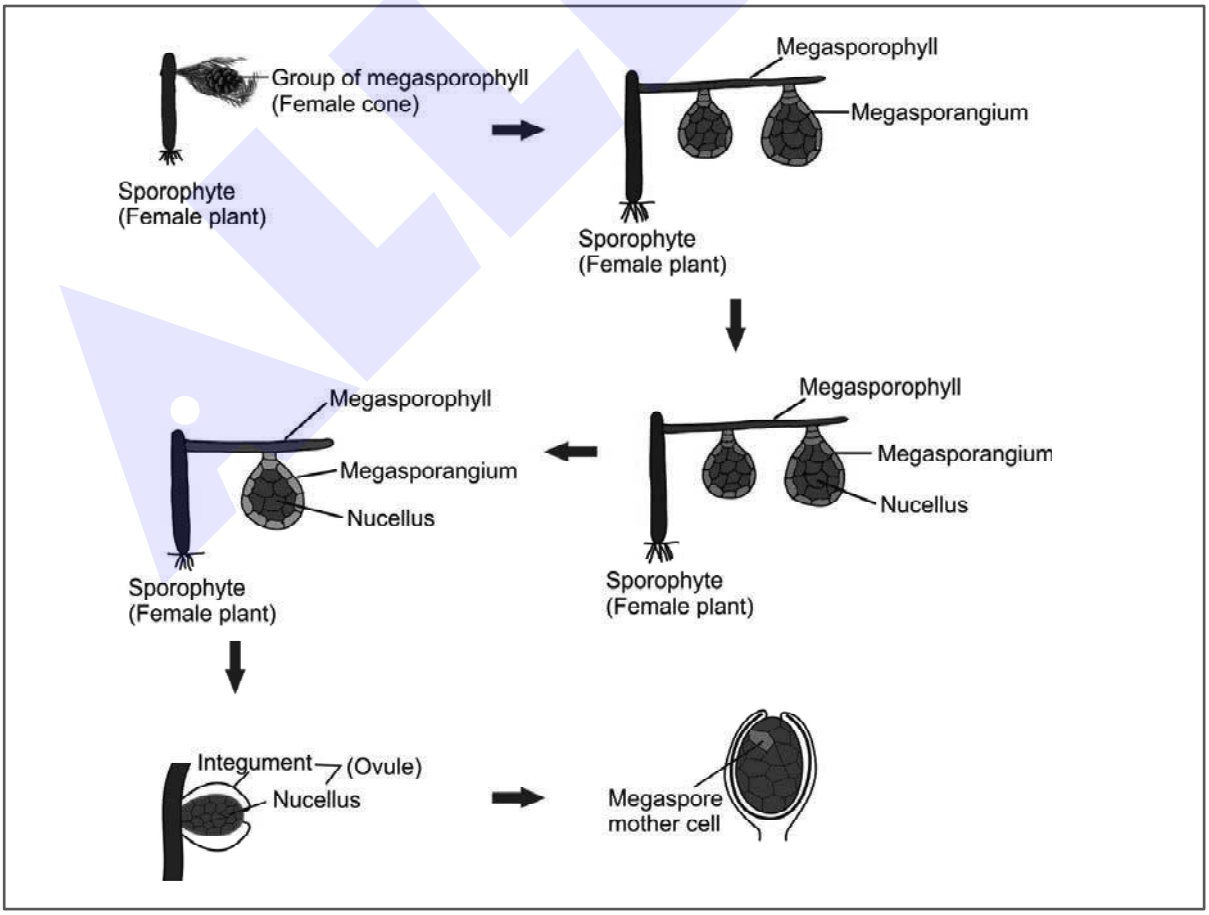
After pollination male gamete fuses with the egg, as a result of which a diploid zygote is formed.

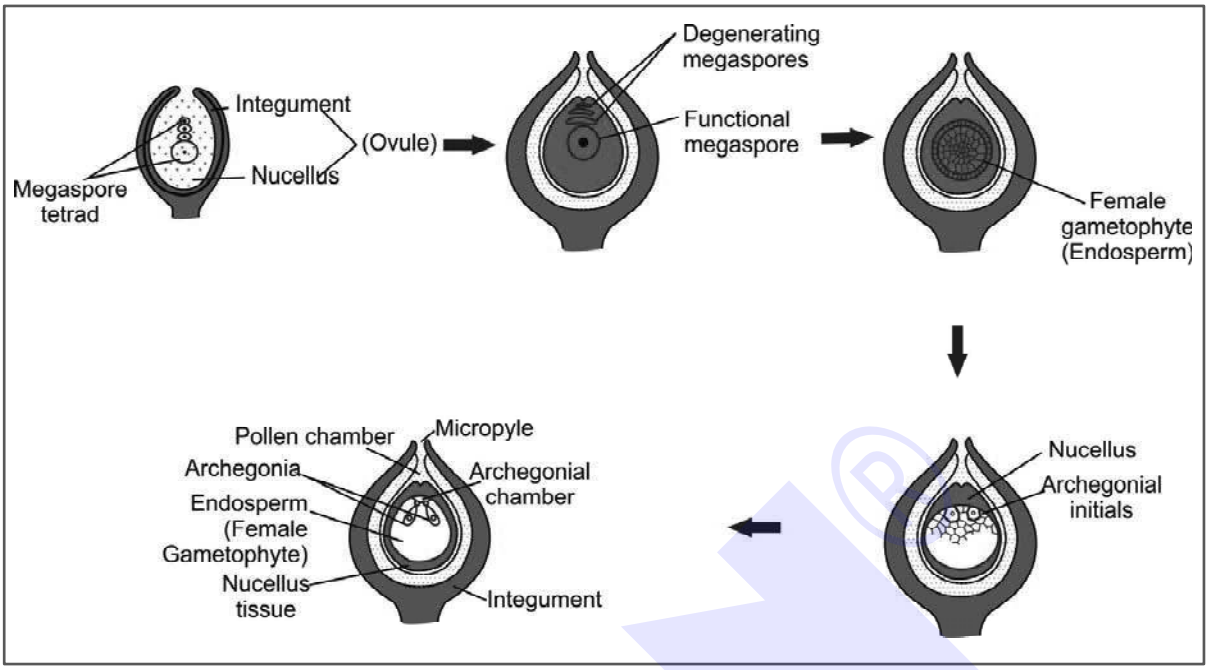
Note :- Polyembryony is commonly found in gymnosperms i.e. occurrence of **more than one embryos** with in seed.

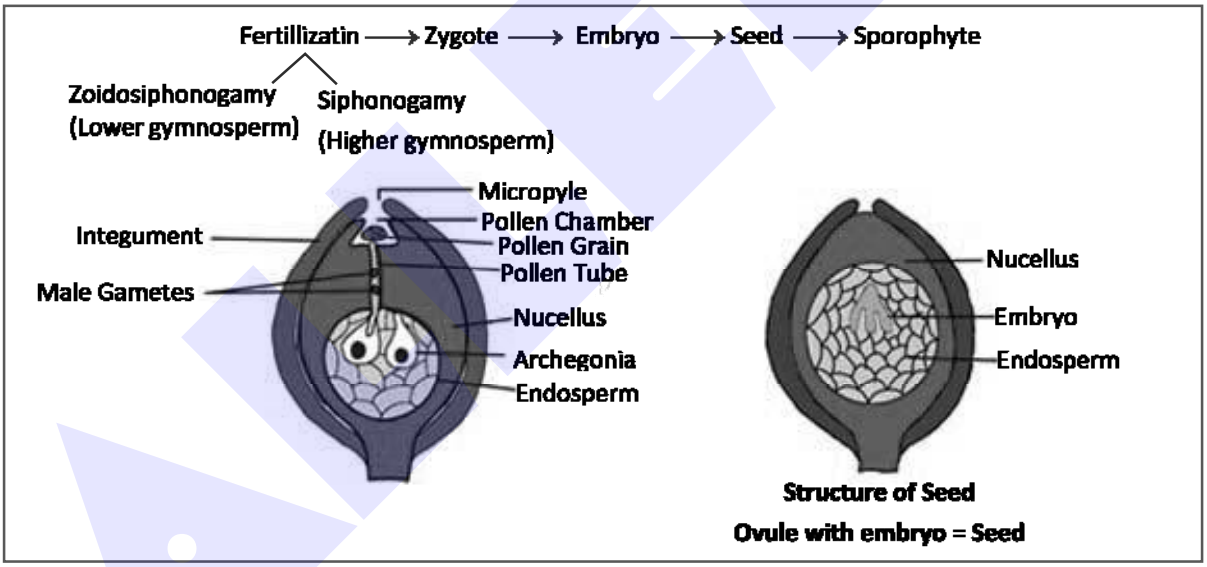
LIFE CYCLE :

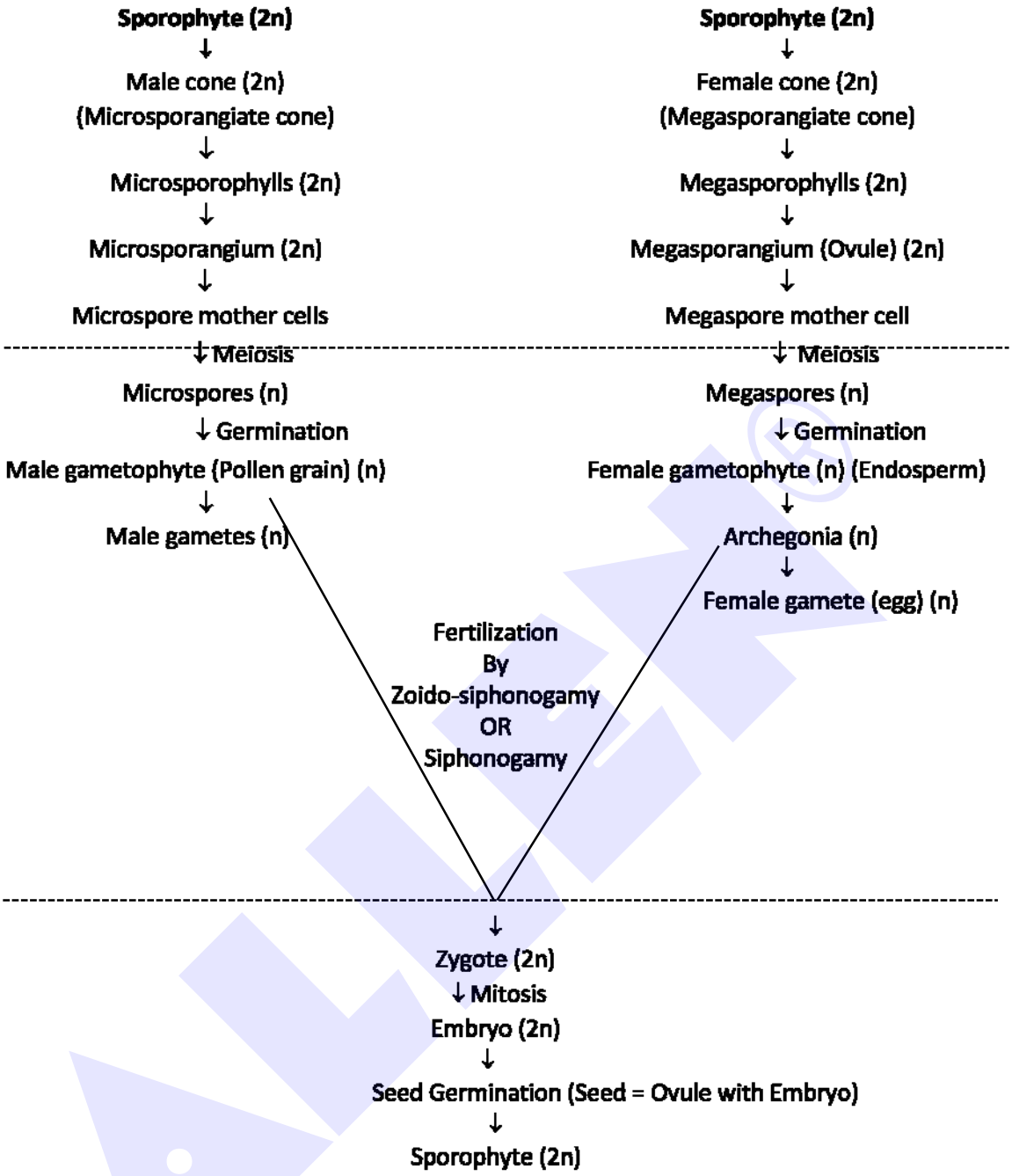
Life cycle of Gymnosperm & Angiosperm is diplontic because gametophytic generation is short lived. Gametophyte is very reduced & depends on sporophyte.


Group of microsporophyll
(Male cone)
Male sporophyte
(Male plant)
Microsporophyll
Microsporangium
Microspore
mother cell
Sporophyte
(Male plant)
Meiosis
Microspores
Endosporic devlopment/
Germination
Male Gametophyte
(Pollen Grain)
Pollen Grain
(Pollination by wind = Anemophily)


Group of megasporophyll
(Female cone)
Sporophyte
(Female plant)
Megasporophyll
Megasporangium
Sporophyte
(Female plant)
Megasporophyll
Megasporangium
Nucellus
Sporophyte
(Female plant)
Megasporophyll
Megasporangium
Nucellus
Sporophyte
(Female plant)
Integument
(Ovule)
Nucellus
Megaspore
mother cell


Integument
(Ovule)
Nucellus
Megaspore tetrad
Degenerating megaspores
Functional megaspore
Female gametophyte (Endosperm)
Nucellus
Archegonial initials
Pollen chamber
Micropyle
Archegonia
Archegonial chamber
Endosperm (Female Gametophyte)
Nucellus tissue
Integument


Fertillizatin → Zygote → Embryo → Seed → Sporophyte
Zoidosiphonogamy (Lower gymnosperm)
Siphonogamy (Higher gymnosperm)
Micropyle
Pollen Chamber
Pollen Grain
Pollen Tube
Integument
Male Gametes
Nucellus
Archegonia
Endosperm
Nucellus
Embryo
Endosperm
Structure of Seed
Ovule with embryo = Seed



LIFE CYCLE OF GYMNOSPERM

Gymnosperms are divided into two groups

(A) Cycadophyta (Lower Gymnosperm)

(B) Coniferophyta (Higher Gymnosperm)

(A) Cycadophyta :- (Class : Cycadopsida)

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

(a) Male gamete is motile.

Cycadophyta is divided into three orders

(i) Cycadofillicales or Pteridospermae :-

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

(ii) Benettitales :-

It is also a completely extinct group.

(iii) Cycadales -

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

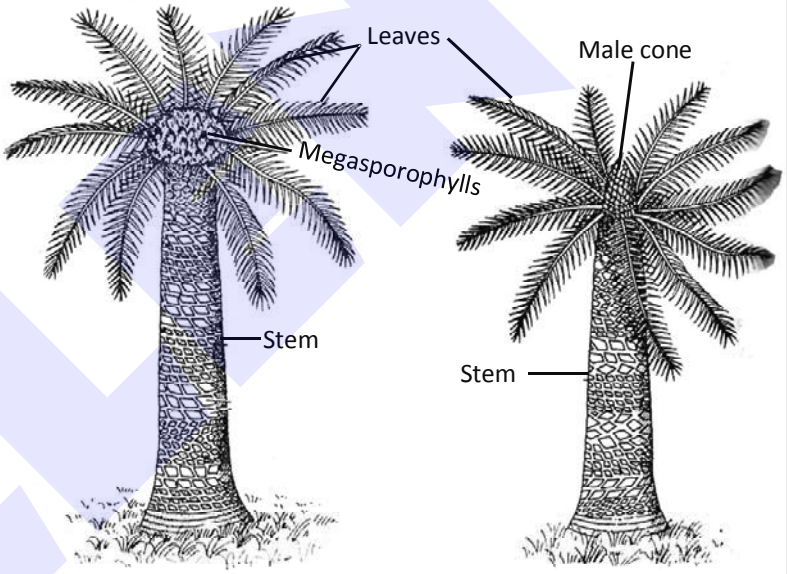
(b) All the plants of this group are living fossils.

- ***Cycas***

- Ovule, egg, male gametes and male cone of *Cycas* are largest in plant kingdom.
- In embryo of *Cycas* two cotyledons are present.
- **In *Cycas* female cone is absent.**
- In ***Cycas*** male gametes are motile, multiciliated and top shaped.

Cycas

NCERT XI Page No. 39,
Figure No. 3.4 (a)



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

CONIFEROPHYTA

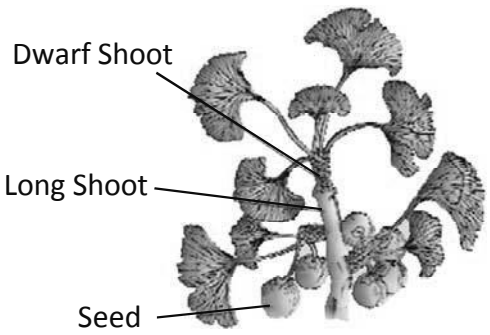
Four orders are included in this group

(i) Ginkgoales :-

It is the oldest order of coniferophyta.

eg. ***Ginkgo biloba*** **-** living fossil.

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



Ginkgo

NCERT XI Page No. 39
Figure No. 3.4 (c)

(ii) Cordaitales :-

(a) It is completely extinct group

(iii) Coniferales :-

(a) Conifers are included in this group.

(b) It is the largest group of gymnosperm

Examples of Coniferales -

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

(b) ***Cedrus*** – It is known as deodar.

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

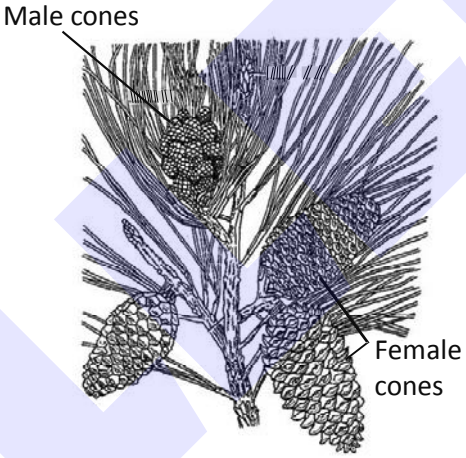
(d) ***Araucaria*** – It is known as Christmas tree.

(e) ***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.

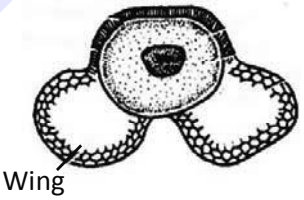
(f) ***Metasequoia*** – It is a living fossil.

Pinus

NCERT XI Page No. 39, Figure No. 3.4 (b)



***Pinus* [Monoecious plant]**



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

(iv) Gnetales -

(a) They are the most advanced gymnosperms.

(b) Exceptionally members of this group have vessels in xylem.

(c) Archegonia are absent in 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 are 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

- Bryophytes are amphibians of the plant kingdom because these plants can live in soil but are dependent on water for fertilization.
- In Bryophyta the sporophyte is depend on gametophyte.
- Most developed gametophyte in kingdom plantae is found in mosses.
- Mosses along with lichens are the first organisms to colonise rocks hence are of great ecological importance.
- Pteridophytes are vascular cryptogams.
- Prothallus is independent and mostly photosynthetic gametophyte.
- *Selaginella, Salvinia, Marsilea* and *Azolla* are heterosporous pteridophytes, which show precursor of seed habit.
- Gametophyte is monoecious in homosporous pteridophytes.
- The ovules are not enclosed by ovary wall and remain exposed, both before and after fertilization in gymnosperms.
- Integumented megasporangium is called ovule.
- In gymnosperms single fertilization takes place so only zygote is formed through fertilization.
- Pollen grains and seeds are winged in *Pinus*.
- *Ephedra* and *Taxus* are medicinal gymnosperms.
- **Zoidogamy :-** The process of sexual reproduction or fertilisation in which male gamete is motile means have flagella or cilia, so water is must for fertilisation. Such plants which perform **Zoidogamy** are known as **zoidogamous plants.** They are **Thallophyta (algae), Bryophyta** and **Pteridophyta.**
- **Siphonogamy :-** The process of sexual reproduction or fertilisation in which male gametes are not motile means they do not have flagella or cilia, so water is not required for this process. In siphonogamy pollen tube is responsible for carrying male gametes upto female gametes. Such plants which perform siphonogamy are known as **siphonogamous plants.** They are **gymnosperms** and **angiosperms.**

BEGINNER'S BOX

BRYOPHYTA, PTERIDOPHYTA AND GYMNOSPERM

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

2. The sporophyte of mosses is :-
(1) Parasite (2) Semi-parasite
(3) Free living (4) Most advanced

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

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

5. 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

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

7. 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

8. Roots, stem and leaves, constitute the plant body of :-
(1) Pteridophytes (2) Gymnosperms
(3) Angiosperms (4) All of these

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

10. In gymnosperms gamelophyte are :-
(1) Monoecious (2) Dioecious
(3) Heterosporous (4) Homosporous

Botanical Gardens and 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 and museum 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, Howarh (Sibpur), Kolkata. Established by Robert Kyd, 1786.

- The 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.
- Indian Botanical Garden also harbours the Botanical Survey of India (BSI) which was established by William Rouxburgh (1890).
- **BSI** 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) Lloyd Botanical Garden – Darjeeling.

(8) **CDRI** - Central Drug Research Institute - Lucknow

(9) **CAZRI** - Central Arid Zone Research Institute - Jodhpur

(10) **IARI** - Indian Agriculture Research Institute (Pusa Institute) - New Delhi

(11) Birbal Sahani Institute. of Paleobotany (National Institute of paleobotany) - Lucknow

Paleobotany is study of fossil plants.

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 commercialised as blood-cholestrol lowering agent.
5. *Aspergillus niger* is used to obtain citric acid.

ESSENCE

Kingdom Plantae
(Multicellular, eukaryotic, autotrophic, cellulosic cell walled organisms)

Algae
- Multicellular thalloid
- Photosynthetic thallophyte
- Unicellular sex organs
- Isogamy (*Spirogyra, Chlamydomonas*) anisogamy (*Eudorina*) and oogamy (*Volvox, Fucus*) can occur in algae
- Zygotic meiosis
- Embryo formation absent

Bryophyta
- First land plants
- Amphibians of plant kingdom
- Non vascular embryophytes
- Dorsiventral thalloid or leafy gametophytes
- True leaf, true stem and true roots are absent
- Sporophytes depends on gametophytes

Pteridophyta
- First true land plants
- Reptiles of plant kingdom (Botanical snakes)
- Vascular cryptogams
- Main plant body sporophyte having true roots, true leaves and true stem
- Sporophytes and gametophytes both are independent to each other
- Usually homosporous

Gymnosperms
- Naked seeded plants
- Ovules are not covered by ovary wall before and after fertilization
- First spermatophytes or first seeded plants on earth
- First completely successful plants on earth
- Male and female gametophytes are reduced and do not have independent existence
- Pollination occurs by air currents
- Endosperm is haploid and formed before fertilization
- Gametophytes depend on sporophytes

Angiosperms
- Flowering plants

Classes and Common Name	Cell Wall	Pigments	Stored Food
Cholorophyceae (Green algae)	Pectin and cellulose	Chl. a and b	Starch
Phaeophyceae (Brown algae)	Cellulose and algin	Chl. a and c	Mannitol and Laminarin
Rhodophyceae (Red algae)	Cellulose, pectin and poly sulphate ester	Chl. a and d	Floridean starch

	Hepaticopsida (Liverwort)	Anthecerotopsida (Hornwort)	Bryopsida (Moss)
Plant body (Gametophyte)	Dorsiventral thalloid	Dorsiventral thalloid	First stage : Protonema Second stage : Leafy gametophytes
Rhizoids	Unicellular and unbranched	Unicellular and unbranched	Multicellular branched
Asexual or vegetative reproduction	Fragmentation, Gemmae formation	Fragmentation	Fragmentation of protonema Bud present on secondary protonema
Sporophyte	Foot, seta and capsule, Completely dependent on gametophytes	Foot and capsule, Partially dependent on gametophytes	Foot seta and capsule Partially dependant on gametophytes

- Most developed gametophytes : Bryophyta
- Most reduced sporophytic generation : Algae
- Most developed sporophytic generation: Angiosperms
- Most reduced gametophytes : Angiosperms
- Group of archegoniate : Bryophytes, pteridophytes and gymnosperms
- Antheridium is present in algae, bryophytes and pteridophytes
- Water is required for fertilization in cryptogames
- Siphonogamy is present in spermatophytes

Pteriodophytes classified into four classes :

1. Psilopsida e.g. *Psilotum*
2. Lycopsida e.g. *Selaginella, Lycopodium*
3. Sphenopsida e.g. *Equisetum*
4. Pteropsida e.g. *Dryopteris, Pteris, Adiantum*

BEGINNER'S BOX — ANSWERS KEY

THE LIVING WORLD TO CLASSIFICATION

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	**2**	**2**	**4**	**1**	**2**	**4**	**2**	**2**	**3**	**1**

TAXONOMIC CATEGORIES TO CARL WOESE

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	**4**	**1**	**2**	**2**	**2**	**3**	**4**	**3**	**1**	**1**

KINGDOM MONERA

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	**3**	**2**	**2**	**4**	**2**	**2**	**3**	**3**	**3**	**1**

KINGDOM PROTISTA & FUNGI

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13
Ans.	**4**	**1**	**2**	**1**	**1**	**4**	**2**	**1**	**1**	**1**	**4**	**3**	**1**

VIRUS, LICHEN, MYCORRHIZA AND ALGAE

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	**2**	**3**	**2**	**1**	**1**	**3**	**4**	**3**	**3**	**2**

BRYOPHYTA, PTERIDOPHYTA AND GYMNOSPERM

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	**2**	**2**	**2**	**3**	**2**	**3**	**1**	**4**	**4**	**2**