INFORMOSOME

Volume I

A Compendium cum E-Proceedings

of Departmental Seminars given

By the students of UG, Botany Honours.

An initiative of the Department of Botany (UG and PG)

Hooghly Mohsin college, Chinsurah, Hooghly, West Bengal, India


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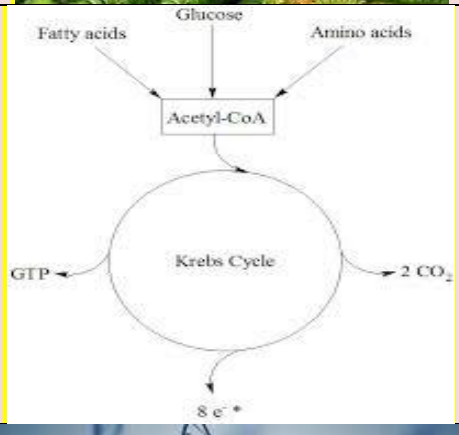
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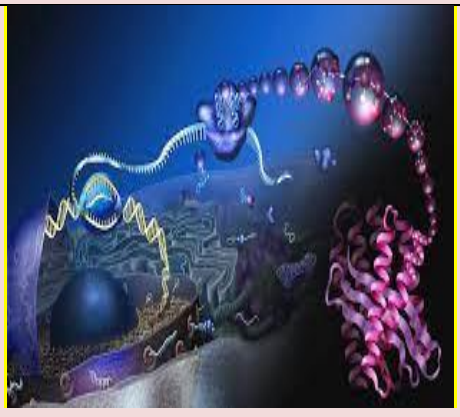

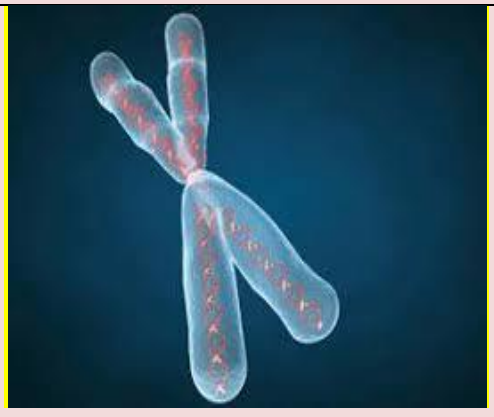

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Date: 26/08/2021

From:

The Head (HOD)

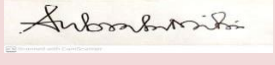
The PG Department of Botany,

Hooghly Mohsin College, Chuchura, Hooghly.

It is really an event of exhilaration that Botany Department of Hooghly Mohsin College is going to release students seminar volume 'INFORMOSOME'.

Students' seminars provide an opportunity to give expression of their ideas and vision and display their creativity and imagination and develop them to their full potential. Young students are thus equipped enough to meet the challenges of life in a mature and effective way. I am sure that under the guidance of teachers and overall supervision; provide students a platform for maturing their literary talents.

I extend my best wishes to the students' community and hope that this seminar volume will be a shining record of the achievements of the students and teachers and inspire all to a greater heights.



Dr.SUBRATA MITRA, ASSOCIATE PROF. AND HEAD, UNDER GRADUATE AND POST GRADUATE DEPT. OF BOTANY,HOOGHLY MOHSIN COLLEGE. CHUCHURA, HOOGHLY

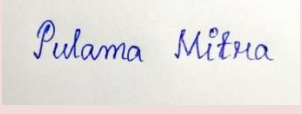
Note from Assistant Editors desk: -

The topics covered in this eBook include various aspects in the field of Botany. The students have carried out the work on topics which include classical as well as applied portions of Botany. The classical portions of this field include topics such as the types of venation in leaf, structure of gynoecium in flowers, various fungi (such as *Ascobolus, Agaricus)* and many others. On the other hand topics covering the applied portions include structure of DNA, experiments proving DNA to be the genetic material, structure of nucleosome and chromatin, gene mutations etc. Topics on practical aspects of life such as the impact of Covid-19, defense system of the Sunderbans against natural calamities have also been covered in this eBook.

While going through their papers we realized that they have researched a lot on the particular topics and thus they have provided a lot of information. Many of the students have gone through the core portions of their respective topics in order to complete this research work. Several links and references of the respective texts as well as the pictures have been provided. These links provide a broad field of gaining knowledge in various aspects as they lead to a vast source of information. These links as well as the sub-links present in each site have also enriched our knowledge. Topics which are of main concern in today's life have been discussed in this eBook. Pictorial representations, diagrams, graphs have also been added for the better understanding of their particular topic. The methods of representation of all the individual students are quite elucidative. While reviewing their papers we also enhanced our knowledge and came across several new facts and discoveries that we were not aware of.

The students have done a great job on their part. From the very inception of their student hood in the department they have been working hard and they are emotionally quite attached with this project. I wish them every success in all their future endeavors.

(ARKA DEY, 3rd year, Assistant Editor)



(PULAMA MITRA, 3rd year, Assistant Editor)

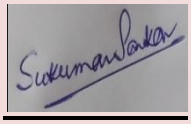
A note from Associate Editors' Desk

It gives us an immense pleasure to announce that the department of Botany, Hooghly Mohsin College, boasts of a bunch of budding botanists who are really enthusiastic in showcasing their prowess and mettle in delivering and writing some very interesting research papers on the very onset of their inception in this department. The students are our pride and their honest endeavours has culminated in shaping this E-seminar Proceeding-cum-scientific dossier that highlights some varied and updated knowledge about the myriad aspects of Plant Science. All the departmental professors have given their valuable inputs into shaping up the inquisitive minds of our students, without whose help and active support the whole episode would have been a mess.

The students have tried to showcase their enthusiasm in selecting their topic, and reading and writing the manuscripts and delivering their seminar talks that entailed their genuine hard work. We have encouraged the First Year (2^{nd} semester) UG students to concentrate on the core and fundamental topics of Botany and give their utmost sincerity to prove their foundation and knowledge. The 2^{nd} year (4^{th} Semester) students have chosen a wide array of topics which included cell biology; Orchid biology and fundamental molecular biology, which they have conceptualized from their syllabus. But they have taken a wonderful venture to explore the insights of the topics chosen, and they were ultimately able to come up with wonderful papers. The final semester students (Semester VI) were extremely prudent in choosing the topics for paper writing. They exploration ranges from the world of plant genetics and breeding to Plant biotechnology to environmental Biotechnology. Their outreaches have really been well documented, thoroughly researched and scientifically represented.

We could see that our encouragement and support induced the scientific temperament of literature searching, data collection, documentation vis- a- vis content writing with scientific explanations and comments in our students against the backdrop of the toughest days of Covid pandemic. I feel our efforts that we are able to take the appropriate steps in this regard, which has been extremely successful.

We wish them all-round success in their future academic life.



Dr. Manashi Aditya, (Assistant Professor, Associate Editor, Informosome),

Dr. Sukumar Sarkar (Associate Professor, Associate Editor, Informosome)

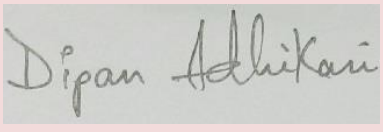
From Editor-in-Chief's Desk:

Knowledge is power and information is the foundation of knowledge. In the toughest hours of Covid pandemic, when the normal life came to a standstill, the Department of Botany, Hooghly Mohsin College had been engaged in an episode of constant academic care and encouragement for all the students of this department to cater to them in the utmost way possible. In this event of online activities, the department had organized students' seminars and encouraged them to utilize the challenge of writing scientific paper. The department is indebted to Dr. Debobrata Mukhopadhyay (Ex-HOD) of the department in this context, who constantly encouraged and created an atmosphere of motivation among all the departmental staffs and the students to excel in a better way. This constant encouragement and interactions had yielded this result in the shape of this ebook cum seminar proceedings for the first time in the history of this department. All the departmental staff members were cordial and energetic to reap this fruit.

While editing the scientific writing of the students, what I could envisage that the students are highly motivated and technologically savvy in preparing their research articles. They have done sound research and literature reviewing to choose the topics, data collection and content development. What is also a point of great delight that all of them followed the finer nuances of scientific paper writing at this very tender age as undergraduate students. The choice of topic and content developments were delightful and engrossing to read. I have enjoyed a lot reading these write-ups.

We, the teachers of this department, are the stakeholders of the emotional content development of our students apart from helping them in their regular academic pursuits. I strongly feel all the departmental teachers are whole-heartedly devoted to quenching their thirst for knowledge and developing their scientific acumen. This has been nicely reflected in their deliverance of seminar lecture and paper writing.

I wish them all-round development of their scientific career in the coming years.



(Dr. Dipan Adhikari, Assistant Professor and Editor-in-Chief, Informosome, the e-book)

Table of contents

Paper-I

LEAF VENETATION

NAME : ARITRI DUTTA

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ABSTRACT

An arrangement or system of veins and veinlets (as in the tissue of a leaf) is called venation.

Venation is of two types- i) Reticulate venation ii) Parallel venation. In some leaves the veins and veinlets are irregularly distributed over the entire lamina, forming a network and such leaves are said to have Reticulate venation. In some leaves the veins and veinlets run parallel to each other and such leave are said to have parallel venation. Reticulate venation is of two types – i) Unicostate or Pinnate venation ii) Multicostate or Palmate venation. Multicostate venation is of two types- a) Convergent type b) Divergent type. Parallel venation or striate venation, similarly, may be unicostate or multicostate.

INTRODUCTION

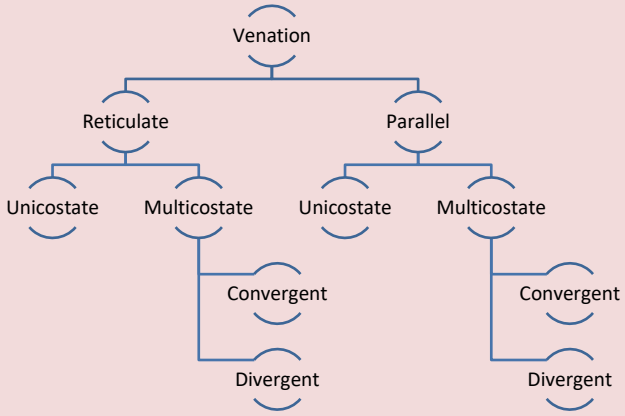
The fibro vascular tissue system supplying a leaf reaches the base of the lamina through the petiole and from this point it branches out or ramifies according to certain patterns. The ramifications are called veins and their arrangement is known as venation. The conducting and mechanical tissues of the vascular system circulate water and other raw material such as prepared food throughout the leaf and at the same time give mechanical rigidity to the leaf. The veins, therefore, serve as a circulatory system as well as the skeleton of the leaf. Venation is very clear on the lower surface of thin leaves.

Venation follows certain basic patterns. In lower plants like pteridophytes, the branching of the veins is dichotomous. The angiosperm leaf shows two principal types of venations. In the first type reticulate venation is characteristic of dicotyledonous leaf excepting a few like ***Calophyllum inophyllum.*** Generally, monocots show parallel venation excepts ***Colocasia esculenta, Smilax zeylanica.*** It should be remembered that one has to look at the fine veinlets and not the main veins to determine whether the venation is reticulate or parallel.

VENATION

DEFINITION-

The pattern of arrangement of veins and veinlets on the leaf lamina is called VENATION.



Generally dicot shows reticulate venation. (Except- *Calophylluminophyllum),* Generally monocot shows parallel venation (except – *Smilax zeylanica),* HAIT BHATTACHARYA GHOSH

1) Reticulate Venation-

When the main axis divides into various branches it forms a net like structure in the lamina, it is called reticulate venation.

It is of two types –

i) Unicostate or Pinnate:

Figure - Unicostate reticulate venation

Source – Google

There is only mid vein in the center of lamina. The mid vein gives out branches on two lateral sides like feather and those ultimately anatomize by veinlets forming a network. E.g.- *Mangifera indica.*

HAIT BHATTACHARYA GHOSH

ii) Multicostate or Palmate:In this type many mid veins develop from the tip of the petiole and progress towards the upper side of lamina.
It is of two types-

a) **Convergent type –**

Figure - Convergent multicostate venation

Source - Google

When the prominent veins spread out from the base and again converge towards the tip of the lamina. E.g. *Cinnamomum tamala.*

After GANGULY, DAS & DUTTA

Here all the mid veins, after developing from the basal region, spread at different direction. E.g.- *Cucurbita maxima.*

HAIT BHATTACHARYA GHOSH

Convergent multicostate venation

Source - Google

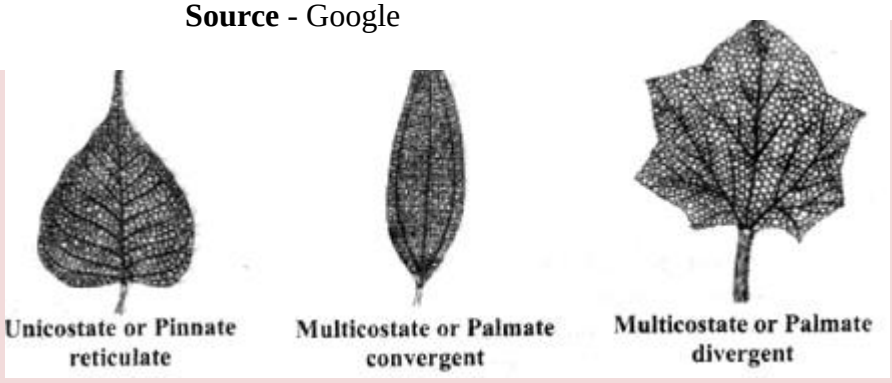


Figure - Diagrammatic view of different types of reticulate venation

Source - Google

2)Parallel or Striate: Here all veins run parallel to each other, either from the base to the apex of the lamina or at right angles to the mid-rib. They don't form any network.

It is also divided into two types-

a) **Unicostate or Pinnate-**

Figure - Parallel unicostate venation

Source - Google

In this type there is only one mid vein in the center of lamina. The mid vein gives out branches on two lateral sides perpendicular to the midrib. The branches run parallel to each other towards the margin or apex of lamina.

E.g.- *Musa paradisiaca*

b) **Multicostate or palmate-**

In this case there is more than one prominent rib which arise from the base of the leaf blade and secondary veins i.e., veinlets are formed transversely in parallel manner.

After MITRA, MITRA, CHAUDHURI-

It is of two kinds-

a) Convergent type-

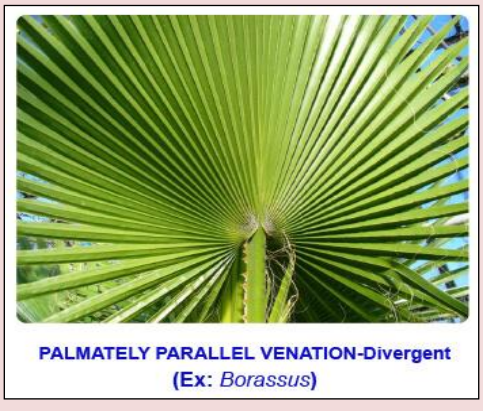
Figure - Convergent multicostate venation
Source - Google

Here all the mid-veins run parallel to each other from base and united at the apex.

E.g.- *Bambusa tulda*

After HAIT BHATTACHRYA GHOSH-

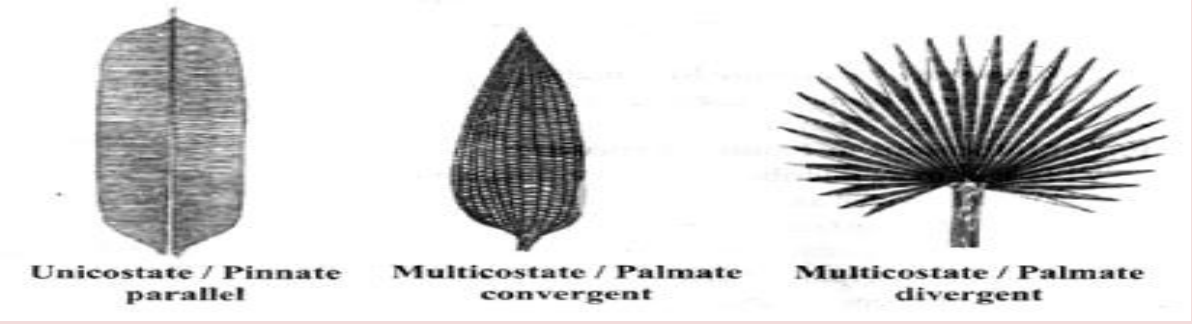
b) Divergent type-



Source - Google

Here all the mid-veins after originating from the apex of the petiole, spread towards the periphery away from each other. E.g.- *Borassus flabellifer*

After HAIT BHATTACHRYA GHOSH



Source - Google

CONCLUSION

"VENATION" provide physical assistance to the leaves. It helps the blades in maintaining their shape and structure during their lifetime. Leaves can coordinate with other parts of a plant due to the presence of venation. Also, it protects a blade as a whole. Venation also helps in carrying the required nutrients to the leaves, which, in turn, helps them to grow. This also leads to the overall development of the blade. This helps in identifying a specific plant by looking at the formation of veins. Out of all types of venations, parallel venation is advance type of venation.

ACKNOWLEDGEMENT

I would like to express my special thanks of Gratitude to my respected professors of Botany Deparment of Hooghly Mohsin College to give me golden opportunity to do this presentation. I came to know about so many things I am really thankful to them. I would also like to extend my gratitude to the HOD of Botany Department of Hooghly Mohsin College **"Dr. Debabrata Mukhopadhyay**" and many other associate professors Dr. Samir Kumar Pal, Dr. Subrata Mitra and some respected seniors for providing me with all facilities that were required.

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Paper II

TYPES OF LEAVES ON THE BASIS OF INCISION OF LAMINA

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ABSTRACT

Leaves are usually the expanded, dissimilar, lateral members of stem and branches with limited growth. They are exogenous in origin and bear buds in their axis. They develop on stem or branches in acropetal order. The variation of characteristics that has been noted in response to the variation of environment serves different functions.

Leaves on the basis of incision are of two types i.e. simple leaf and compound leaf. The simple leaf may be petiolated or sessile. The simple leaves have axillary buds in their axil. The lamina of

compound leaf is divided into small leaf like structures which are known as leaflets. The leaflets do not have buds in their axils. Simple leaves have more surface area for absorbing sunlight, and are more often found in habitats where water loss is not a serious problem. Leaves may be pinnately compound, with each leaflets directly opposite another along a central vein or palmately compound, having leaflets which radiate out from a single point. Example of simple leaf is *Mangifera indica* and an example of compound leaf is *Rosa indica*.

Keywords: Expanded, Dissimilar, Limited growth, Exogenous, Incision, Axillary buds, *Mangifera indica* and *Rosa indica*.

INTRODUCTION

Leaves are usually green flattened lateral appendages born on the stem and branches. Developing exogenously from a node in acropetal order and bearing an axillary bud in its axil. They are usually green in colour and are developed in acropetal order from the nodes (the place from where a leaf originates and it comprises the point of attachment of the leaf round the stem or branch). The leaves bear buds at their axils and are exogenous in origin.

Leaves on the basis of incision are of two types i.e., simple leaf and compound leaf. Simple leaves are single leaves that cannot be sub - divided into leaflets. These leaves attach to a twig by the petiole or stem. Compound leaves are divided to multiple leaflets or blades on a common rachis. The leaf base can have small bud like stipules. Simple leaves with incised margin are of 3 types and compound leaves are of 2 types.

Leaves on the basis of incision are of two types i.e. Simple leaf and Compound leaf.

- **SIMPLE LEAF:**

When the leaf consists of a single lamina with usually entire or incised margin, but the incision never touches the mid-vein, it is called simple leaf. After HAIT, BHATTACHARYA, GHOSH.

The simple leaves with incised margins are of three types -

1. ENTIRE SIMPLE LEAF:

The leaves in which incisions are absent and are simple with smooth margins.

E.g.- *Mangifera indica*

Figure – Entire Simple leaf

Source - https://image.shutterstock.com

2. PINNATE SIMPLE LEAF: When the direction of incision is towards the midrib it is called pinnate simple leaf. E.g.- *Brassica campestris.*

After: HAIT, BHATTACHARYA, GHOSH

Figure – Pinnately Simple leaf

Source - https://blog.medillsb.com

3. PALMATE SIMPLE LEAF:

When the direction of incision is towards the petiole it is called palmate simple leaf.

E.g.- *Cucurbita maxima* (**After** HAIT, BHATTACHARYA, GHOSH)

Figure – Palmate Simple Leaf

Source - https://upload.wikimedia.org

- **COMPOUND LEAF:**

In this type, the lamina becomes incised and the incision reaches up to the midrib or petiole. Thus, the lamina is divided into several small parts (leaflets) forming compound leaf.

(**After** HAIT, BHATTACHARYA, GHOSH)

It is of two types: -

1. **PINNATE COMPOUND LEAF:**

In a pinnate compound leaf a number of leaflets are present on a common axis, the rachis, which represents the midrib of the leaf.

Based on the division of rachis it is of 4 types-

a. UNIPINNATE
b. BIPINNATE
c. TRIPINNATE
d. DECOMPOUND

a) UNIPINNATE: When the midrib bears the leaflets directly it is termed as unipinnate.

It is of two types-

I. **Paripinnate:** When the leaflets are arranged in pairs i.e. rachis bears even numbers of leaflets, it is called paripinnate.

E.g. *Cassia tora* **(After** J.N. MITRA, D. MITRA, S.K. CHAUDHURI)

Figure – Paripinnate compound leaf

Source - https://upload.wikimedia.org

II. Imparipinnate: When the leaflets are arranged on the rachis in such away that the terminal end of the rachis bears a single leaflet, so that rachis bears at apex an unpaired odd leaflet, it is called Imparipinnate.

E.g.- *Rosa indica*

(After J.N. MITRA, D. MITRA, S.K. CHAUDHURI)

Figure – Imparipinnate compound leaf

Source - https://qph.fs.quoracdn.net

b) BIPINNATE:

When rachis divides and develops secondary axis where leaflets are arranged on both the side, it is called bipinnate.

E.g. *Mimosa pudica* (**After-** HAIT, BHATTACHARYA, GHOSH)

Figure – Bipnnate compound leaf

Source - https://images-na.ssl-images-amazon.com

c) TRIPINNATE:

When the secondary axis divides and gives rise to tertiary axis, where leaflets are arranged on both the sides it is called tripinnate.

E.g.:- *Moringa oleifera*. (**After** HAIT, BHATTACHARYA, GHOSH)

Figure – Tripinnate compound leaf

Source- https://www.morifa.co.id

c) DECOMPOUND:

When the incision goes beyond the tripinnate condition, it is called decopmound.

E.g.- *Daucus carota*.

(**After** HAIT, BHATTACHARYA, GHOSH)

Figure – Decompound leaf

Source - https://keyserver.lucidcentral.org

2) PALMATE COMPOUND LEAF:

In a palmate compound leaves, the leaflets are attached at a common point i.e., at the tip of petiole.

It is of following types –

a. Unifoliate, b. Bifoliate , c. Trifoliate, d. Quadrifoliate

a) UNIFOLIATE: When one leaflet is articulated to the apex of the winged petiole, it is called unifoliate.

E.g.- *Citrus limon*

(After J.N. MITRA, D. MITRA, S.K. CHAUDHURI)

Figure – Unifoliate compound Leaf

Source - https://aggie-horticulture.tamu.edu

b) BIFOLIATE: When two leaflets are articulated to the apex of the petiole, it is called bifoliate.

E.g.- *Bignonia grandiflora*

(**After** STUDIES IN BOTANY – J.N. MITRA, D. MITRA, S.K. CHAUDHURI)

Figure – Bifoliate compound leaf

Source - http://gardennova.es

c) TRIFOLIATE: When three leaflets are articulated to the apex of the petiole, it is called trifoliate.

E.g.- *Aegle marmelos*

(**Source** - STUDIES IN BOTANY – J.N. MITRA, D. MITRA, S.K. CHAUDHURI-VOL I)

Figure – Trifoliate compound leaf

Source - https://images-na.ssl-images-amazon.com

d) QUADRIFOLIATE: When four leaflets are articulated to the apex of the petiole, it is called quadrifoliate.

E.g.- *Marsilea sp.*

(After STUDIES IN BOTANY – J.N. MITRA, D. MITRA, S.K. CHAUDHURI)

Figure – Quadrifoliate compound leaf

Source - https://upload.wikimedia.org

e) MULTIFOLIATE OR DIGITATE- When more than four leaflets are articulated to the apex of the petiole, it is called multifoliate.

E.g.- *Bombax ceiba*

(**After** STUDIES IN BOTANY – J.N. MITRA, D. MITRA, S.K. CHAUDHURI)

Figure – Multifoliate compound leaf

Source - https://live.staticflickr.com

CONCLUSION

A simple leaf has a broad, undivided leaf blade while the leaf blade is divided into several leaflets in a compound leaf. Compound leaf contains a series of leaflets attached to the midrib. In simple leaf lateral bud occurs at the base of the petiole while no lateral buds at the bare of each leaflet in a compound leaf. The main difference between a simple leaf and compound leaf is the division of lamina.

ACKNOWLEDGEMENT

I would like to express my special thanks of Gratitude to my respected professors of Botany Department of Hooghly Mohsin College to give me golden opportunity to do this wonderful Presentation.

I would also like to extend my gratitude to the HOD of Botany Department of Hooghly Mohsin College **Dr. Debabrata Mukhopadhyay** for providing me with all facilities that were required.

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13. https://images-na.ssl-images-amazon.com/images/I/81cuQhPM71L._SL1500_.jpg
14. https://upload.wikimedia.org/wikipedia/commons/thumb/1/1c/Marsilea_minuta_8915.jpg/271px-Marsilea_minuta_8915.jpg
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Paper- III

LIFE CYCLE OF *Saccharomyces sp*

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ABSTRACT

The yeasts have been exploited thousands of years for food and fermentation processes by mankind. Traditionally the yeast has been used for the production of alcoholic beverages, biomass and glycerol.

Leeuwenhoek (1680) first described yeast as the simplest and the most widely described members of ascomycotina. Guilliermond (1920) reported the presence of only 18 genera of yeast. They are the oldest knowncultivated plants. “About 74000 species of fungi including yeasts have been described, while estimates of the total number of fungal species has been estimated to be as high as 1500000” by Hawksworth in 2004.

Yeasts are unicellular eukaryotic fungi with completely different properties from those of bacteria, which are prokaryotic microorganisms. Yeast contains almost the same organelles of a mature eukaryotic cell. Nucleus, Golgi apparatus, Mitochondria, ER, vacuole and cytoskeleton are the most important one. Yeast cell particle is typically of 5 x10 µm. The primary method of the reproduction is by budding and occasionally by fission. The asexual reproduction of *Saccharomyses* takes place by formation of endospore and sexual reproduction takes place by the formation of ascus and

ascospores.Guilliermond (1940)has recognised three main types of life cycle in the yeast. These are known as- i) Haplobionticii) Diplobiontic iii) Haplo-diplobiontic life cycle.

INTRODUCTION

Leeuwenhoek (1680) first described yeast as the simplest and the most widely described members of ascomycotina. *Saccharomyces* (Gr.*Saccharon, sugar*;mykes, fungus)consist of about 40 species (van der Walt, 1970), while Kirk et al. (2001) recognised only 10 species.*Saccharomyces cerevisiae* is a saprophytic fungus, commonly found in bread, decaying fruit and vegetables etc. Species of *Saccharomyces*are cosmopolitan i.e., found everywhere over the surface of the earth. Yeast is able to grow in environment with changing concentrations of carbon and nitrogen (Goddard and Greig, 2015). "Some are found to occur as parasites in plants and animals including man" (Gwynne – Vaughan and Barnes,1927).*S. cerevisiae* commonly known as Brewer yeast or Baker's yeast because it is widely used in wine and baking industry produces two types of enzymes; an extracellular invertase and an intracellular zymase. The invertase hydrolyses cane sugar to dextrose or invert sugar and zymase breaks invert sugar into ethyl alcohol and carbon dioxide.

Several yeasts produce enzymes and biocatalysts of realized and potential value in the traditional enzyme industry and as chiral-specific biocatalysts for the fine chemical and pharmaceutical industries (Aehle,2004; Liese et al,2006). Lipase and esterase commonly produced by yeast, are the most frequently used biocatalysts in industrial organic synthesis(Kapoor and Gupta,2012; Brigidaa et.al, 2014; Wache et.al,2006; Fickers et.al., 2011)

SACCHAROMYCES Systematic Position:

Ainsworth (1993)

Kingdom - Mycota

Division - Eumycota

Sub- Division - Ascomycotina

Class - Hemiascomycetes

Order – Endomycetales

Family - Saccharomycetaceae

Genus –*Saccharomyces*

Thallus Structure:

Saccharomyces cerevisiae is a saprophytic and unicellular fungus. The cells are globose, elliptical or oval. about 2-8 µm in diameter and 3-15 µm in length. The cells are very polymorphic and sometime produce pseudo mycelium but true mycelium is absent.

Each cell has a distinct cell wall which is made up of protein, lipid and chitin.According to **Agar and Douglas(1957)** the cell wall consists of two layers, of which outer electron dense layer is about 0.5µ thick and inner micro fibril containing layer is less electron dense and is about 0.2µ thick. According to **Matile et al (1969)** the cell wall consists of 3 layers **1**. The outer most layer consists of protein and some chitin **2.** The middle layer consists of glucan **3**. The inner most layer consists of protein and glucan. Some phosphates and lipids are also present, while cellulose is absent. Each cell has a large vacuole, limited by a single, membrane called tonoplast, which contains polymetaphosphate and lipid. The cytoplasm of the cell contains organelles like nucleus, mitochondria, golgi apparatus, ER, ribosome and oil globules etc. Some hydrolytic enzymes like proteases, esterase, ribonuclease etc are also present in cytoplasm. The nucleus is bipartite in nature having major Feulgen positive and a smaller Feulgen negative region**(Moor and Muhlethaler,1963).**

Electron microscopic studies **(Agar and Douglas, 1957; Mones and Rapport, 1971; Hartwell,1974;Webster,1980)** suggested that nucleus is distinct. It is surrounded by a envelop composed of double unit membrane perforated by spores. The young nucleus is provided with a cup shaped nucleolus and dome shaped nucleoplasm at the time of budding.

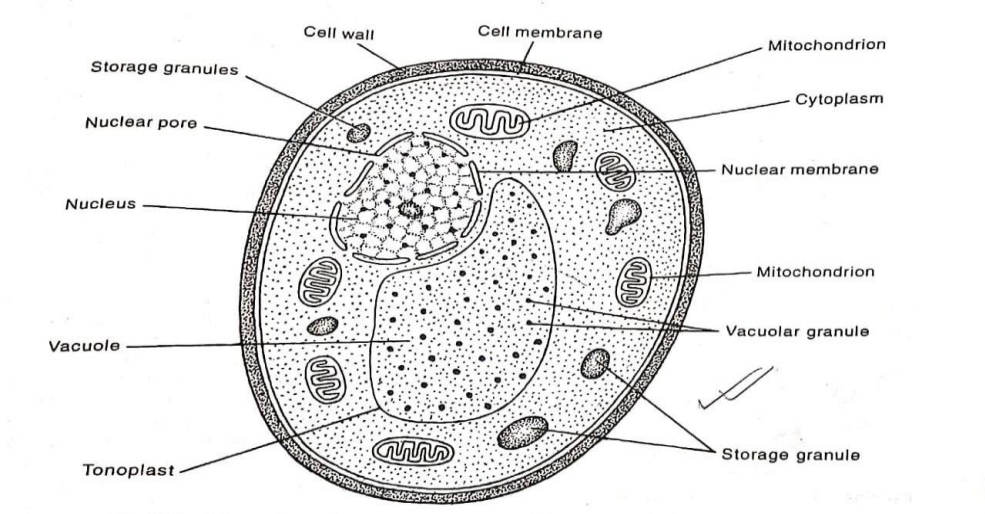


Fig. 4.34 : Cell structure of *Saccharomyces cerevisiae* under electron microscope

(Source - HAIT, BHATTCHARYA, GHOSH**)**

Reproduction:

It takes place by vegetative, asexual and sexual methods.

Vegetative reproduction:

It takes place by fission and budding.

Fission: It takes place during favourable condition. In this process, single vegetative cell forms two daughter cell of equal size. During fission, a constriction appears in the middle of the cellandsimultaneously nucleus undergoes mitotic division. Both the steps progress simultaneously. After nuclear migration, one at each side, partition wall forms almost in the half way of the mother cell and, as such two daughter cells are formed.

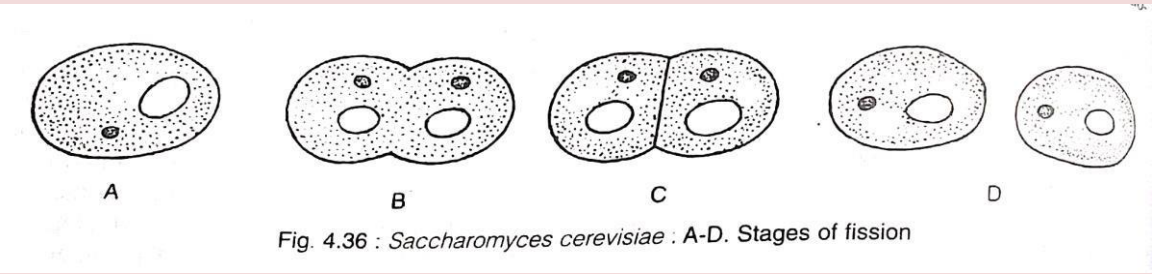


Fig. 4.36 : *Saccharomyces cerevisiae* : A-D. Stages of fission

(Source - HAIT, BHATTCHARYA, GHOSH**)**

Budding: It takes place by the formation of bud near the pole of the cell under favourable condition.

During the formation of bud, the cell wall at a Specific part become thin, soften and bulges out to produce an outgrowth, called bud. The nucleus divides amitotically (without spindle formation) to produce two daughter nuclei. One daughter nucleus with cytoplasm migrates into the bud which enlarge and become constricted at the base. The mature bad separates from the mother cell leaving a scar on the wall. It is called bud scar. Similar scar with concave surface remains on the wall of bud called Birth scar. When budding takes place repeatedly the cells remain attached in a chain to

produce pseudomycelium. Finally the cells get detached and grow individually.

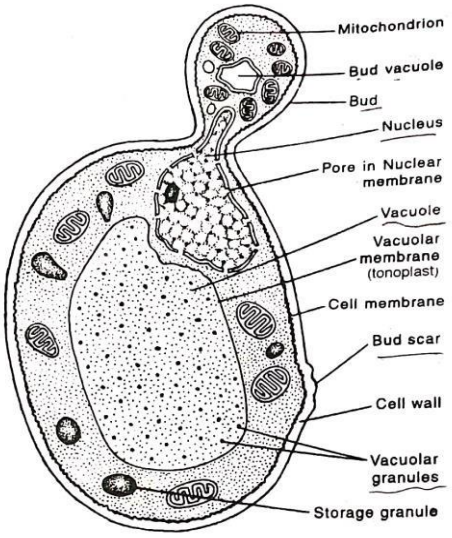


Fig. 4.35 : Structure of a budding cell of *Saccharomyces cerevisiae* under Electron microscope

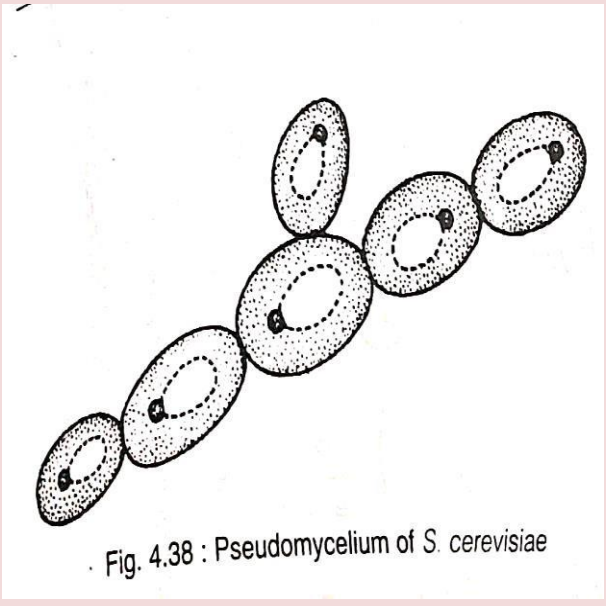


Fig. 4.38 : Pseudomycelium of *S. cerevisiae*

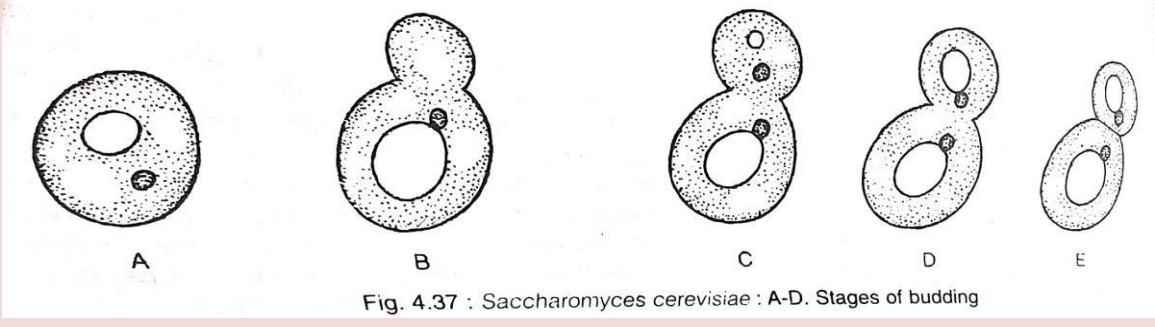


Fig. 4.37 : *Saccharomyces cerevisiae* : A-D. Stages of budding

(Source - HAIT, BHATTCHARYA, GHOSH-)

Asexual reproduction:

It takes place by formation of endospores with in the cell during unfavourable condition.

The nucleus divides mitotically to produce 4 nuclei the protoplast of the cell also divides into 4 parts Each part of protoplast with single daughter nucleus develops into an endospore. During favourable condition each endosporegerminates by budding to produce daughter cell.

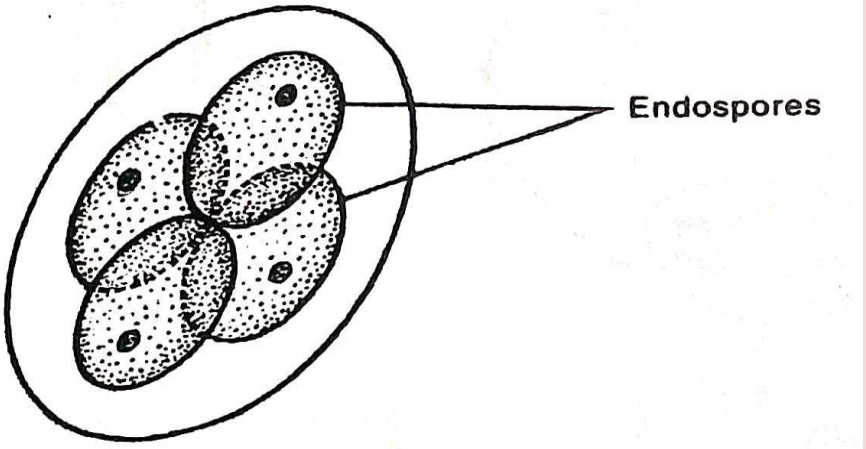


Fig. 4.39 : *Schizosaccharomyces pombe* : Endospores (four) in a cell

(Source - HAIT, BHATTCHARYA, GHOSH-**)**

Sexual reproduction:

In takes place by genetic copulation during unfavourable condition. The vegetative cells act as genetics. Two gametes come very close together and develop a beak like outgrowth towards each other. These two gametes fuse to produce a diploid zygote. This zygote behaves as ascus mother cell. The diploid nucleus divides by meiosis to produce 4 haploid nuclei. Each haploid nucleus with surrounding cytoplasm develops into an ascospore.

Thus, 4 ascospore are produced on germination of zygote after liberation from the ascus which is formed by enlargement of zygote cell, the ascospore produces vegetative cell by budding.

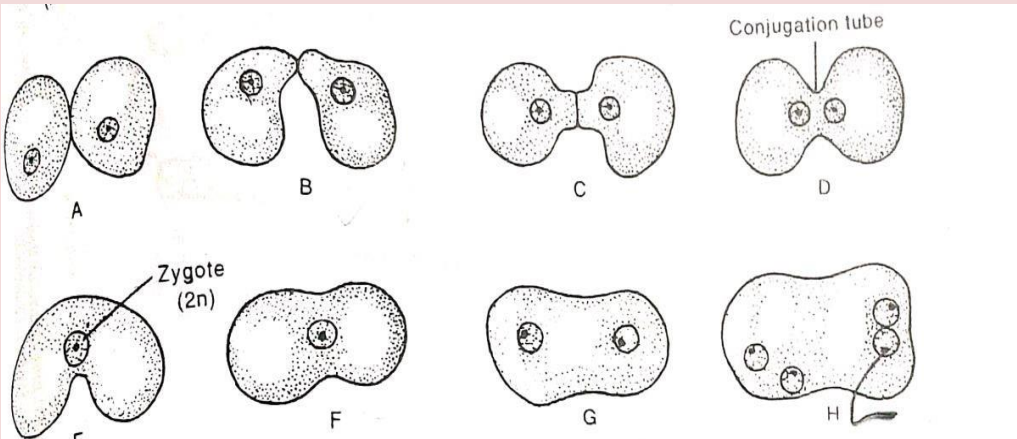


Fig. 4.40 : Different stages (A-H) of sexual reproduction

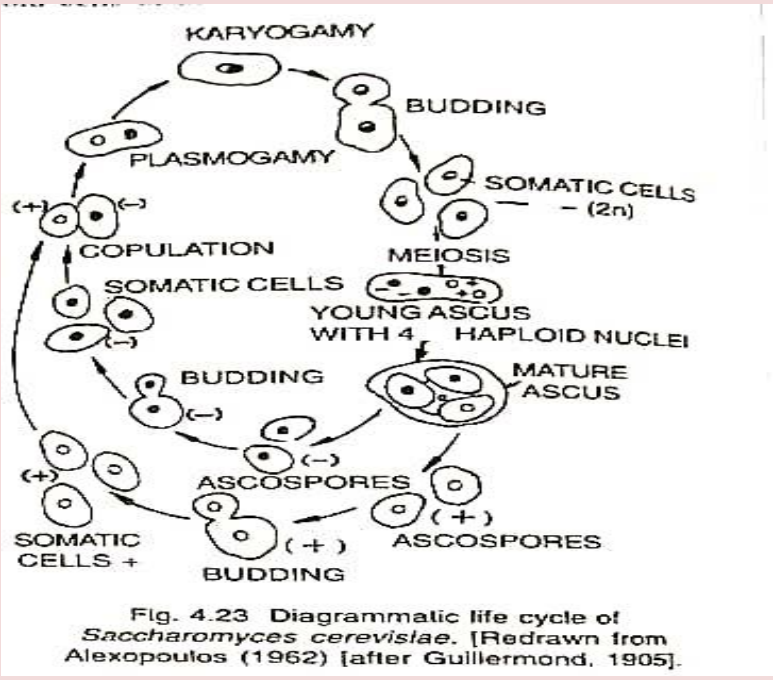


Fig. 4.23 Diagrammatic life cycle of *Saccharomyces cerevisiae*. [Redrawn from Alexopoulos (1962) [after Guillermond, 1905].

(Source - STUDIES IN BOTANY**)**

LIFE CYCLE PATTERN OFYEAST:

In every living organism there is an alternation of generation during sexual reproduction where diploid phase alternate with haploid phase in a cyclic way. This cyclic way is known as the life cycle of this organism.

According to **Guilliermond (1940)**, in yeast 3 types of life cyclesare found depending upon the length of diploid phase and haploid phase. Such as -

1. Haplobiontic Life Cycle.
2. Diplobiontic Life Cycle.
3. Haplo-diplobiontic Life Cycle.

1. Haplobiontic Life Cycle:

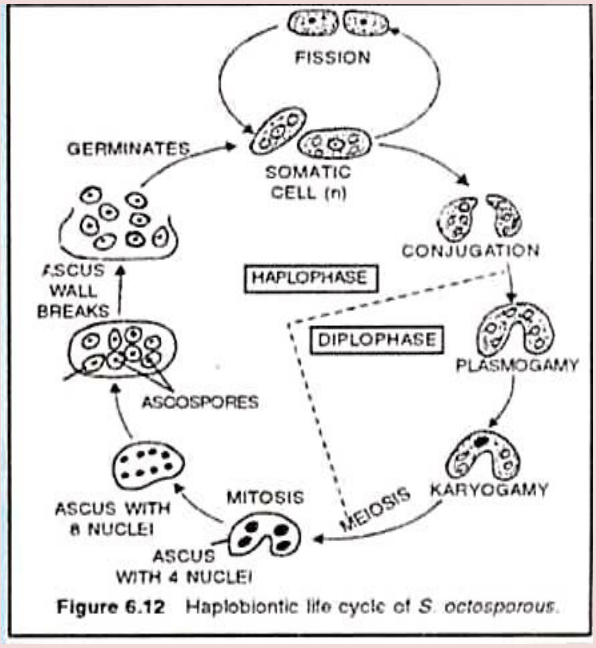


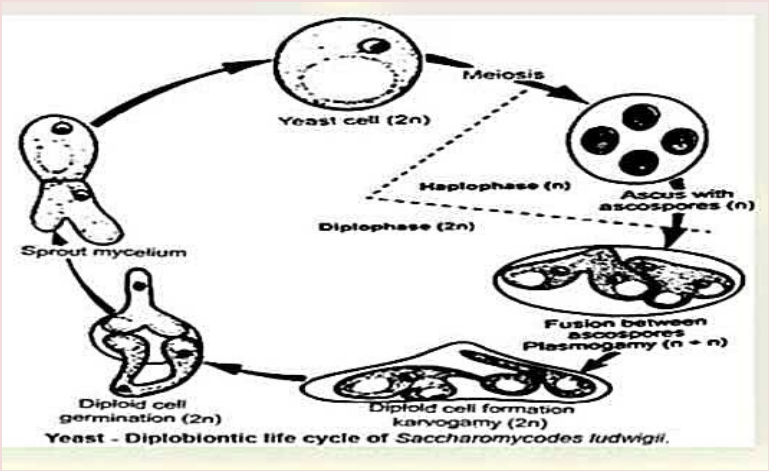
Figure 6.12 Haplobiontic life cycle of *S. octosporous.*

(**Source** – Google)

In this type the diploid phase is very short and is restricted to diploid zygote cell only. Meiosis takes place during the germination of zygote. The vegetative cells are haploid.e.g.,*Schizosaccharomyces octosporus.*

2. Diplobiontic Life Cycle:

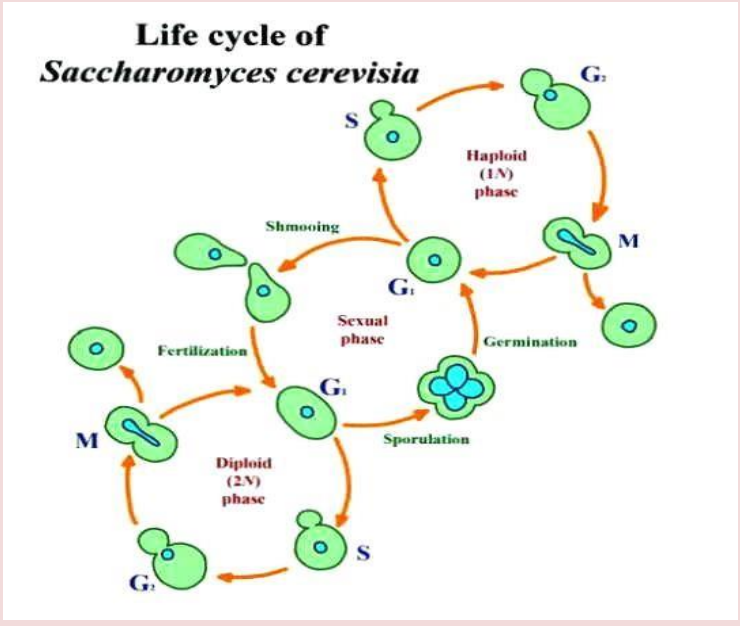
In the type the haploid phase is very short. It is restricted to ascospore(n) only. The vegetative cells are diploid. It is found in *Saccharomyces ludwigii.*



(**Source -** Google)

3. Haplo - diplobiontic Life Cycle:

In this type both haploid and diploid phases are equally represented. Both haploid and diploid vegetative cells are found and they multiply by budding.



(**Source** – Google)

CONCLUSION

The study of life cycle of *Saccharomyces*helps us tounderstand its occurrence, the cell structure and cell wall structure andcomposition of fungi the budding method, sexual and asexual reproduction, the formation of ascus and ascospores and 3 different types of life cycle, such as, Haplobiontic, Diplobiontic and Haplo-diplobiontic life cycle.

ACKNOWLEDGEMENT

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I would also like to extend to the gratitude to the H.O.D of Botany Department of Hooghly Mohsin College Dr. Debabrata Mukhopadhyay for giving me all facilities that were required.

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Paper- IV

The STRUCTURE OF GYNOECIUM

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Abstract:

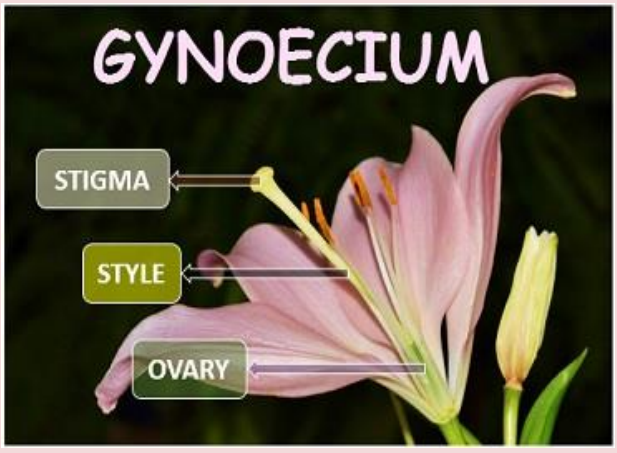
The gynoecium is composed of carpels. In more basal families (Magnoliaceae) the carpels are spirally arranged, and in more advanced families they tend to be in a single whorl. Carpel number varies from one (e.g., Fabaceae) to many (e. g. *Rubus*).

At the base of carpel, within ovary, develop one or more multicellular structures called ovules that each contain an egg. The upper part of the carpel is the **stigma** which receives the pollen. A slender stalk called the **style** often connects the ovary and stigma. The carpels may be separate (apocarpous) or fused together (syncarpous), with the individual carpel walls and cavities (locules) still present. Syncarpy may involve only the ovaries, leaving the styles and stigmasfree, as is found in the waterleaf of the wood sorrel (**Oxalis**), or it may involve both the ovaries and styles, leaving only the stigmas free, as in the waterleaf(**Hydrophyllum**). The number of carpels in a syncarpous (or compound) **ovary** generally equals the number of locules (in some cases the inner carpel walls break down, leaving a single locule); in an **orange** or a **grapefruit** for example, the juice sacs are actually trichomes that line inner carpel walls of each cavity.

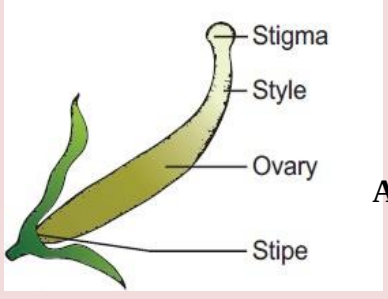
The position of the gynoecium with respect to the petals, sepals, and stamens on the floral axis also characterizes the flower like **hypogynous, perigynous and epigynous flowers.**

Introduction:

Gynoecium is the fourth innermost part of flower. It possesses three structures (stigma, style and ovary). A carpel refers to the unit of the gynoecium, which is generally the modified **leaf structure**. Gynoecium refers to the female reproductive unit because it bears an **ovule,** which on fusion with the pollen grain forms egg cells. Towards the gynoecium base, the **thalamus** provides the support to the female reproductive part and others parts as well. The sterile pistil is called **pistilide.** Gynoecium also called **pistil.**The word 'pistil' comes from **Latin** *pistillum* meaning **pestle**.



➢ **Types:**



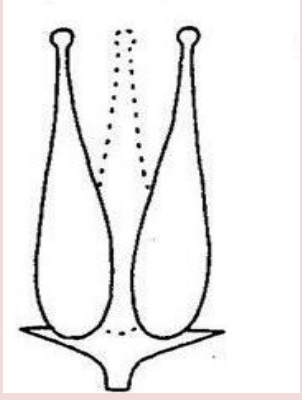
(Source - https://www.brainkart.com)

Depending upon the pattern of a carpel, gynoecium can be of two types:

A. **Simple or monocarpellary:** When the gynoecium is made up of one carpel, it is called simple gynoecium, e.g. *Pisum sativum* and other members of Fabaceae etc.

A. **Compound or polycarpellary:** When the gynoecium is made up of two or more carpels, it is called polycarpellary gynoecium.

Polycarpellary gynoecium is of two types:



a. **Apocarpous:**The carpels remain completely free from one another e.g. members of Magnoliaceae, Alismataceae etc.

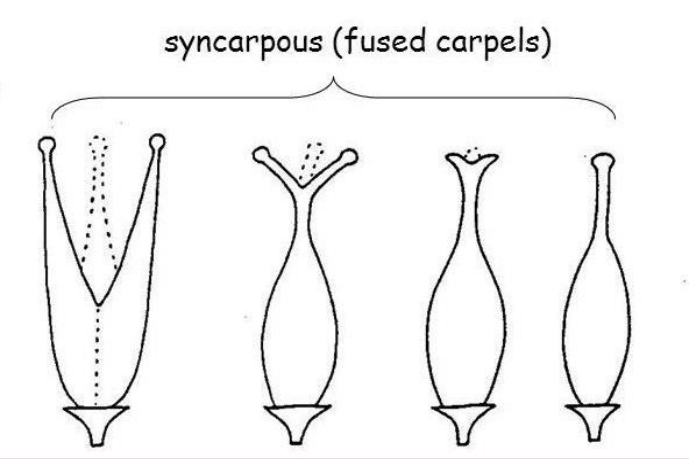
(Source - https://www.toppr.com)

b. Syncarpous: The carpels are

united with each other, e.g.Members of

Malvaceae, Liliaceae etc.

(**Source** - BHATTACHARYA, HAITH, GHOSH –VOL 2)

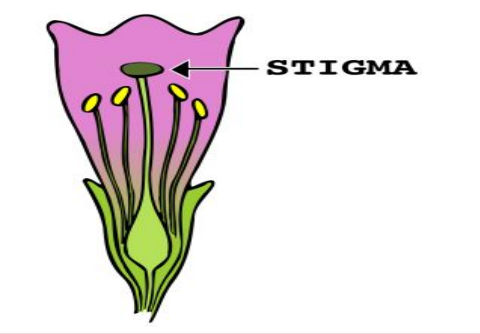


The degree of containing ('fusion') in a syncarpous guneocium can vary. The carpels may be "fused" only at their base but retain separate style and stigmas. The carpels may be "fused" entirely, except for retaining separated stigmas. Sometimes (e.g**. Apocynaceae**) carpels are fused by their styles or stigmas but possess **distinct ovaries**. In syncarpus gynoecium, the "fused" ovaries of the constituent carpels may be referred collectively as a single compound ovary. It can be a challenge to determine how many carpels fused to form a syncarpous gynoecium. If the style and stigmas are distinct, they can usually be counted to determine the number of carpels.

Within the compound ovary, the carpels may have distinct locules divided by walls called **septa**. If a syncarpous gynoecium has asingle style and stigma and asingle locules in the ovary, it may be necessary to examine how theovules are attached. Each carpel will usually have a distinct line of placentation where the ovules are attached.

❖ **Stigma:** It is the top most part of flower's female reproductive unit. A stigma refers to the **head of the pistil**, which remain exposed to the air or surroundings The surface of the stigma can be sticky, hairy, smooth or rough etc.The stigma itself forms the distal portion on the style or stylodiaand it is composed of stigmatic papillae, the cells of which are receptive to pollen.

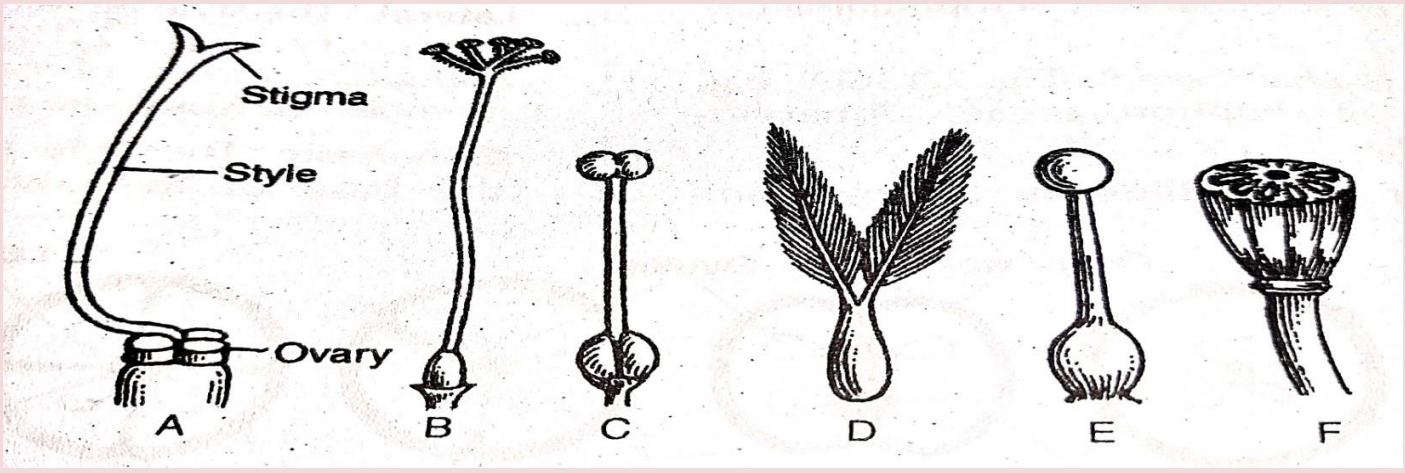
(Source - https://en.wikipedia.org)



It acts as a receptor for the attachment of pollen grains. Stigma has been shown to assist in the rehydration of pollen and in promoting germination of the pollen tube. Stigma also ensures proper adhesion of the correct species of pollen.

Stigma can play an active role in pollen discrimination and some **self-incompatibility** reaction that reject pollen from the same or genetically similar plants, involve interaction between the stigma and the surface of the pollen grain. When a stigma is directly present on the top of the ovary; it is called a **sessile stigma** .e.g.*Nelumbo nucifera* (Lotus) etc.

(Source - BHATTACHARYA, HAITH, GHOSH –**)**



The stigma may be –

A. Bifid(e.g. *Leourus sibiricous* and others members of **Labiatae)**

B. Pentafid(e.g. *Hisbiscus rosa-sinensis* and other members of **Malvaceae**)

C. Bilobed(e. g. *Ruellia tuberose* and others member of **Acanthaceae**)

D. Feathery(e.g. *Oryza sativa* and others member of **Poaceae**)

E. Capitalate(e.g. *lapmonea sinensis* and others member of **Convolvulaceae**)

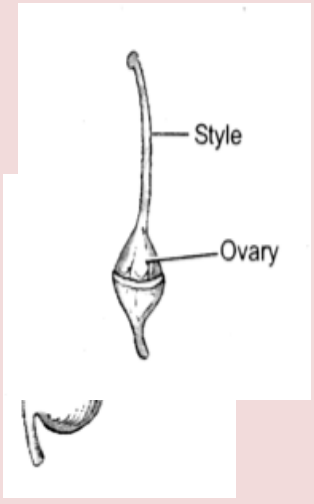
F. Radiate(e.g. *Argemone mexicana* of **Papaveraceae**)

(Source - BHATTACHARYA, HAITH, GHOSH**)**

- **Style:**The style is a narrow upward extension of the ovary, connnecting it to the stigmatic papillae. It may be absent in some plants. Styles are generally tube like- either long or short. The style can be open (containing few or no cells in the central portion)with a central canal which may be filled with mucilage. Alternatively the style may be closed (densely packed with cells throughout).Most **syncarpous monocots** and some **eudicots** have open styles, while many syncarpous eudicots and grasses have closed (solid) styles containing specialized secretory transmitting tissue linking the stigma to the center of the ovary. This forms a nutrient rich tract for pollen tube growth.

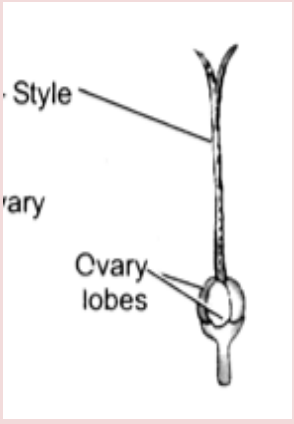
(Source - https://en.wikipedia.org**)**

Depending on their position on the ovary they are three types:

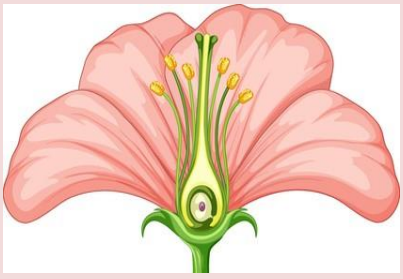


1. **Apical or terminal:** The style develops on the top of the ovary. e.g. members of Solanaceae; Fabaceae etc.

2. Lateral: The style develops from one side of the ovary. e. g. *Mangifera indica*(Mango) of Anacardiaceae and other members Rosaceae etc. **(Source -** BHATTACHARYA, HAITH, GHOSH **)**



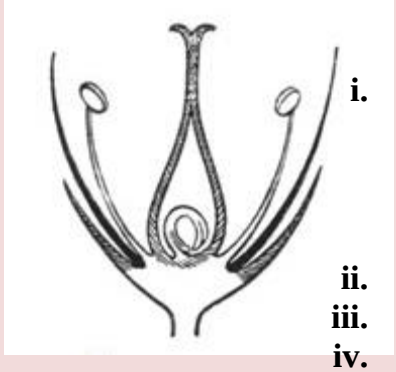
3. Gynobasic: The style appears to arise from the base of the invaginated ovary. e. g. *Leucas linifolia* of Lamiaceae etc.



- **Ovary:** The ovary is the swollen region formed by the folding of by the Lamina, containing one or more ovules. After fertilization the ovary develop into fruit and ovules develop into seeds. The ovules usually develop from the **placenta** produced on the inner surface of the united margins of the carpel.

(Source - BHATTACHARYA, HAITH, GHOSH**)**

Depending on the position of ovary on the Thalamus With respect to other floral whorls, it is of the following types:



i. **Superior:** The ovary is situated at the top of the thalamus with respect to other floral whorls, e.g. members of Malvaceae, Solanaceae etc.

(Source - https://www.pinterest.com**)**

ii.

iii.

iv.

Inferior: The ovary is situated on the thalamus at a level lower than the other floral whorls e.g. Members of Rubiaceae, Cucurbitaceae etc.

(Source - BHATTACHARYA, HAITH, GHOSH**)**

Half or semi-inferior: The ovary is partly adherent to the receptacle i.e. an intermediate i.e. an intermediate position of ovary between the inferior and superior types. e. g.-*Pisum sativum* (Pea) of Fabaceae, Rosa centifolia (rose) of Rosaceae etc.

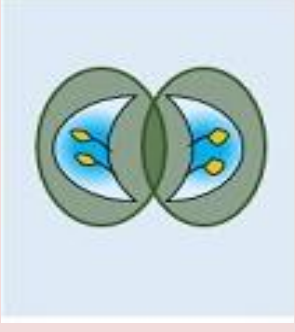
(Source - https://www.pinterest.com**)**

The ovary of a **monocarpellary** gynoecium has a single locule or chamber. The ovary with **polycarpellary** gynoceium may be of the following types:

I. Unilocular: It consists of a single chamber. e. g. *Papaver somniferum*

(Poppy) of Papaveraceae etc.

II. Bilocular: It consists of two locules e.g. members of Acanthaceaeetc.



(Source - https://biologyreader.com**)**

III. Trilocular: It consists of three locules, e.g. Euphorbiaceae, Liliaceae

etc

IV. Multilocular: It comprises many chamber e.g. members of

Malvaceae, Rutaceae etc.

CONCLUSION:

The presence of a gynoecium composed of carpels is a key feature of angiosperms. The gynoecium is one of the most complex structures in angiosperm, ensuring proper development, protection and fertilization of ovules at anthesis and undergoing extremetransformations in the fruit to secure proper seed maturation and dispersal. It is formed by one or more carples with highly specialized tissues, which represent fourth and innermost whorl of the flower. The evolutionary and developmental origins and morpho-anatomical innovations shaping the gynoecium are central questions in plant evolutionary biology.

ACKNOWLEDGEMENT

I would like to express my special thanks of gratitude to my respected professors of Botany Department of Hooghly Mohsin College to give me a golden opportunity to do this wonderful presentation. I came to know about so many things I am really thankful to them. I would also like to

extend my gratitude to HOD of Botany Department of Hooghly Mohsin College "**Dr.Debabrata Mukhopadhyay**" for providing me with all facilities that were required.

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- **(https://www.toppr.com/ask/question/which-of-the-following-is-correct-option-regarding-apocarpus-gynoecium/)**
- https://www.digitalatlasofancientlife.org/learn/embryophytes/angiosperms/flowers/

Paper –V

STUDY OF THE GENUS *Ascobolus sp* (Pers)

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ABSTRACT

Ascobolus is a saprophytic, coprophilous fungus belonging to class-Discomycetes; plant body is branched , septate , mycelial; septum is simple pore septum. It reproduces by both asexual and sexual process. Asexual reproduction takes place by oidia and papulospoe formation. Sexual reproduction is gametangial contact type. The male and female sex organs are known as antheridia and ascogonia respectively. Sexual reproduction leads to formation of ascogenous hyphae and then ascus and ascospores by crozier formation. Each ascus contains eighthaploid ascospores which is produced by meiosis followed by mitosis. After formation of ascogenous hypha allthe surrounding hyphae interwind to produce an ascocarp, which is cup or saucer shaped apothecium type. The hymenial layer of ascocarp shows a series of ascus mixed with sterile paraphyses.

Keywords: Discomycetes, Saprophyte, Coprophilous, Ascogenous hyphae, Apothecium.

INTRODUCTION

The fungi has heterotrophic mode of nutrition. They depend upon other source for their nutrition. They may be either saprophytic or parasitic. *Ascobolus* is an example of saprophytic fungus.The study of thallus structure, mode of reproduction,types of fruit bodies and lifecycle have great significance to obtain knowledge about the various members of fungi.It helps to establish the evolutionary relationship among the members of fungi.

ASCOBOLUS(Coprophilous fungi)

❖ Systematic position:-

Ainsworth(1973)

Kingdom: Mycota

Division: Eumycota

Sub-division: Ascomycotina

Class: Discomycetes

Order: Pezizales

Family: Pezizaceae

Genus: *Ascobolus*

(HAIT,BHATTACHARYA, GHOSH-)

➢ Thallus Structure:-

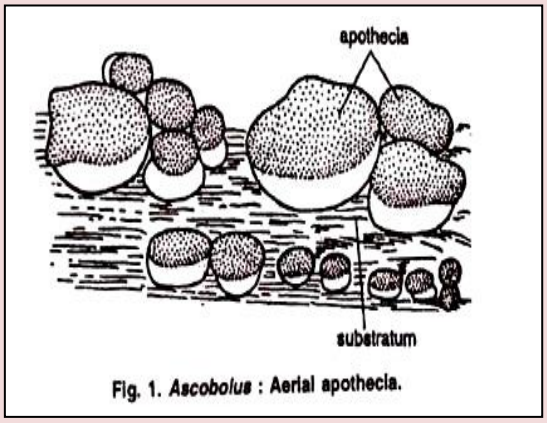


Fig. 1. *Ascobolus* : Aerial apothecia.

Source -
https://www.biologydiscussion.com

- *Ascobolus* is a saprophytic, coprophilous fungus as it grows on dung of herbivorous animals like cow, buffalo etc.
- Plant body is mycelial, composed of branched septate hyphae with multinucleate cells.
- Septum is simple pore septum.

(Source- J.N. MITRA, D. MITRA, S.K. CHAUDHURI)

➢ Reproduction

Ascobolus reproduces by two methods-

(i) Asexual reproduction
(ii) Sexual reproduction

❖ Asexual Reproduction:-

It takes place by oidia and papulospore-

a)**Oidia:** They are also called arthospores.They are produced in chain on the vegetative mycelium . Each oidia on germination produces new mycelium . Arthospores are produced by separation of hyphae into very small fragments.

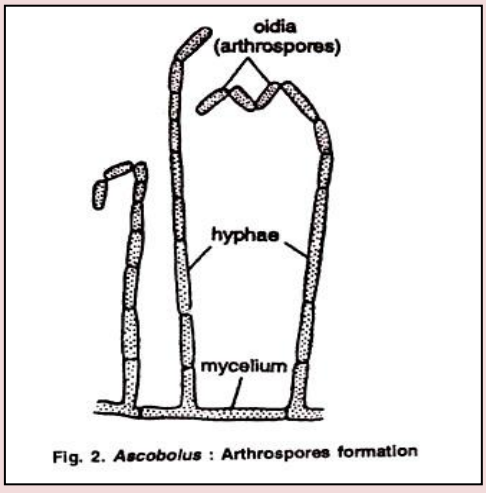


Fig. 2. *Ascobolus* : Arthrospores formation

Source -
https://www.biologydiscussion.com

b) **Papulospore:** A papulospore has one or two large centralstorage cells surrounded by a covering of hyphae. It is sclerotium like in structure.

(HAIT ,BHATTACHARYA, GHOSH-)

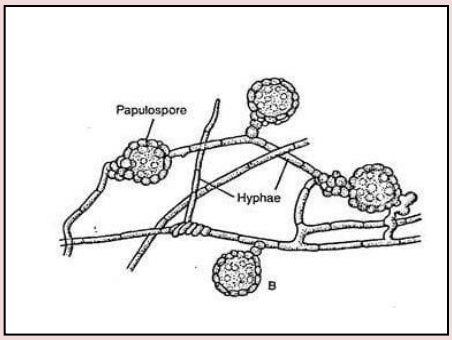


Fig.;- Papulospore

(**Source** - HAIT ,BHATTACHARYA, GHOSH-)

❖ Sexual Reproduction:-

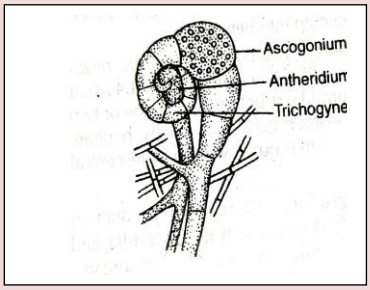
It takes place by gametangial contact method. The male sex organ is called **antheridium** and female sex organ is called **ascogonium.**

1. Sexual reproduction occurs by the development of antheridium and ascogonium.

2. The species of *Ascobolus* may be **heterothallic**(Gwynne-Vaughan and Williamson 1932)

[ex - *A. scatigenus*] or **homothallic** (Dodge 1912,1920)

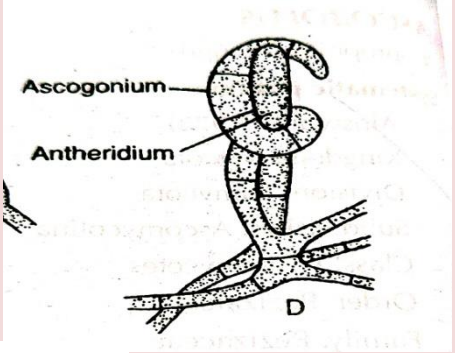
[ex- *A. crenulatus*).



Trichogyne circling around the erect antheridium

(**Source** - HAIT ,BHATTACHARYA, GHOSH-)

3. After sexual reproduction it reproduces cup shaped fruit body called apothecium.



Formation of antheridium and ascogonium

(**Source** - HAIT ,BHATTACHARYA, GHOSH-)

4. Antheridial branches are clavate or cylindrical and remain erect and cut of an apical antheridium in course of time.

5. The female branch develops by neighbouring

mycelium and gradually coils around the antheridium and becomes multicellular by septation.

The multicellularascogonial branch becomes differentiated into -

a) A terminal long, septate, multicellular trichogyne.
b) A large unicellular, multinucleate ascogonium.
c) A multicellular stalk.

6. The apical point of the trichogyne is attached with the apical side of the antheridium. The common wall of their contact dissolves and content of the antheridium passes to the ascogonium through the trichogyne.

7. After nuclear migration , the ascogonium increases in size and buds out ascogenous

hyphae.

8. The ascogenous hyphae grow in

size and a pair of opposite

nuclei migrates inside and the

ascogenous hyphae becomes septate.

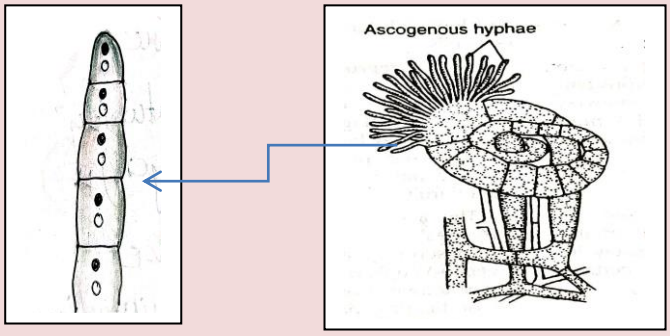


Figure - Formation of ascogenous hyphae

Source - HAIT, BHATTACHARYA, GHOSH

9. The apical cell of ascogenous hyphae

bends to form hook shaped structure

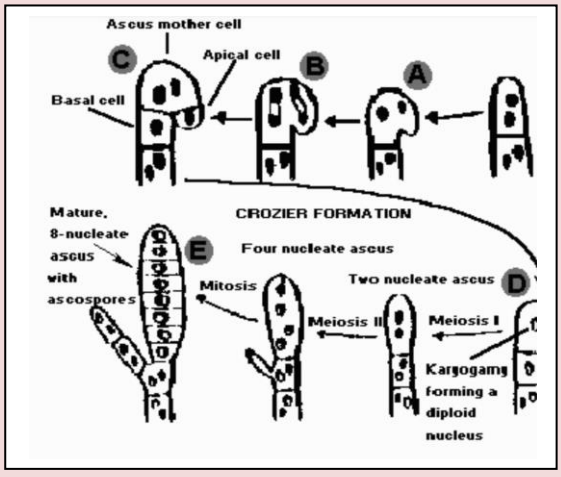
called crozier and with mitotic division

of nuclei forms three celled structure –

a) Haploid basal cell .

b) Dikaryotic penultimate cell.

c) The haploid terminal or ultimate cell.



Of which the middleone, i.e. thepenultimate cell enlarges and forms an ascuswhich contains eight ascospores, developed sequentially by karyogamy , meiosisand mitotic division of nuclei.

10. The asci remain intermingled with septate paraphyses in the upper region of the fruit body, i.e. hymenium.

Ascospores are liberated from ascus through operculum and they germinate on substrate to produce vegetative mycelium.

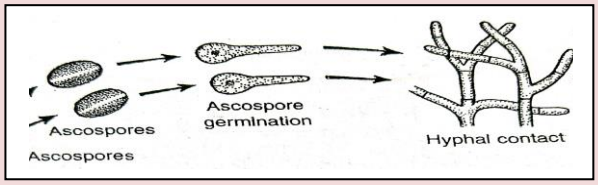


Figure - Germination of ascospore

Source - HAIT, BHATTACHARYA, GHOSH-

- **Ascocarp or Fruit Body:-**

It is a small (5mm-2.5cm in diameter) cup or saucer shaped, sessile, greenish-brown in colour. The upper convex part is called hymenium which contain ascus and ascospores along with sterile paraphyses. Mature ascus protrude above the hymenial layer.Hymenium is followed by sterile hypothecium composed of compactly woven hyphae.

Van Brummeler (1967) reported two types of ascocarp development-

i) **Gymnohymenialor gymnocarpic type**- In this type the hymenium remains exposed till the maturity of asci. E.g. *Ascobolus magnificus*

ii) **Cleistohymenial or angiocarpic type**- In this type the hymenium is exposed at least during its early part of development. E.g.- *A. immersus*

(HAIT ,BHATTACHARYA, GHOSH-

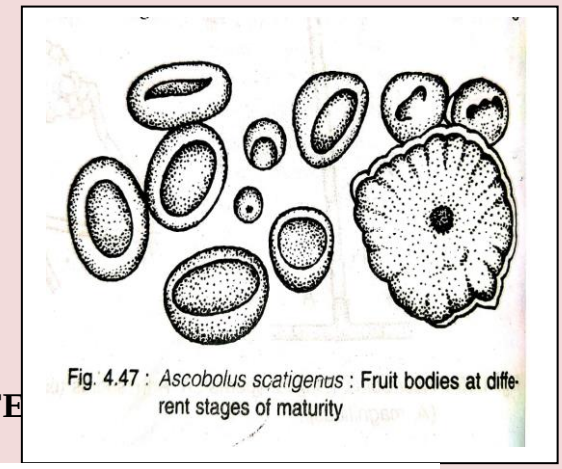


Fig. 4.47 : *Ascobolus scatigenus* : Fruit bodies at different stages of maturity

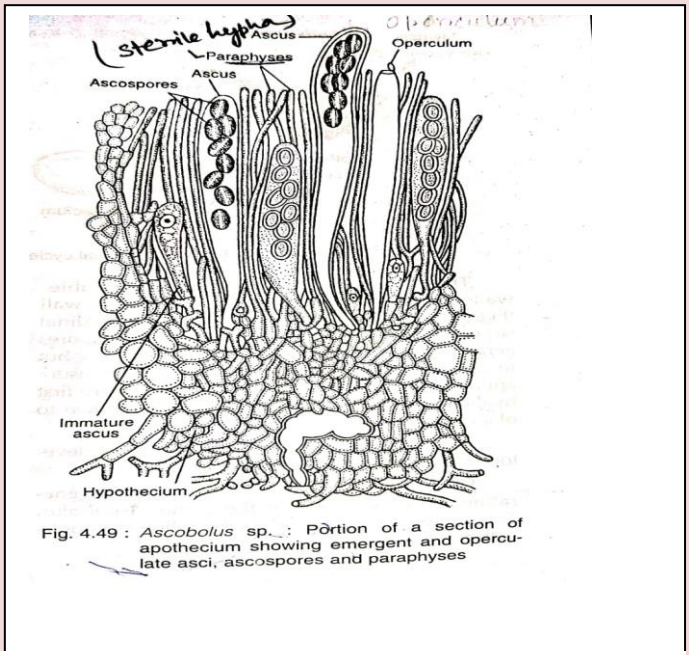
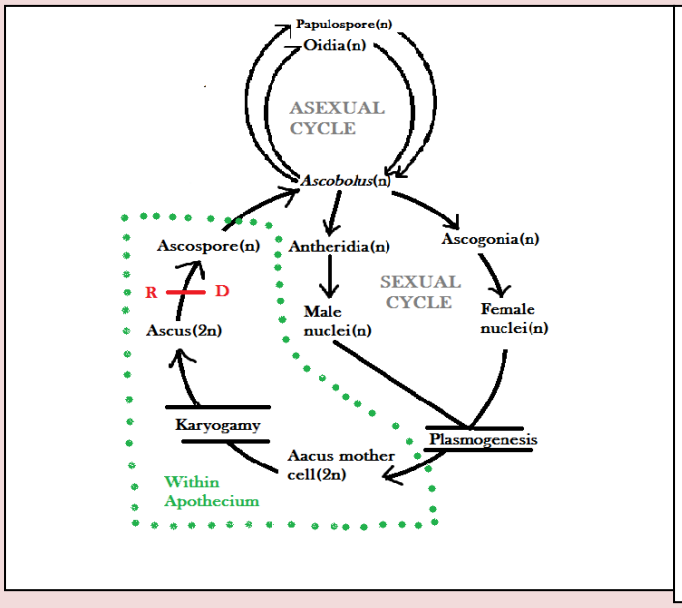


Fig. 4.49 : *Ascobolus* sp. : Portion of a section of apothecium showing emergent and operculate asci, ascospores and paraphyses

LIFE

(**Source** - HAIT ,BHATTACHARYA, GHOSH -)

(**Source** - HAIT ,BHATTACHARYA, GHOSH-)



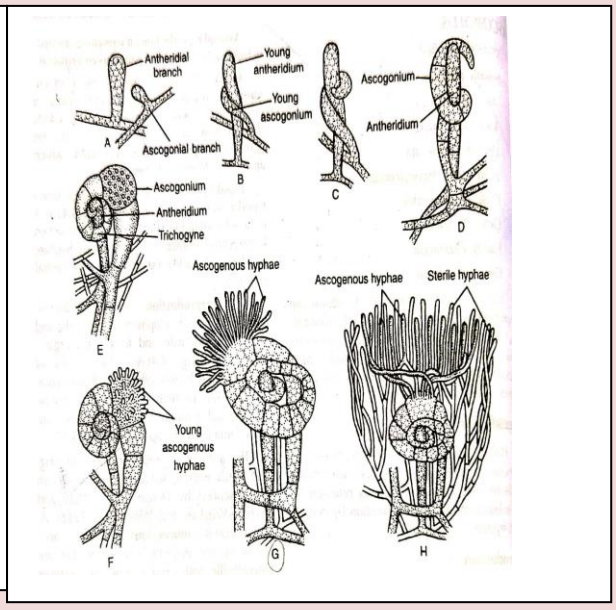


Figure - Graphical representation of *Ascobolus* life cycle

Figure - Diagrammatic representation of *Ascobolus* life cycle

❖ **Here are some species of *Ascobolus*:-**

(After HAIT ,BHATTACHARYA, GHOSH)

Figure - *Ascobolus scatigenus*

Source - https://ascomycete.org

Figure - *Ascobolus crenulatus*

Source - https://ascomycete.org

Figure - *Ascobolus carbonarius*

Source - http://www.mushrooms.su

Figure - *Ascobolus denudatus*

Source - https://upload.wikimedia.org

CONCLUSION

The study of life cycle of *Ascobolus* provide it's mode of nutrition thallus structure, reproductive structure and fruit bodies. *Ascobolus*, being a coprophilous saprophytic fungi shows a variety of asexual spore for rapid propagation. Generally sexual reproduction occurs to produce a fruit body which is comparatively a long lived structure with a definite shaped that contribute to the identifying features of *Ascobolus.* The mode of sexual reproduction, the structure of fruit body establishes relationship of *Ascobolus* with groups of ascomycetes. It helps to understand the relationship among the other members of fungi.

ACKNOWLEDGEMENT

I would like to express my special thanks of Gratitude to my respected professors of Botany Department of Hooghly Mohsin College to give me agolden opportunity to do this wonderful presentation.

I am grateful to my honorable professors **Dr. Tapash Kumar Das** and **Dr. Subrata Mitra** for their encouragement and provide knowledge about the subject matter, and I am also grateful to other professors of the Department for helping and providing the study materials.

I would also like to extend my gratitude to the HOD of botany dept of Hooghly Mohsin College **Dr. Debabrata Mukhopadhyay** for providing me with all facilities that were required.

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Paper- VI

STUDY OF GENUS *Agaricus*

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ABSTRACT

Agaricus is a saprophytic fungus, commonly grows on damp wood, decomposed organic matters like humus, horse dung, etc. It is fairly common in grassy lands. These fungi are commonly known as mushroom. The genus *Agaricus* includes both edible and poisonous species, with more than 400 species worldwide. This genus includes many species, which are enormously important as sources of food and medicines, such as button mushroom (*Agaricus bisporous*) and the almond mushroom (*Agaricus subrufescens).* There are about 25 species of *Agaricus* in India.

INTRODUCTION

Agaricus is a genus of mushrooms containing both edible and poisonous species, with possibly over 400 members worldwide. The genus includes the common ("button") mushroom (*Agaricus bisporous*) and the field mushroom (*A. campestris*), the dominant cultivated mushrooms of the West**.** Members of Agaricus are characterized by having a fleshy cap or pileus, from the underside of which grow a number of radiating plates or gills on which naked spores are produced. They are distinguished from other members of their family, Agaricaceae, by their chocolate –brown spores. Members of *Agaricus* also have a stem or stipe, which elevates it above the object on which the mushroom grows, or substrate, and a partial veil, which protects the developing gills and later forms a ring or annulus on the stalk.

➢ SYSTEMATIC POSITION

Figure - Mushroom

Source - Google

Kingdom. Mycota

Division. - Eumycota

Subdivision- Basidiomycotina

Class- Hymenomycetes

Order- Agaricales

Family- Agaricaceae

Genus- *Agaricus*

➢ HABIT AND HABITAT

- *Agaricus* is a saprophytic fungus, commonly grows on damp wood, decomposed organic matters like humus, horse dung etc.
- Butler and Bisbay (1958) recorded 25 species of *Agaricus* from India.
- Two important edible species of *Agaric*us: *A. campestris*, is the field mushroom and *A.brunescens*is cultivated commercially in various parts of India.
- *A. xanthodermus* is a poisonous species whereas *A. placomyces* and *A. silvaticus* may cause gastrointestinal disturbances in some person.

➢ STRUCTURE OF *Agaricus*

It can be studied into two parts:

a) Vegetative mycelium (living inside the soil)
b) Fruiting body or basidiocarp (present above the soil)

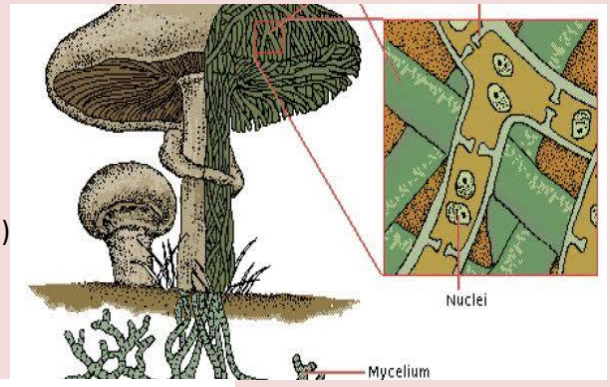


Figure – Detailed structure of *Agaricus*

Source -Youtube

- **VEGETATIVE STRUCTURE**
-

Vegetative body is mycelial and consists of muchseptate branched hyphae. Spores on germination develop into monokaryotic or primary mycelium either + or – type. The primary mycelium is short lived and it is soon transformed into dikaryotic or secondary mycelium by thefusion of two cells of different monokaryotic mycelium (+ and -) followed clamp connection. The hyphae of the diakaryotic mycelia interplace and twist together to form thick white hyphal cord, called rhizomorph which bear the fruit bodies.

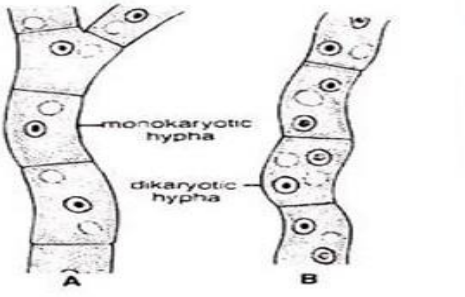


Fig. 1 (A, B). *Agaricus* mycelium. (A) Monokaryotic, (B) Dikaryotic

➢ FAIRY RING

Due to centrifugal growth (growth outward from the centre) of the dikaryotic mycelium, fruit bodies are formed in circular ring around the spot where the fruit body is formed in the last year. These fruit bodies are arranged in a ring, imagining that these circular ring marks arethe path of dancing fairies called fairy ring. The perfect ring of *Agaricus* is usually less than 5 meters in diameter, but Shantz (1917) reported a perfect ring of about 50 meters in diameter.

Figure – Fairy Ring

Source - Google

➢ REPRODUCTION IN *Agaric*

http://www.vpscience.org

e means vegetative, asexual and sexual.

- **VEGETATIVE REPRODUCTION**

It is mostly propagated by vegetative means where dikaryotic mycelium develops spawn, the mushroom seed. The mass of spawn divides artificially into small blocks that are grown in soil supplemented with organic manure to obtain fruit bodies.

- **ASEXUAL REPRODUCTION**

It takes place by chlamydospores, that are formed rarely during unfavourable condition. Terminal or intercalary chlamydospores are developed on dikaryotic mycelium, which on germination during favourable condition producesdikaryotic mycelium.

- **SEXUAL REPRODUCTION**

Sex organs are absent in *Agaricus*and sexual reproduction takes place by somatogamy. Most of the species including *A. campestris*are heterothallic, but *A. brunescens* is homothallic. Somatogamy includes plasmogamy, karyogamy, meiosis.

PLASMOGAMY

- Two cells of monokaryotic hyphae of opposite strain (+ and -) come in contact with each other.
- The cell wall dissolves at the point of contact and a dikaryon (n+n) is formed.
- This dikaryotic cell develops into dikaryotic mycelium by regular cell divisions through clamp connection.
- The dikaryotic mycelia are subterranean and after aggregation at some points they form button which remains dormant before the rain.
- After rain, the soil becomes soft and the button develops into fruit body.

KARYOGAMY

- It takes place in young basidium which develops on gills of the fruit body. Both the nuclei fuse together and form diploid nucleus.

MEIOSIS

It takes place soon after karyogamy and forms four haploid nuclei. The basidiospores, thus formed on the sterigma of basidium are haploid and either of + or – type**. (HAIT BHATTACHRYA)**

DE

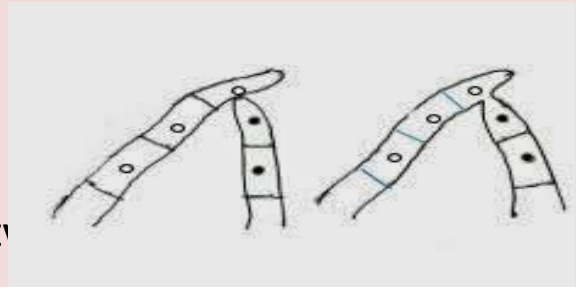


Figure – Mechanism of Plasmogamy

Source - Google

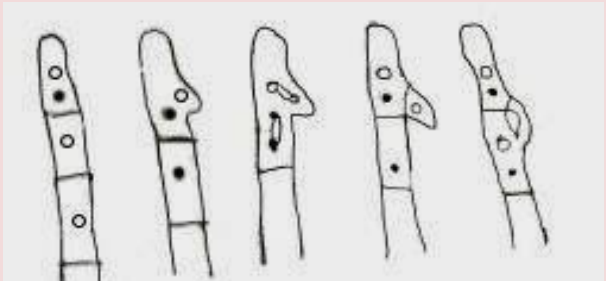


Figure – Mechanism of Plasmogamy

Source - Google

- The underground di-karyotic mycelia aggregate at some point and form a knob-like structure, called button.
- The button does not grow in dry seasons and remain hidden one or two inches below the soil surface.
- In the late summer with heavy rain, when the soil becomes moist and soft, the button grows rapidly and develops the basidiocarp.
- During development, the button is differentiated into a basal bulbous part and an apical hemispherical region. The bulbous part gradually differentiates into elongated, solid, cylindrical structure, the stipe and the hemispherical region differentiates into a round, convex region, looks like the top of an umbrella, the pileus.
- Some hyphae are drawn apart and form a ring-like cavity towards the bottom of the hemispherical region, the pre-lamellar chamber.
- The upper surface of prelamellar chamber becomes deeply concave and lined with alternating radial bands of slow and rapidly dividing cells.
- The region with rapid divisions forms gill-primordia, which develop into gills, that hang downwardly into the pre-lamellar chamber.
- The edge of the pileus of young basidiocarp connects with the stipe by a membranous tissue called the velum, partial veil or inner veil.
- The velum remains attached with the upper part of the stipe in the form of a ring, the annular ring or annulus.

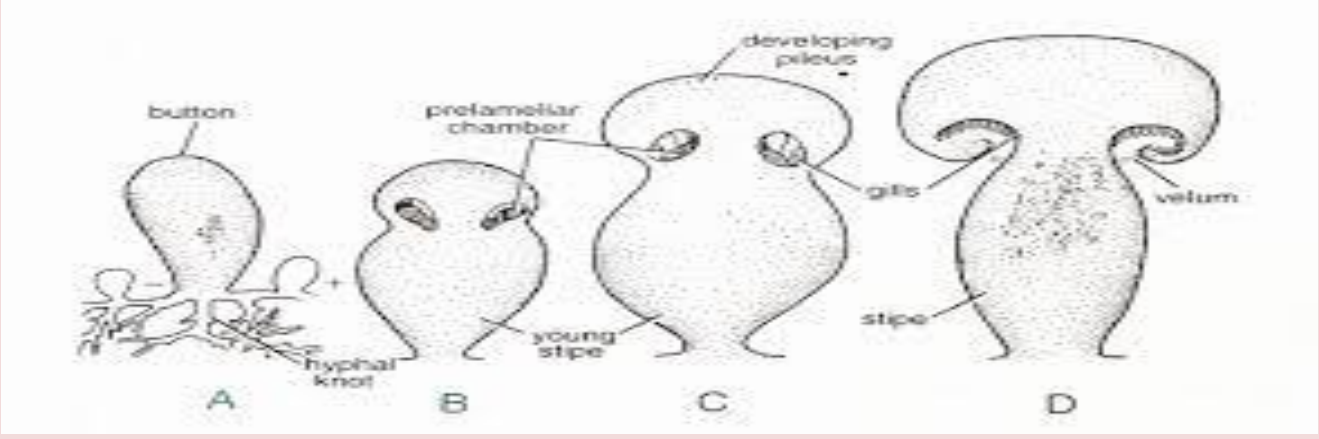


Figure – Development of Basisidiocarp

Source - https://encrypted-tbn0.gstatic.com/

STRUCTU

- EXTERNAL STRUCTURE

  - The mature basidiocarp is an open umbrella shaped structure with a broad expanded pileus on a long massive stalk-like stipe.
  - The pileus is 5-12cm in diameter with a convex upper surface, maybe of white, yellow or light brown in colour.
  - The lower surface of the pileus bears about 300-600 radially arranged gills of three different lengths- normal, half, quarter; the last one lying between half and normal length gills.
  - The young gills are light pink in colour, but becomes purple or brown at maturity

- The fruit body remains attached with the substratum by rhizoidal mycelium.

(O P SHARMA- FUNGI AND ALLIED MICROORGANISMS)

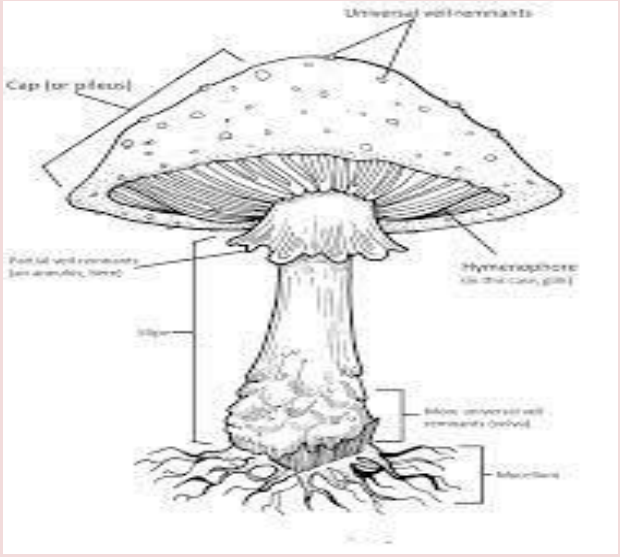


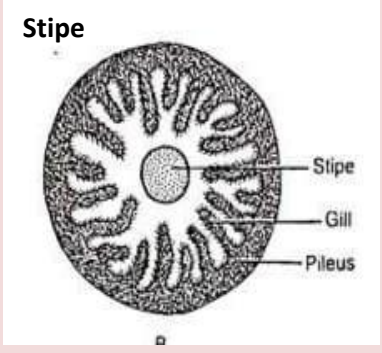
Figure – Structure of basidiocarp

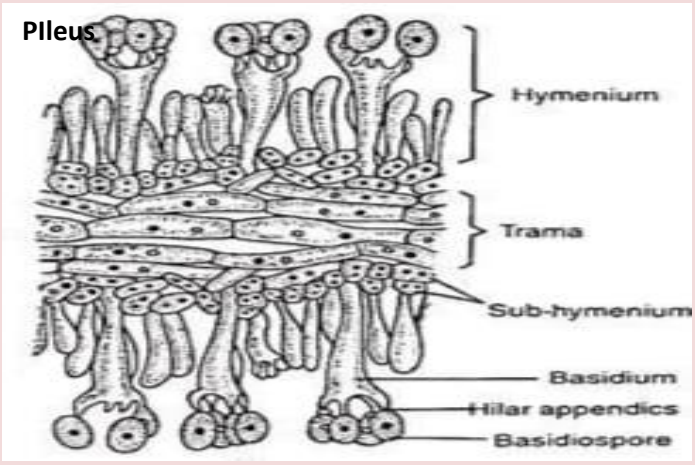
Source - Google

- INTERNAL STRUCTURE

1. STIPE: It is differentiated into central medulla, composed of loosely interwoven hyphae and an outer cortex, made up of densely compact hyphae.
2. PILEUS: It is differentiated into outer compact and inner loose hyphae, like stipe.
3. GILLS: It is differentiated into three regions- trama, sub-hymenium and hymenium.

I. TRAMA- It is the central sterile region of the gill, consists of many layers of loosely arranged interwoven hyphae.
II. SUB-HYMENIUM (hypothecium) - It is also a sterile zone, situated on both sides of trama, formed by the lateral branches of hyphae develops from trama.
III. HYMENIUM-The layer is present on the outer side of sub-hymenium, composed of fertile basidium and club-shaped sterile paraphyses.





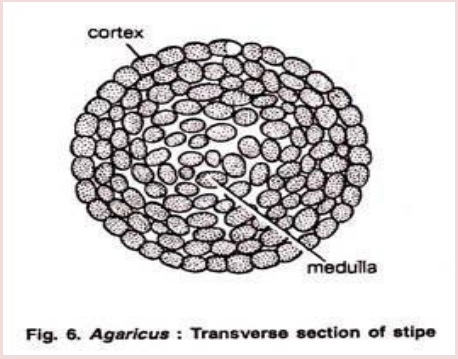


Fig. 6. *Agaricus* : Transverse section of stipe

(SOURCE - HAIT BHATTACHRYA GHOSH)

DEVELOPMENT OF BASIDIUM

- Young basidium is aseptate, fertile dikaryotic cell present in the hymenial zone. As the basidium matures, the nuclei (+ and -) dikaryon fuse together and form diploid nucleus(2n). The diploid stage is ephemeral.
- The diploid nucleus undergoes meiosis and forms four haploid nuclei(n), of which two are of "+" strain and the other two are of "-" strain.
- Four peg-like or horn-shaped outgrowths are developed at the apex of the basidium, known as sterigmata.
- The sterigmata swells at the tip and after collecting one nucleus with cytoplasm, it develops into a single basidiospore.

BASIDIOSPORE

- Basidiospores are oval, thin-walled and uninucleate.
- The mature basidiospores are discharged from the basidium by water-drop mechanism.

GERMINATION OF BASIDIOSPORE

- Falling on suitable substratum, the basidiospore germinates by initiating germ tube which develops into primary mycelium, either+ or- strain depending on the strain of spore, (+ or -).

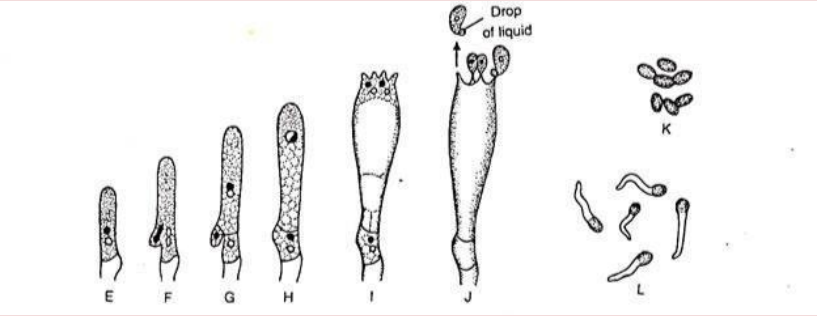


Figure – Germination of Basidiospore

(Source - HAIT BHATTACHARYA)

CONCLUSION

Agaricus genus represents the most important cultivated edible mushroom. *A. bisporous* (J. E. Lange ,Emil J. Imbach), a "common button mushroom," has the leading position among edible cultivated mushrooms, whereas ***A. brasiliensis***Waser is cultivated all around the world for its medicinal properties. These species have been demonstrated to express diverse and valuable medicinal properties including antitumor, antiaromatase, anti-inflammatory, as well as antioxidant activities. Nowadays, mushrooms are popular valuable foods because they are low in calories, carbohydrates, fat, and sodium; also, they are cholesterol-free. Besides, mushrooms provide important nutrients, including selenium, potassium, riboflavin, medicine, vitamin D, proteins, and fiber. Mushrooms being fungi even act as a decomposer and play important role in decomposing the dead organic matters. Wild mushrooms act as the source of food for wild lives including insects.

ACKNOWLEDGEMENT

I would like to express my special thanks of gratitude to my respected professors of Botany Department of Hooghly Mohsin College to give me a golden opportunity to do this wonderful presentation. I came to know about so many things so I am thankful to them. I would also like to extend my gratitude to the HOD of Botany department of Hooghly Mohsin College **"Dr. Debabrata Mukhopadhyay**" for providing me with all facilities that were required.

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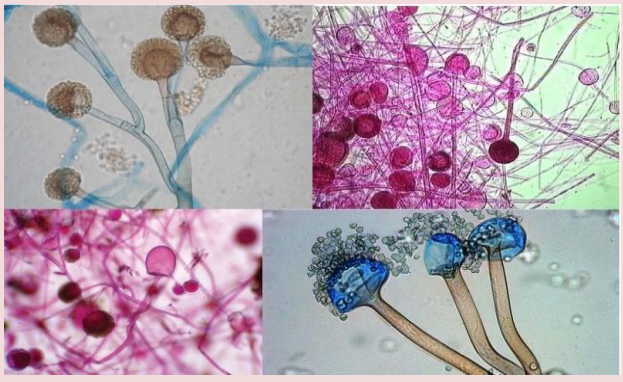
Paper –VII

ECONOMIC IMPORTANCE OF FUNGI



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ABSTRACT

Fungi are multi-cellular organisms and are considered as a kingdom known as Myceteae. There are thousands of fungi surrounding us throughout the environment and we, the humans are constantly exposed to fungi in the air we breathe, the food we eat and the water we drink. Fungi have several beneficial and harmful effects on us and our environment. There are some fungi which causes several infections in humans and plants. Fungal infection to humans causes many kinds of diseases like ringworm, Athlete's foot, blastomycosis and chromomycosis etc and fungal infection to plants causes disease like late blight of potato, ergot of rye, brown spot of rice etc which causes destructive effect on crop plants leading to yield loss. On the other hand there are several industries which are dependent on several beneficial fungi for the production of medicine, organic acids, enzymes, proteins, vitamins and foods like bread, cheese, alcoholic beverage etc. Fungi are involved in the maintenance of balance of ecosystem by playing role of decomposer. Overall we can say that without them it is very difficult to spend a single day for us.

INTRODUCTION

Fungi are eukaryotic, achlorophyllous, heterotrophic and spore bearing organisms. Cell wall is made up of chitin with other organic compounds. They obtained food by absorption directly through the cell wall (O P Sharma 1989). Being heterotrophic in nature they obtain carbon and energy from other organisms. Some fungi obtain their nutrients from a living plant or animal called biotrophs; others obtain nutrients from dead plants or animals and are called saprotrophs. Some fungi infect a living host, but kill host cells in order to obtain their nutrients; these are called necrotrophs. Fungi are involved in a wide range of activities—some fungi are decomposers, parasites or pathogens of other organisms, and others are beneficial partners in symbiosis with animals, plants or algae (Carris et al 2012). Fungi include hundreds of species which are of great economic importance to man. In fact our lives are intimately linked with those of fungi. On the other hand they have several harmful activities also.

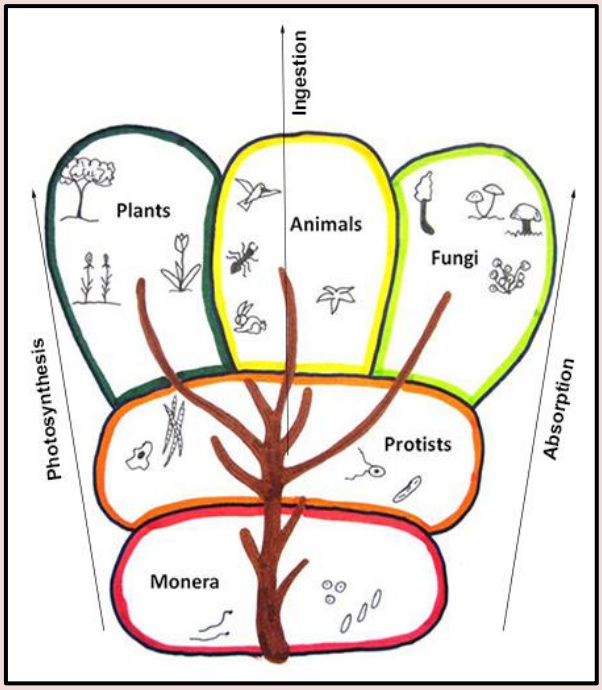


Fig 1: Position of fungi in five-kingdom classification system (Whittaker 1969)

Source - https://asm.org

❑ Beneficial aspects of fungi

❖ Religious aspect

There is a religious book named 'The Sacred Mushroom and the Cross' (Allegro 1970) which describes Study of the Nature and Origins of Christianity Within the Fertility Cults of the Ancient Near East. In some parts of the world *Amanita muscaria* is thought as warning of thunder and lightning.

Source - https://www.farnhamanglingsociety.com

Antibiotic	Sources	Active against
Penicillium	*Penicillum notatum*	Gram +ve bacteria

Fig 2: *Amanita muscaria*

❖ Preparation of Medicine

Fungi are used in the production of several important drugs. The most important species are *Penicillium notatum, Claviceps purpurea, Saccharomyces cerevisiae, Aspergillus proliferous* etc. several antibiotics, vitamins, steroids, alkaloids are obtained from

fungi.

Streptomycin	*Streptomyces grecious*	Broad spectrum antibiotic
Griseofulvin	*Penicillum griseofulvum*	Used as Systemic fungicide
Trichodermin	*Trichoderma viride*	Antifungal and anti-bacterial
Fusidic acid	*Fusidium coccineum*	Bacteria

Vitamins	**Sources**
Vitamin B-complex	*Saccharomyces cerevisiae*
Vitamin C	*Aspergillus niger*
Riboflabin	*Ashbya gossypii*

Ref of tables: Hussain M 2018

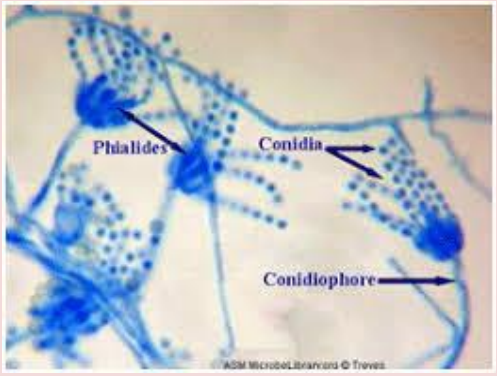
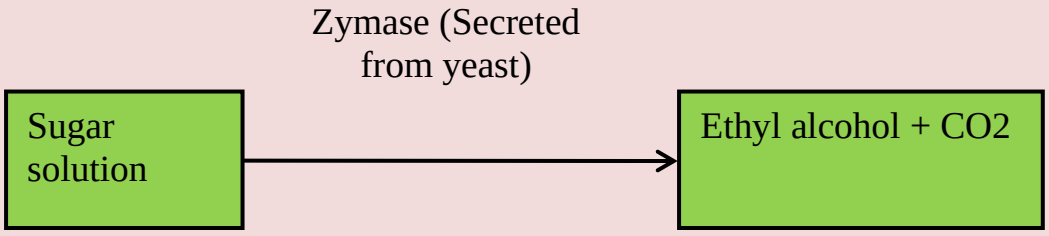


Fig 3: *Penicillium sp.*

Source - https://www.austincc.edu

❖ **Fungi in brewing and baking industries**

In brewing and breaking industries *Saccharomyces cerevisiae* i.e. yeast is widely used. In baking industries CO_2 causes the dough to rise and makes the bread light and spongy.



❖ **Preparation of organic acids**

Several fungi are used in the preparation of organic acids

Organic acids	**Sources**
Citric acid	*Aspergillus niger*
Oxalic acid	*Aspergillus niger*
Malic acid	*Rhizopous oryzae*
Gallic acid	*Aspergillus gallomyces*
Lactic acid	*Rhizopous oryzae*
Acetic acid	*Aspergillus niger*

Ref of tables: Hussain M 2018

Fig 4*: Rhizopous sp.*

Source - https://www.dreamstime.com

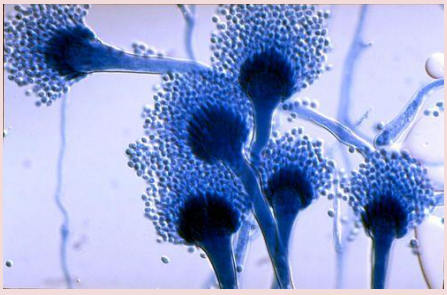


Fig 5: *Aspergillus sp.*

Source - https://microbewiki.kenyon.edu

- **Production of enzymes**

Several enzymes having industrial values are produced by fungi.

Enzymes	Sources
Amylase	*Aspergillus niger*
Protease	*Rhizopus stolonifer*
Cellulase	*Trichoderma sp.*
Takamine	*Aspergillus flavus-oryzae*

- **Anticancer property of mushroom**

Mushrooms are used in the treatment of cancer.

Anti-cancer compound	Sources
Lentinin	*Lentinus edodens*

Schizophyllin	*Schizophyllum communae*
Ganopoly	*Ganoderma lucidum*
Cordycepin	*Cordyceps sp.*

❖ Manufacture of proteins

Some fungi contain high percentage of protein of great native value on nutrition. *Saccharomyces cerevisae* is highly used in the industrial manufacture of proteins.

➢ Fungi used as food

- Mushrooms (*Agaricus bisporus, Pleurotus* sp.) are used as food due to their high protein content.
- Ascomycetes are used in the food production. For bread, cheese making yeast are used.
- Ascocarps are used for food flavouring.
- Yeast metabolite, ethanol imparts flavour to beer. (biologyease.com)

Fig 6: *Agaricus bisporus* as food

Source - https://food.ndtv.com

❖ Fungi and hormones

Gibberella fuzikuroi produces gibberellin which is a plant hormone involved in the acceleration of growth of many crop.

➢ Plant nutrition

Fungi with algae forms symbiotic association and forms lichen. Another symbiotic association formed by fungi is called mycorrhiza, where fungi(*Phallus* sp., *Rhizoctonia* sp.) associates with the root of higher plants.

❑ Harmful aspects of fungi

Beside several beneficial activities fungi have harmful effects too. Fungus affect directly by destroying our food, forms several diseases in plants and humans.

➢ Plant disease by fungi

Fungi cause much disease in crop, fruit and other economic plants. These diseases are responsible for tremendous economic losses.

Name of the diseases	Causal organism
Late blight of potato	*Phytophthora infestans*
Blast disease of rice	*Pyricularia oryzae*
Black stem rust of wheat	*Puccinia graminis var tritici*
Loose smut of wheat	*Ustilago tritici*
White rust of Crucifer	*Albugo candida*
Brown spot of rice	*Helminthosporium oryzae*
Ergot of rye	*Claviceps purpurea*
Covered smut of wheat	*Ustilago hprdei*

Source - https://www.britannica.com

Fig 7: Late blight of potato

Source - https://www.fwi.co.uk

Fig 8: Blast disease of rice

Fig 9: Black stem rust of wheat

Source - https://www.plantwise.org

Fig 10: Loose smut of wheat

Source - https://www.invasive.org

❖ Human diseases caused by fungi

Fungi cause many human diseases which includes infection on skin and other body parts. Dermatological disorders caused by fungi are called mycoses.

Name of the diseases	Causal organism
Athlete's foot	*Epidermophyton floccosum*
Blastomycosis	*Blastomycis dermatidis*
Chromomycosis	*Ajellomyces*
Cryptococcosis	*Cryptococcus neoformans*

Dermatomycosis	*Gymnoascus*
Ring worm	*Gymnoascus*

Fig 11: Athlete's foot

Source - https://health.clevelandclinic.org

Fig 12: Ring worm

Source - https://www.healthline.com

❖ **Poisonous fungi**

Some fungi are deadly poisonous, if ingested they may prove fatal. Some poisonous fungi are *Amanita muscaria*, *Boletus satanus*, *Coprinus* sp. etc.

Fig 13: *Boletus satanus*

Fig 14: *Amanita muscaria*

Source - https://boletussatanaslenz.wordpress.com

Source - https://vocal.media/potent/santa-took-shrooms

CONCLUSION

- Though fungi have several negative aspects and are involved in the spoilage of food but fungi also have several additive value in our everyday life.

- They maintain balance of the ecosystem by playing the role of decomposers (decompose lignin and cellulose).

- Fungi play great role in production of food like bread, cheese, alcoholic beverage and many other food preparations.
- Fungi contribute to the economy by commercially producing several useful enzymes, vitamins etc.
- They are highly used for the production of several antibiotics.

ACKNOWLEDGEMENT

I would like to thank **Dr. Debabrata Mukhopadhyay, Head of the Department of Botany, Hooghly Mohsin college** for his guidance. I am very much thankful to **all my teachers** of **the Department of Botany, Hooghly Mohsin College** for their constant motivation and inspiration which helped me to execute this work. I would also like to thank all our **seniors** and **friends** for their kind co-operation.

Finally I wish to acknowledge my **Parents** for their immense mental support and continuous encouragement.

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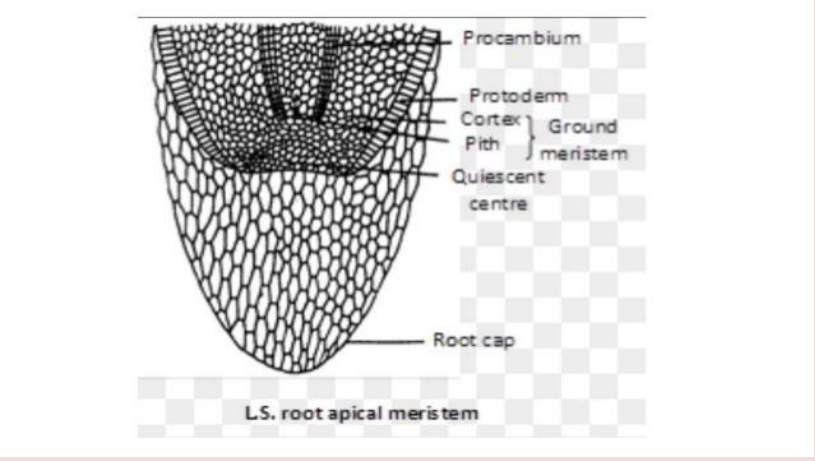
Paper -VIII

STRUCTURAL ORGANIZATION OF ROOT APEX



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ABSTRACT

The root apical meristem or root apex is a smaller region at the tip of a root in which all cells are capable of repeated division and from which all primary root tissues are derived. Basically, the part of the axis opposite to the shoot apex is called Root Apex. It basically found in lower and higher groups of plants- Pteridophytes, Gymnosperm and Angiosperm.

In vascular cryptogams, a solitary cell occurs at the root apex. Two groups of initials occur at the apex of roots of many gymnosperms. Of the two, the inner group forms the plerome, and the outer forms the periblem and the root cap. Unlike other groups dermatogen doesn't occur at the apex. In common dicotyledonous angiosperm three groups of initials usually occur at the root apex. In monocotyledonous angiosperm, one outermost layer is formed called calyptrogen.

In recent years many investigators (Jensen, Clowes and others) have claimed that a zone of low mitotic activity composed of the cells of the central part of the promeristem called quiescent centre.

Based on the occurrence of the root apex 3 theories are proposed – Apical cell theory**(Nageli,1878),** Histogen theory **(Handstein,1870 and Strasburger,1868)** and Korper-kappe theory **(Schuepp,1917).**

INTRODUCTION

In comparison to the stem apex the apical meristem of the root is similar, because of the absence of nodes and internodes and lateral appendages but it has a protective cap, which acts as the buffer between root tip and the soil particles. As the cap occupies the terminal position, the apical meristem is subterminal here. Curiously enough, growth in the root-tip proceeds in two directions opposite to each other- towards the tip in the cap and away from the tip in the root proper.

Though histogen theory has been practically discarded in case of stem apex, it is followed in interpreting the structure and growth of root apex. The apical meristem here is rather short. Considerable variations exist in the relation between the cap and the tip. In fact, root apices are of a few types depending on the mode of origin of cap and relations between histogens and primary tissue regions of the root proper.

Root apex is situated opposite to the shoot apex. The seedlings of most dicotyledonous have one main root, i.e., tap root that is soon replaced by adventitious root and lateral roots. The roots have root cap at their apices and the apical meristem occurs below the apices. Lateral and adventitious roots have promeristem with similar composition. Promeristem gives rise to all the tissues of the root and it may consist of an apical cell or group of initials.

Root Apex:

Definition-

The part of the axis opposite to the shoot apex is called root apex. It consists of the apical part of the root where the cells are meristematically active. It has simple organization as compared to stem.

Root apex is sub terminal in position because of terminal position of root cap.

STRUCTURE OF ROOT APEX IN ANGIOSPERMS –

- **In Dicot-**

  Dicot root apices are of following 3 types according to the number of initials present-
  - In **Rananculus** type, a single row of initials gives rise to epidermis, cortex and stele and root cap of root. E.g.- members of Ranunculaceae, Juglandaceae, Leguminosae.
  - In **Casuarina** type, two rows of initials present inner row gives rise to stele and the outer row produces cortex, root cap and epidermis. E.g. - Casuarinaceae, Proteaceae.
  - In common Dicot type, three rows of initials are present – Outer row (dermatogen) produces epidermis and root cap, Middle row (periblem) produces cortex and the inner row (plerome) produces stele.

(Source - HAIT BHATTACHARYA,)

❖ In Monocot:

Here four rows of initials are present, the innermost row producing stele, the middle row producing cortex, the outer row producing epidermis, the fourth outermost row called calyptrogen produces root cap.

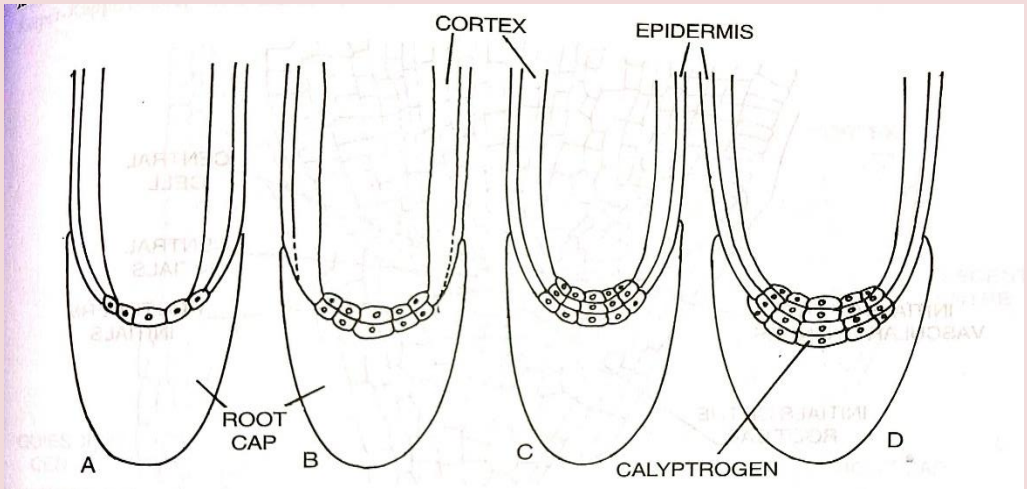


Fig. 4.8 Diagrams of different types of root apices in l.s. A—*Ranunculus* type. B—*Casuarina* type. C—Typical (common) dicot type. D—Monocot (Maize) type.

(**Source** - STUDIES IN BOTANY- VOL I, CHAPTER- PLANT ANATOMY)

ROOT APEX OF PTERIDOPHYTES

In some Pteridophytes, e.g., *Equisetum sp.* , Ophioglossaceae and Polypodiaceae, the entire root develops from a single apical cell, while in others e.g., Marattiaceae it develops few apical initials. When there is single apical cell, it is tetrahedral and it divides in such a way so that new cells are added to the body of the root from its upper surface and to the root cap from its base

.

ROOT APEX OF GYMNOSPERM

At the root apex, two groups of initials are found. Inner group forms the plerome, and the outer group forms the cap and the periblem; no sharp demarcation exists between these two regions. The apex or tip of the dermatogen is not demarcated but is originated from the periblem, a little below the apex where the base of the root cap is separated from the periblem as "a distal proliferation."

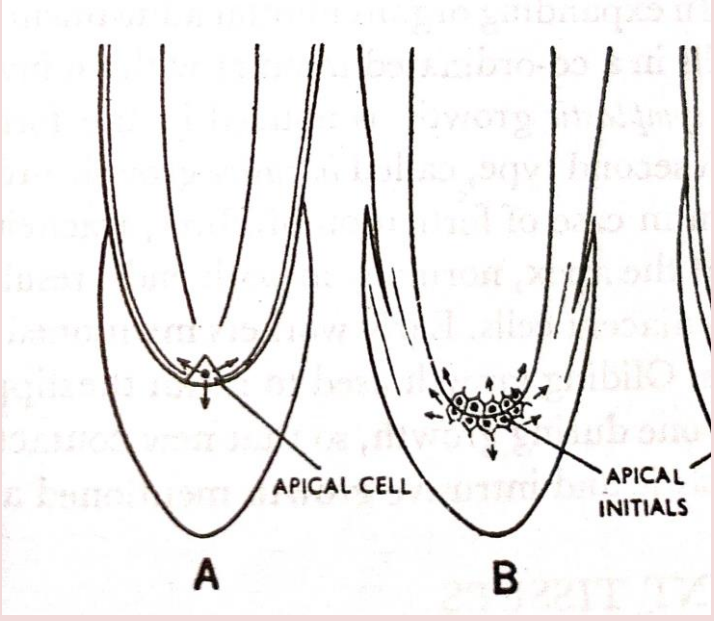


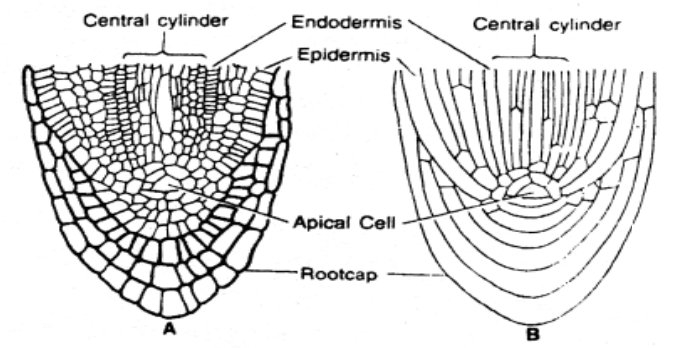
Figure - Root apices diagrammatic – A. Type found in pteridophytes with solitary apical cell. B. As found in Gymnosperms

Source - - Gangulee, Das & Dutta –

THEORIES OF ORGANISATION OF ROOT APEX

- **APICAL CELL THEORY**:

- Apical cell theory is proposed by **Hofmeister** (1852) and **Nageli** (1878).



Root tips of ferns showing apical cells.

Source - Google

- A single cell is the structural and functional unit.
- This apical cell governs the growth and development of whole plant body
- It is applicable in algae, bryophytes and some pteridophytes.
- The apical cell theory is not applicable to seed plants. This theory is concerned with the shoot and root apices.

HISTOGEN THEORY:

Hanstein and Strasburger (1868, 1870) put forward this theory. The root and shoot apices consist of a group of homogenous meristematic cells which are promeristem. This theory postulates the existence of three cells. He proposed that three regions originate from independent group of initials.
The regions are histogen termed as dermatogen, periblem, plerome.

- **Dermatogen-** Dermatogen is the outermost single cell layer. The cell usually divides by radial walls produce epidermis.

- **Periblem -** Periblem is the intermediate zone between dermatogen and plerome composed of isodiametric cells producing primary cortex.

- **Plerome -** Plerome is massive central core of apices cells divide in all planes produces stele, pericycle, primary vascular tissue, medullary rays and pith.

(Source - HAIT, BHATTACHARYA)

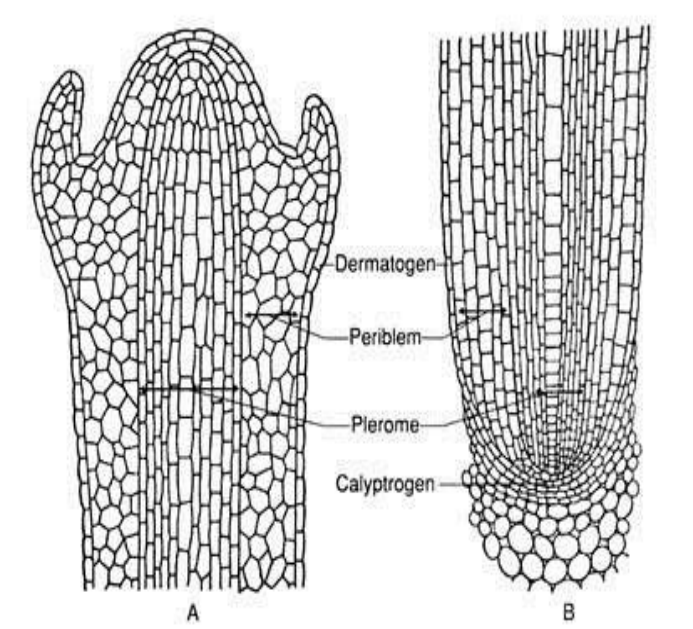


Fig.5.42 : L.S. through shoot apex (A) and root apex (B) showing histogens

Source - Google

KORPER-KAPPE THEORY-

- The theory is put forward by Schuepp (1917). It is the similar to Tunica-Corpus Theory of the shoot apex.
- Korper Kappe concept is also referred to as body-cap concept (Korper = body and Kappe = cap).
- It is based on differences in plane of cell division.

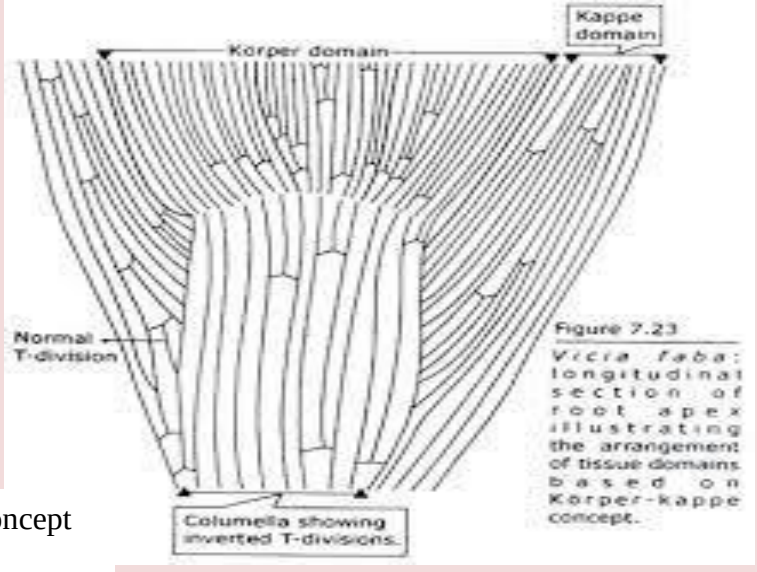


Figure – Arrangement of tissues based on korper kappe concept

Source - Google

KORPER:

- In the Kopper the initial cell first divides by transverse partition and forms two cells. The daughter cell that faces the base of root, i.e., away from the apex, inherits the initial function.
- It divides longitudinally and the two daughter cells thus formed have a potentiality of cell division. The daughter cells divide by transverse partitions followed by longitudinal partitions.
- When transverse and longitudinal partitions are viewed together the cell walls form a configuration resembling an inverted 'T'.

KAPPE:

- In the Kappe the initial cell first divides transversely and forms two cells.
- The daughter cell that faces the root apex inherits the initial function. It divides longitudinally, the two cells thus formed have the capability of cell division.
- When transverse and longitudinal partition are viewed together the combined cell walls appear as 'T' that is right way up.
- When such division continues it is observed that a single row region is left behind over the double row region.
- This occurs in downwardly pointed roots.

(Source - https://youtu.be/**)**

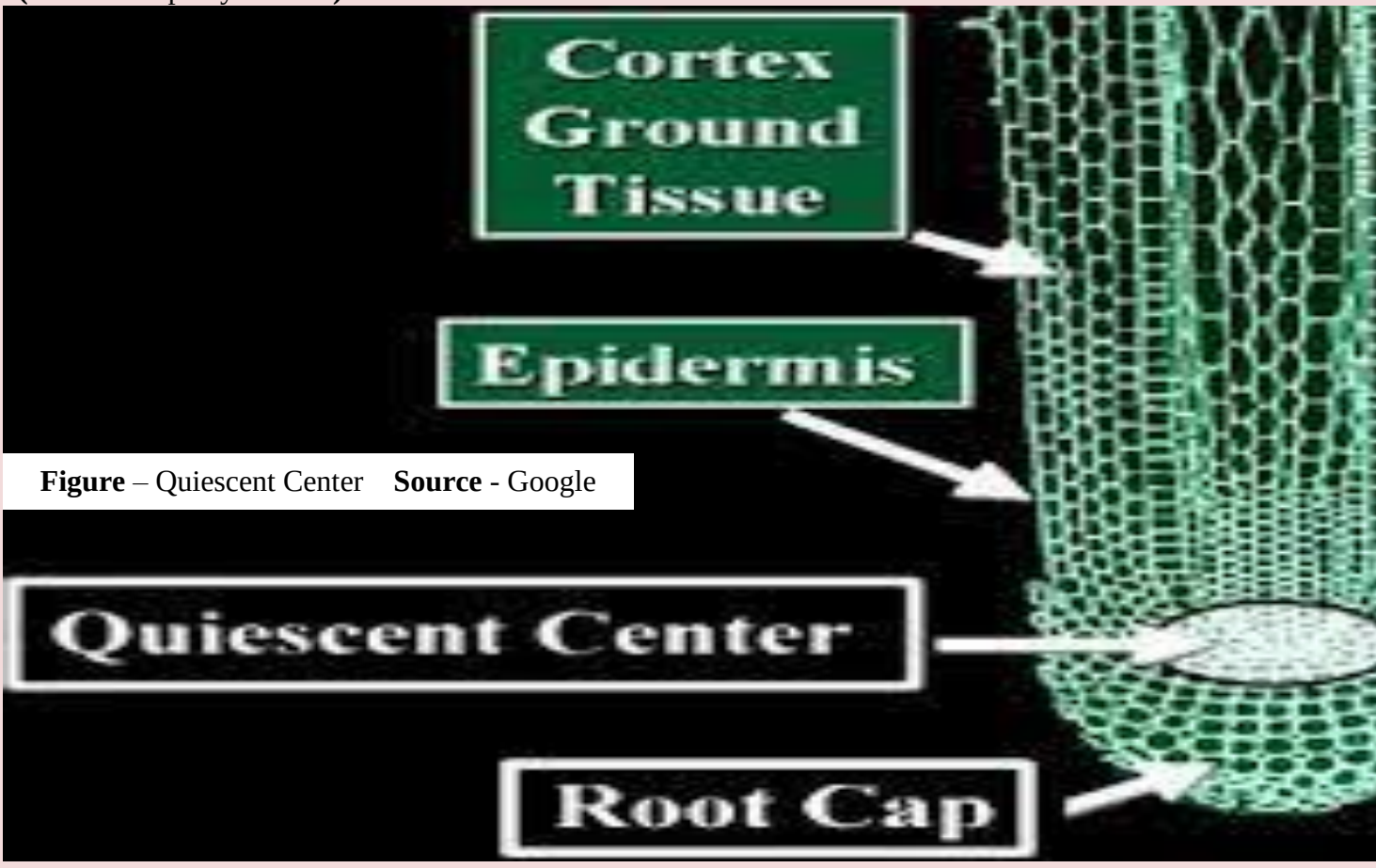


Figure – Quiescent Center **Source** - Google

➢
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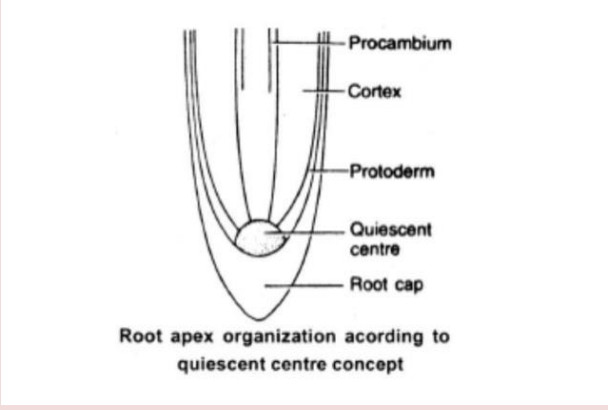
➢

- It shows little endoplasmic reticulum and few mitochondria.
- It contains low concentration of DNA, RNA and proteins.

FUNCTION-

I. It prevents the root from radioactive injury.
II. It is a site of hormone synthesis.
III. It provides blocks of diploid cells, specially during the damage of root tip.

IV. As it is source of hormone at certain concentration, it inhibits cell division.



Root apex organization acording to quiescent centre concept

Source - Google

CONCLUSION

By study of root apex, we can understand the various structure of root apex in pteridophytes, gymnosperms and angiosperms. About the organisation of root apex, I know 3 theories like Apical cell theory, Histogen theory and Korper- kappe theory. About 3 theories I prefer that Korper-kappe theory is much more useful than other theory because it is more helpful for anatomical study of root apex.

ACKNOWLEDGEMENT

I would like to express my special thanks of gratitude to my respected professors of Botany Department of Hooghly Mohsin College to give me a golden opportunity to do this wonderful presentation. I came to know about so many things and I am really thankful to them. I would also like to extend my gratitude to the HOD of Botany Department of Hooghly Mohsin College **"Dr. DebabrataMukhopadhyay**" for providing me with all facilities that were required.

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Paper -IX

SUNDARBAN & ITS DEFENCE SYSTEM

AGAINST NATURAL CALAMITIES

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ABSTRACT:

The Sundarbans, the largest mangrove ecosystem in the world, is under threat from historical and future human exploitation and sea level rise. Limited scientific knowledge on the spatial ecology of the mangroves in this world heritage ecosystem has been a major impediment to conservation efforts. Here, for the first time, we report on habitat suitability analyses and spatial density maps for the four most prominent mangrove species –*Heritiera fomes, Excoecaria agallocha, Ceriops decandra* and *Xylocarpus mekongensis*. Globally endangered *H. fomes* abundances declined as salinity increased. Responses to nutrients, elevation and stem density varied between species. *H. fomes* and *X. mekongensis* preferred upstream habitats. *E. agallocha* and *C. decandra* preferred down-stream and mid-stream habitats. Historical harvesting had negative influences on *H. fomes, C. decandra* and *X. mekongensis* abundances. The Sundarban mangrove cover played a primary role in resisting the storm – by reducing wind speed and breaking the waves, thus protecting the Delta as well as the city

of Kolkata from greater devastations. Sundarban was anticipated to have been hit significantly severe by the cyclone. Ecologists and forest conservators explain that the uniqueness of Sundarban mangroves primarily lies in its ability to absorb the storm steam through the impenetrably thick cluster of prop-roots, extricating the cyclone of its severest effects. Parts of the islands, where the mangrove cover is less have been found to be affectedbadly by the cyclone, whereas the eastern peripheries with a dense cover suffered lesser **devastation.**

INTRODUCTION:

The Sundarbans Mangroves ecoregion on the coast forms the seaward fringe of the delta and is the world's largest mangrove ecosystem, with 20,400 square km (7,900 square mi) of an area covered. Sundarbans is a Mangrove area in the delta formed by the confluence of the Ganges, Brahmaputra and Meghna Rivers in the Bay of Bengal. It spans from the Hooghly River in India's state of West Bengal to the Baleswar River in Bangladesh's division of Khulna. It comprises closed and open mangrove forests, land used for agricultural purpose, mudflats and barren land, and is intersected by multiple tidal streams and channels. The Sundarbans are the world's largest single block of mangrove forest, and a world heritage site, spanning the India-Bangladesh border. Out of theseveral burning issues putting forth the hardship of climate changes around every corner of globe irrespective of nations, sea and surface level temperature rise have been addressed to be the burning issue for the environmental biology. Apart from being a unique ecosystem, mangroves (and other wetlands) provide substantial protection to coastal populations from flooding, erosion and natural hazards. Although mangrove tree species are able to tolerate inundation by tides, they can die and their former habitat can convert to tidal flats or open water when sea-level rise causes the frequency and duration of inundation to exceed species-specific physiological thresholds.

Figure – Geographical region of Sunderban

Source – Google Earth Images

WHAT ARE MANGROVES?

Mangroves can be trees, shrubs, ferns and palms that occupy the boundary between the land and the sea. They mainly grow in or adjacent to areas between the high tide and the low tide. They get regularly covered or immersed in water at high tide and exposed to air at low tide. The roots of mangroves are regularly exposed to saline water. At times, they are also exposed to freshwater surface runoffs and flooding. Mangroves get their nutrition from these tidal saline and freshwater resources and coastal soils and silt that get deposited from the surrounding land after erosion. (**Source -** https://www.indiawaterportal.org)

Figure – Mangrove trees with its breathing roots

Source - Google

WALL OF SUNDARBAN:

Mangroves are salt tolerant vegetation that grows in intertidal region of rivers and estuaries. They are referred to as 'tidal forests' and belong to the category of 'tropical wetland rainforest eco system'. Mangrove trees and shrub species that grow at the interface between land and sea in tropical and subtropical regions of the world, where the plants exist in conditions of salinity, tidal water flow, muddy soil. Sundarbans in the Gangetic delta with an area of 2.12 lakh hectares supports 26 plant species of mangrove with a maximum height 10 meters.

(**Source** - https://www.downtoearth.org.in)

LIFESTYLE OF SUNDARBAN:

Sundarban which is also home to over 5 million people is an ecologically fragile and climatically vulnerable region. The Sundarban provides sustainable livelihood to millions of people and function as a protective barrier for its inhabitance from storms, cyclones, tidal surges, sea water seepage and intrusions.

(**Source** - https://youtu.be/6VHBJdTGH9k)

Figure – Biodiversity of Sunderban

Source - Google

CHALLENGES OF SUNDARBAN:

India is a country in the North Indian Ocean that is the most vulnerable to getting hit by tropical cyclones in the basin from the west. On average, 2-3 tropical cyclone make landfall in India each year, with about one being a severe tropical cyclone or greater. Due to climate change Sundarbanfaces several challenges. With rising sea levels, islands are disappearing and the increasing salinity in water and soil has severely threatened the health of mangrove forests and the quality of soil and crops. Frequent devastating cyclone and erratic monsoon raining pattern are damaging ecology and humanity.

(Source - https://en.m.wikipedia.org**)**

Figure – The people of Sunderban affected by natural disaster

Source - Google

SUPERCYCLONE & THEIR EFFECTS:

• **Sidr:** In 2007 super cyclone Sidr, originating in the Bay, ravaged the entire south and southwestern coast with peaking winds of over 220km/hr. on November 15. This coastline is home of nearly 12 millionpeople whereas Sidr caused human loss of about 5,000 and made the survivors homeless.

Effects: The Sundarbans absorbed the main blow of the Sidr, saving human lives by slowing down the nature's wrath. According to the forest department, one fourth of the Sundarbans forest area had been damaged by the cyclone Sidr. Eight to ten percent of the forest had been damaged completely, while fifteen percent has been partly damaged.

• **Aila:** Storm Aila was the second named tropical cyclone of the 2009 North Indian Ocean cyclone season. Aila formed over a disturbance over the Bay of Bengal on May 23, 2009 and started to intensify and reaching sustained wind speeds of 110 kmph (70 mph). It was the worst natural disaster to affect Bangladesh since Cyclone Sidr in November 2007.

Effects: The storm was responsible for at least 339 deaths across Bangladesh and India; more than 1 million people were left homeless. Health officials in Bangladesh confirmed a deadly outbreak of diarrhea on 29 May, with more than 7,000 people being infected and four dying. In Bangladesh, an estimated 20 million people were at risk of post-disaster diseases due to Aila.

(**Source -** https://en.m.wikipedia.org)

• **Bulbul:** Storm Bulbul in the West Pacific was a powerful and very damaging tropical cyclone. It's landfall in West Bengal on November 09 in 2019 around the Sundarban forest brought extremely heavy rain and winds up to 137 km/h (85 mph) across much of the southern portion of the state.

Effects: Fallen trees caused road blockages across the city of Kolkata as well, and members of the Kolkata Municipal Corporation (KMC) removed these blockages. Operations at Netaji Subhas Chandra Bose International Airport in Kolkata were suspended for 12 hours. Throughout West Bengal, approximately 3.5 million people were directly affected by the cyclone; 14 people died in storm-related incidents. A total of 517,535 homes and 1,489,924 hectares (3,681,680 acres) of crops were damaged or destroyed, with losses reaching Rs 238.11 billion (US$3.34 billion).

(**Source -** https://en.m.wikipedia.org)

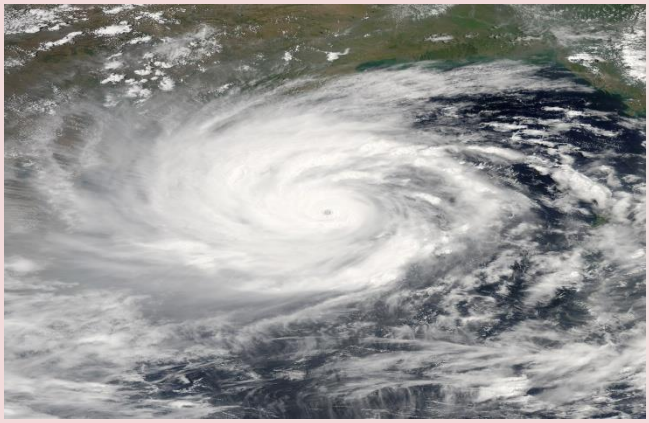

Figure – Satellite image of a cyclone

Source - Google

•**Amphan:** Recently on May 20 in 2020, super cyclone Amphan took a trail over Sundarban resulting in a massive destruction. Winds blowing at over 150kmph hit the Sundarbans by the time cyclone had made its landfall.

Effects: Cyclone Amphan hit West Bengal claiming 86 lives so far and affecting over 10 million people in the eastern Indian state. The storm in West Bengal caused massive damage to standing crops, thousands of trees were uprooted, and power and water supply were interrupted in the state capital Kolkata. Many in the state had lost their entire houses as well.

(**Source -** https://en.m.wikipedia.org)

•**Yaas:** After Cyclone Amphan left its mark on Kolkata last year, another powerful cyclone hit Bay of Bengal began. 'Cyclone Yash' headed towards Bengal on May 26 with a ferocity parallel to Amphan. A low depression formed in the East Central Bay that turned into a 'super cyclone' which made landfall in Balasore.

Effects: Cyclone Yaas devastated Sundarban's surface. As rain water breached embankments, saline water entered the fields, destroying the standing crops. The base of many houses got washed away as the remaining structure stands on bamboo.

(Source - https://www.republicworld.com**)**

HOW DOES MANGROVES PROTECT SUNDARBAN FROM CYCLONES?

•The damage caused by the cyclones on the wildlife is clearly high. The flooding due to cyclones or storms and the rising salinity of sea level in the delta makes it complete unusable for farming.

Experts say that the delta's mangroves have helped to reduce the intensity of the cyclone hitting the coastal communities in the area like always.

•Mangroves are incredibly productive coastal ecosystems found in the tropics and subtropics. These dense green forests are known for their bizarre-looking roots that poke up into the air from shallow water. Among the meshed webs of roots are fish nurseries, enabling humans to make a living from the marine life in and around the mangroves.

Figure - Effect of mangroves on coastal areas

Source - Google

•Mangroves also play another important role for humans i.e., protecting communities from major storms. Climate change is more than rising temperatures, and the increased frequency and intensity of cyclones, hurricanes and typhoons is apparent.

•Mangrove roots can break the force of a storm surge, soaking up some of its energy and protecting the people living on coasts from cyclone damage.

(**Source -** https://science.thewire.in)

HUMANITY VS MANGROVE ECOSYSTEM:

• Mangroves are a type of tropical forest, uniquely positioned at the dynamic interface of land sea. They are found along coasts and estuaries throughout the tropics and subtropics and are capable of thriving in salt water; prospering in conditions to which only a few species have adapted. Mangroves

form the foundation of a highly productive and biologically rich ecosystem which provides a home and feeding ground for a wide range of species, many of which are endangered. Although mangroves make up less than one percent of all tropical forests worldwide, they are highly valuable ecosystems, providing an array of essential goods and services which contribute significantly to the livelihoods, well-being and security of coastal communities. The complex network of mangrove roots can help reduce wave energy, limiting erosion and shielding coastal communities from the destructive forces of tropical storms. Mangrove ecosystems are often an essential source of seafood for both local and national seafood trade. In addition it also provides other materials such as firewood and timber, which support the livelihoods of thousands of coastal communities.

•Beyond their direct benefits, mangroves also play an important role in global climate regulation. The mangrove ecosystem is one of the most threatened on the planet. Mangroves are being destroyed at rate 3-5 times greater than average rates of forest loss and already over a quarter of the original mangrove cover has disappeared; driven by land conversion for aquaculture and agriculture, coastal development, pollution andoverexploitation of mangrove resources. As mangroves become smaller and more fragmented, important ecosystem goods and services will be diminished or lost. The consequences of further mangrove degradation will be particularly severe for the well-being of coastal communities in developing countries, especially where people rely heavily on mangrove goods and services for their daily subsistence and livelihoods.

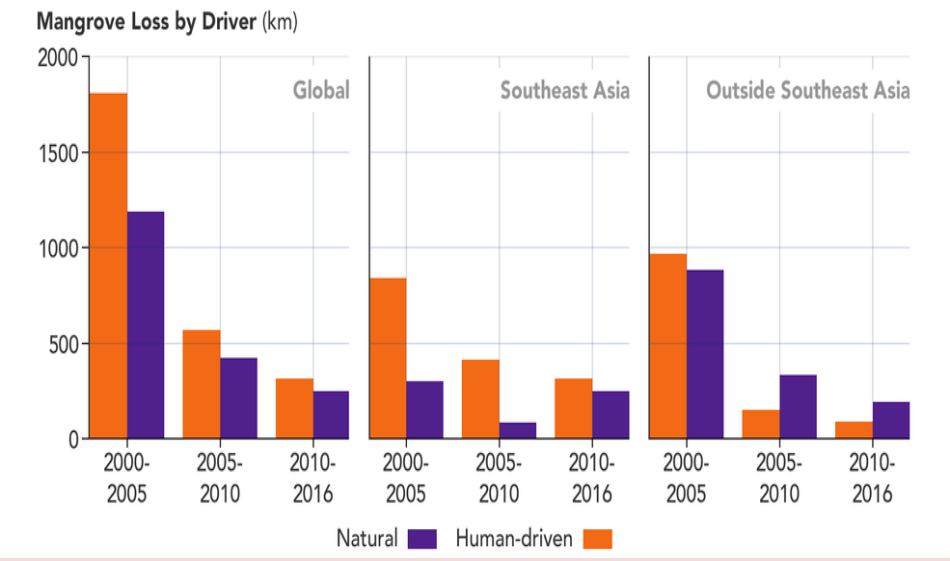

Figure – Natural and human-driven loss in Sunderbans

Source - Google

•The future of mangroves is not bleak. Increasing recognition of the importance of mangrove ecosystems for both biodiversity and human well-being is driving efforts around the world to

conserve, better manage and restore these ecosystems. Many of these have been successful at a local scale, often supported by national policies that recognize the significant long-term benefits of mangroves over short-term financial gains. Mangroves need to be understood for the valuable socio-economic and ecological resource they are and conserved and managed sustainably. This will take a commitment by government to make policy decisions and enforce protection measures to curb the widespread losses from human activities. This global synthesis document serves as a call to action to decision makers and highlights the unique range of values of mangroves to people around the world. It aims to provide a science-based synthesis of different types of goods and services provided by mangroves and the associated risks in losing these services in the face of ongoing global habitat loss and degradation. The document provides management and policy options at the local, regional and global level with the aim of preventing further losses through effective conservation measures, sustainable management and successful restoration of previously damaged mangrove areas.

•Our hope is that this call to action will generate renewed interest in mangroves for policy-makers, helping to safeguard a future for these essential yet undervalued ecosystems. Mangroves act as shock absorbers. They reduce high tides and waves and help to prevent soil erosion. They also provide livelihood opportunities to coastal communities. Mangroves give protection to the coastline and minimize disasters due to cyclonesand tsunamis. Recent studies have shown that mangroves store more carbon dioxide than most other forests. They perform important ecological functions like nutrient cycling, hydrological regime, coastal protection, fish production etc.

(**Source -** https://www.researchgate.net/publication)

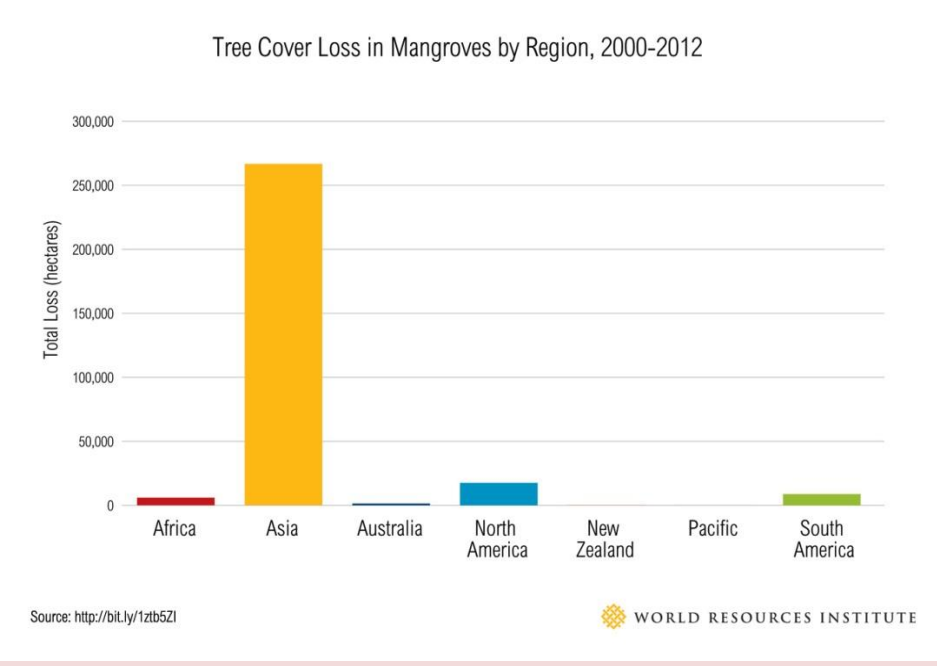

Figure – Tree cover loss in Mangroves by region

SOCIAL AWARENESS:

• Coastal vulnerability and risk assessment due to climate change.

• Integrated coastal and marine zone management.

• Monitoring the impact of climate change on threatened species of Sundarban Mangrove Forest.

• Strict control of poaching vulnerable species.

• Facilitating natural regeneration and succession of native trees species.

•Community based coastal afforestation.

• Education on climate change, DRR and emergency and preparedness.

• Public awareness program to save Sundarban.

• Protecting the Sundarban against encroachment.

• Initiation of International Conservation Program to save the Sundarban.

Figure – Awareness camp to save mangrove tress

Source – Google

CONCLUSION:

The deterioration of Sundarban mangroves can lead to serious consequences, including reduction in biodiversity, species decline, genetic erosion, extinction, increased flooding, and decline in water quality. The future existence of Sundarban mangrove forest depends on the development and successful implementation of a sustainable management plan to protect and conserve these important resources. The government has attempted to introduce some initiatives to protect these important ecosystems but the sustainability of these resources could not be achieved due to lack of sound management strategies. A sustainable management plan should be developed by involving all beneficiaries and stakeholders and should be effectively implemented to conserve the world's largest mangrove ecosystem for present and future generations.

ACKNOWLEDGEMENT:

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