BOTANY
SEMESTER II

Botany

Programme/Class: ***Certificate Course In Microbial Technology & Classical Botany***	Year: **I**	Semester: **II** **Paper-II (Practical)**
Subject: **Botany**		
Course Code: B040202P	Course Title: **Land Plants Architecture**	

Course outcomes:

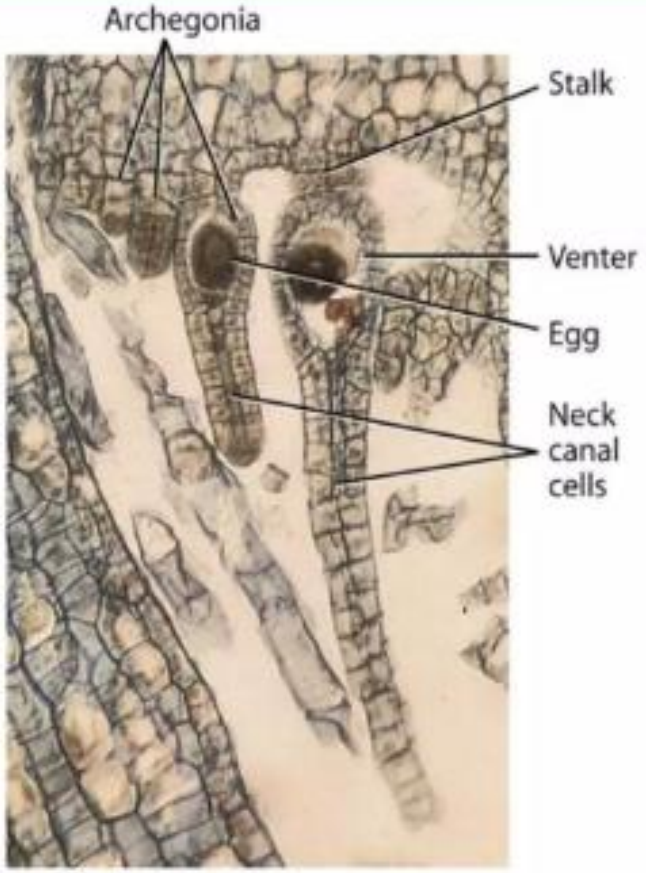
1. The students will be made aware of the group of plants that have given rise to land habit and the flowering plants. Through field study they will be able to see these plants grow in nature and become familiar with the biodiversity.
2. Students would learn to create their small digital reports where they can capture the zoomed in and zoomed out pictures as well as videos in case they are able to find some rare structure or phenomenon related to these plants.
3. Develop an understanding by observation and table study of representative members of phylogenetically important groups to learn the process of evolution in a broad sense.
4. Understand morphology, anatomy, reproduction and developmental changes therein through typological study and create a knowledge base in understanding plant diversity, economic values & taxonomy of lower group of plants
5. Understand the composition, modifications, internal structure &architecture of flowering plants for becoming a Botanist.

Credits: **2**	**Core Compulsory**
Max. Marks: **25+75**	Min. Passing Marks:

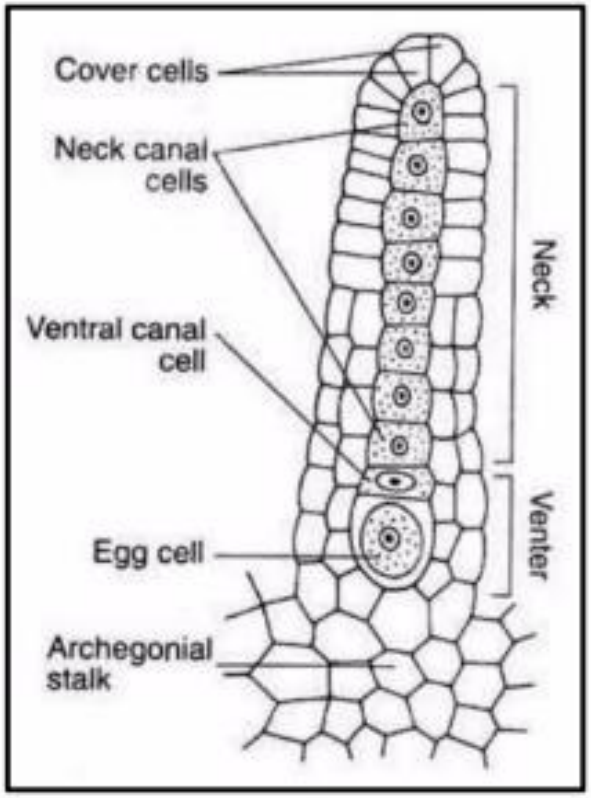
Total No. of Lectures-Tutorials-Practical (in hours per week): **0-0-2**		
Unit	**Topic**	**No. of Lectures**
I	**Bryophytes:** Marchantia- morphology of thallus, W.M. rhizoids and scales, V.S. thallus through Gemma cup, W.M. gemmae (all temporary slides), V.S. antheridiophore, archegoniophore, L.S. sporophyte (all permanent slides). *Sphagnum*- morphology, W.M. leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, L.S. capsule and protonema.	**8**
II	**Pteridophytes:** *Lycopodium*: Habit, stem T. S. stobilus V. S., *Selaginella*: Habit, rhizophore T. S, stem T . S, axis with strobilus, V.S. of strobilus, Megasporophyll and microsporophyll. *Equisetum* - Habit, rhizome and stem T.S. and V. S. of strobilus. *Azolla* – Habitat & its structure	**7**
III	**Gymnosperms** 1. *Cycas* – seedling, coralloid root and coralloid root T. S., T. S. of leaflet and Rachis, micro and megasporophyll, male cone V. S., microsporophyll T. S. entire and V. S. of ovule. *Pinus* - Branch of indefinite growth, spur shoot, T. S of old stem and needle R.L.S and T. L. S. of stem, male and female cone, V.S. of male and female cone. 2. *Ephedra* & *Thuja*: Habit, stem T. S (young and mature), leaf T. S, male and female strobilus, V. S. of male and female cone, ovule V. S. and seed.	**8**
IV	**Palaeobotany & Palynology** 1. Morphology of *Rhynia* and fossils gymnosperms & other groups. 2. Visit Birbal Sahni Institute of Palaeosciences or virtual conference with their scientis to learn fossilization. 3. Mark and know about Indian geographical sites rich in plant fossils.	**6**
V	**Angiosperm Morphology** 1. To study diversity in leaf shape, size and other foliar features. 2. To study monopodial and sympodial branching. 3. Morphology of Fruits 4. Inflorescence types- study from fresh/ preserved specimens 5. Flowers- study of different types from fresh/ preserved specimens 6. Fruits- study from different types from fresh/preserved specimens 7. Study of ovules (permanent slides/ specimens/photographs)- types (anatropous, orthotropous, amphitropous and campylotropous) 8. Modifications in Roots,stems, leaves and inflorescences	**8**

VI	**Plant Anatomy:** Normal & Anomalous secondary thickening - *Bignonia, Dracaena, Boerhaavia diffusa, Nyctanthes* Study of primary and secondary growth in the root and stem of monocots and dicots by section cutting and permanent slides. Study of internal structure of dicot and monocot leaves. Study of structure of stomata.	**8**
VII	**Reproductive Botany** 1. Structure of anther, microsporogenesis and pollen grains 2. Structure of ovule and embryo sac development (through slides). 3. Study of embryo development in monocots and dicots. 4. Vegetative propagation by means of cutting, budding and grafting exercises. 5. Study of seed germination. 6. Study of pollen morphology of the following plants –*Hibiscus, Vinca, Balsam, Ixora, Crotalaria, Bougainvillea* by microscopic observation. 7. Calculation of pollen viability percentage using in vitro pollen germination techniques.	**8**
VIII	**Commercial Uses and Production technology** 1. *Azolla* production 2. Production technology of Resins 3. Production and propagation of Ornamental *Pteris*, Cycadales, Coniferales for landscaping. 4. Lab method for qualitative testing/ extraction of Ephedrine ,Taxol and *Thuja* oil.	**7**
Suggested Readings:		

ARHEGONIATES



WHAT ARE ARCHEGONIATES?

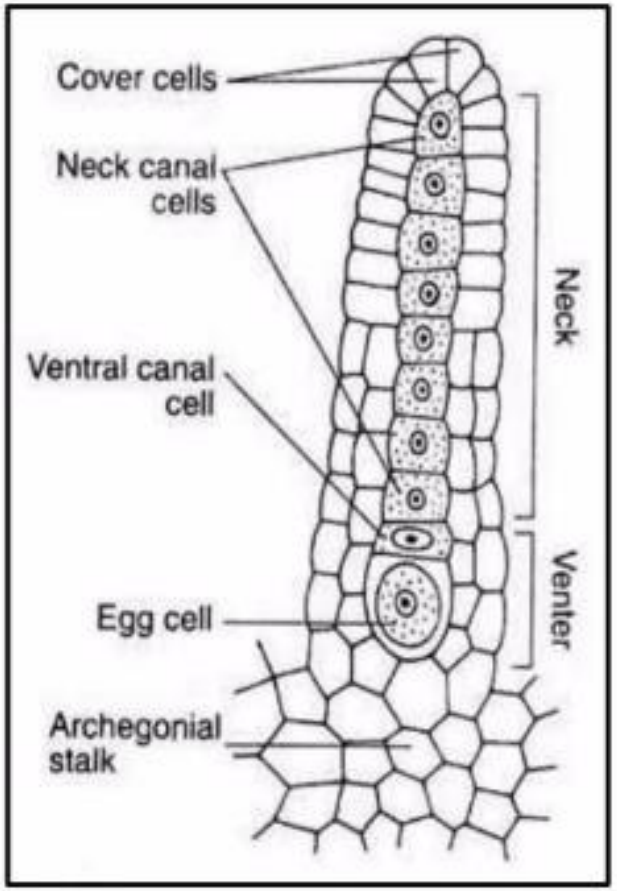


- They are plants having archegonia as female reproductive part.
- Archegonium is a flask shaped female reproductive part.
- It is found in the archegoniate plants

e.g. Bryophyta, Pteridophyta and Gymnosperms.

What is an archegonium?

- A mature archegonium is a flask shaped structure, without neck canal cells and with an egg (oosphere) in its venter.
- At the top of the neck of the archegonium there are four cover cells, which become separated from the archegonium, as soon as the gelatinization of the venter and neck canal cells is over.



Unifying Characteristics of Archegoniates

1. The archegoniates seem to have **originated from** a monophyletic group of **aquatic green algae**.
2. Presence of Female sexual organs are called **archegonium** and the male sexual organs are called **antheridium**.
3. The presence of **Chloroplasts** containing chlorophyll a, b and carotene.
4. The presence of multicellular **gametophytic and sporophytic generation.**

Unifying Characteristics of Archegoniates

5. Heteromorphic alternation of generation.
6. Provides protection to their embryo
7. Male gametes are flagellated and motile in bryophytes, pteridophytes, (Cycadales, Ginkgoales) while the female gamete (egg) is non-motile.
8. Water is needed for fertilization in Bryophytes and Pteridophytes but not in Gymnosperms.

Unifying Characteristics of Archegoniates

9. In gymnosperms, pollen grains germinate to form a pollen tube (siphonogamy) which is not dependent on external fluid water to reach the archegonial neck.
10. Differentiated tissues with thickened cell walls (collenchyma) and lignified walls (sclerenchyma) to support the erect habit.
11. Efficient spore dispersal mechanism.
12. The archegoniates evolved several adaptive strategies to survive on land.

The transition from water to land

- There are lots of evidences regarding the evolution of land plants from the aquatic environment.
- The first multicellular organisms that lived in the water are **green algae** which are considered to be the **ancestors** of land plants.
- This transition from water to land habit was made possible due the following **adaptations** that occurred in those plants.

Adaptations...

1. **Body support**

- Supportive structures developed to withstand the forces of gravity.
- Such as **Rigid cell walls**, different types of **supportive tissues** (e.g., woody tissues, branch cells, etc.).
- However, the mosses lack these tissues, and are thus **limited to land habit**.
- This type of support is found in the **ferns**, although it is very primitive.
- In the **conifers and flowering plants**, the most well-developed adaptations of this nature are observed.

Adaptations...

2. **Transport of materials**

- Another challenge to transform from water to land form.
- In aquatic forms, transport occurs directly from the surrounding environment.
- But land plants must absorb water and other materials from the soil.
- Thus, they need to develop **conducting vessels** to transport materials from the soil to the plant as well as from the leaves to the different parts of the plant.
- It also led to the **evolution of differentiation of plant parts**, such as, evolution of **leaf cells** having ability to create food via photosynthesis; **root cells** to transport nutrients from the soil; the **cuticle, stomata, phloem**, **xylem** etc. are also developed to regulate the water inside the plant, etc.

Adaptations...

3. Fertilization

- A third challenge is to bring sex cells together.
- In water, sperm are able to swim directly to eggs.
- However, on land, this is possible only in moist condition as seen in mosses and ferns.
- Land plants show alternation of generations and the sporophytic generation produces spores inside microscopic gametophytes.
- The male gametophytes, which form non-swimming sperm, develop within pollen grains. The female gametophytes, which produce eggs, develop on scales (in conifers) or within ovaries (in flowering plants).
- Pollen is **adapted to use wind** to transport sperm to eggs, which **replaces the need for water** in those plants.

Adaptations...

4. Development and dispersal of the embryo

- A fourth challenge.
- In aquatic environments, a fertilized egg can develop into an embryo without facing the problem of dehydration.
- In addition, the embryo can receive water and nutrients directly from the surrounding environment. Whereas, in land plants, an embryo and exists in an environment where water and nutrients exist in the ground and thus **can dry out rapidly**.
- This problem is mitigated as the seeds enclose an embryo in a moist environment, and the tissues within seeds provide food for a developing embryo.
- Finally, seeds represent a way of dispersing the young of plants away from water as well as away from the parent plant. The seed plants include the conifers and flowering plants.

BRYOPHYTES

Characteristics of Phylum Bryophyta

(Mosses, Liverworts & Hornworts)

BRYOPHYTES

- What are bryophytes?
- What are the characteristics of bryophytes?
- Understand the life cycle of bryophytes.
- Understand how bryophytes reproduces.
- What is the structure of Antheridium and Archegonium of Bryophyta.
- Understand alternation of generation in bryophytes.
- What are the economic importance of bryophytes?
- What are the ecological importance of bryophytes?




BRYOPHYTES: CHARACTERISTICS

Bryophytes

- Bryophytes are the most simplest and most primitive land plants
- Name bryophyte is derived from two words:
  - 'Bryon' = moss
  - 'phyton' = plant
- At present the phylum Bryophyta includes:
  - Genera: ~ 960
  - Species: ~ 24000

BRYOPHYTES: CHARACTERISTICS

Habit and Habitat of Bryophytes

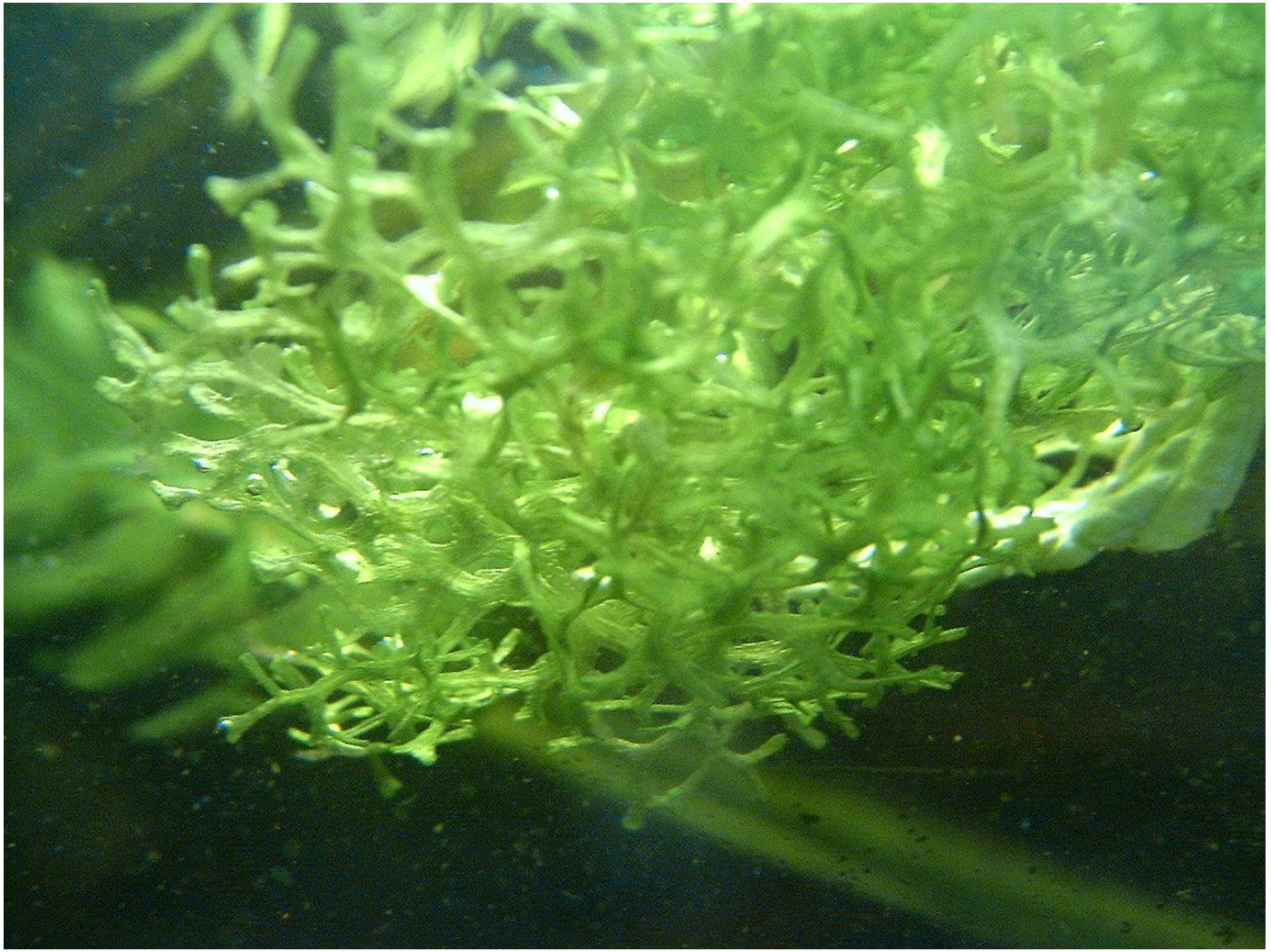
- Cosmopolitan in distribution
- Uncommon in marine environments
- They are terrestrial plants but require water at every stages in their life cycle
- They grow in moist and shady places
- They fail to complete its life cycle in the absence of water

BRYOPHYTES: CHARACTERISTICS

Habit and Habitat of Bryophytes

- Few bryophytes are truly aquatic and underwater forms (*Riccia fluitans*)
- Peat moss (*Sphagnum* moss) grown in bogs and marshy areas
- *Porella* is an epiphytic bryophyte that grow on tree trunks
- *Radulla protensa* is an epiphyllous bryophyte grow on the surface of leaves
- *Tortula desortorum* is a xerophytic bryophyte growing in deserts

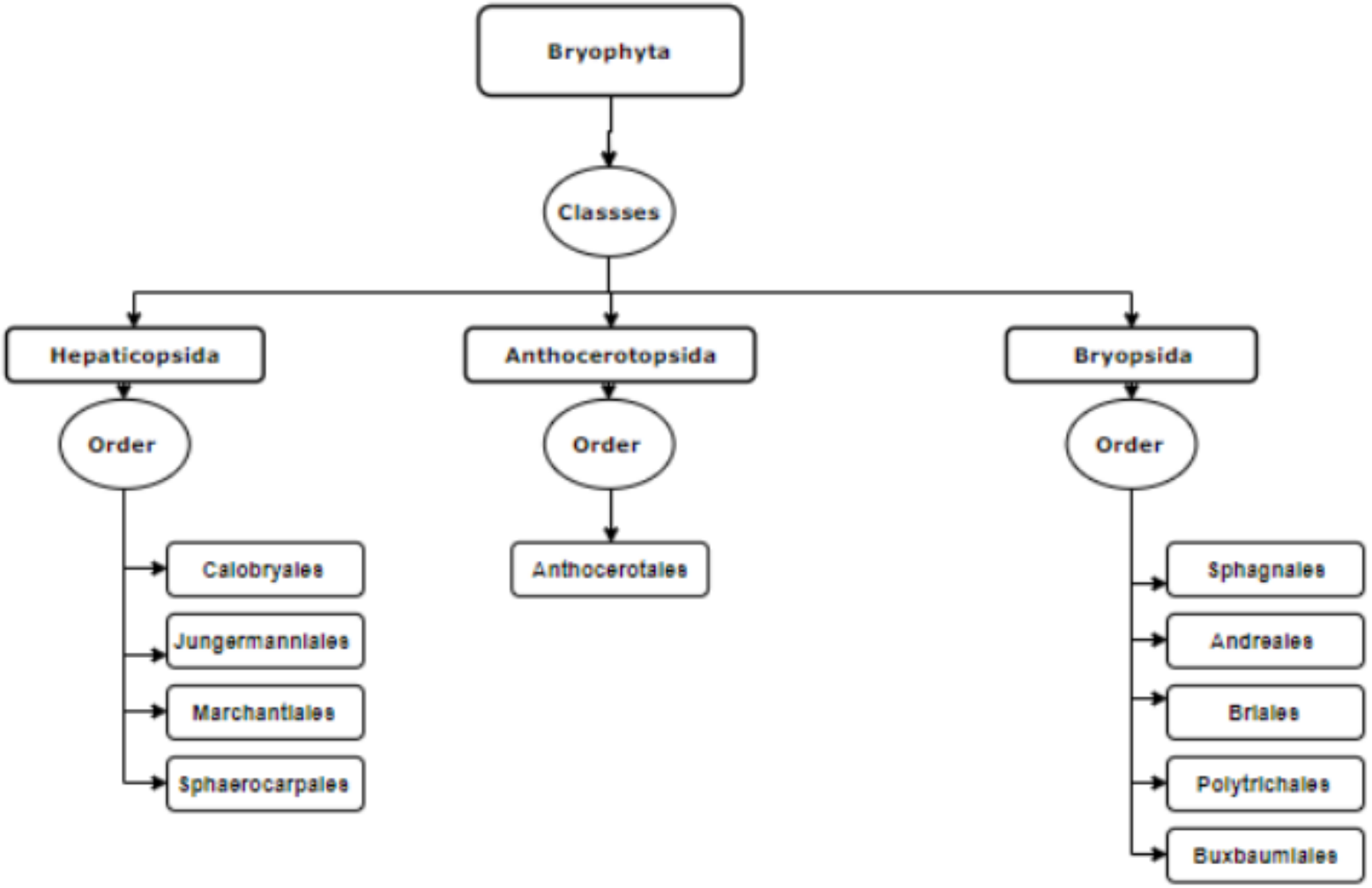
Sphagnum flexuosum



Riccia fluitans

Anthoceros agrestis

Characteristics Of Bryophytes



BRYOPHYTES: CHARACTERISTICS

Land adaptations of bryophytes:

- Bryophytes are fundamentally land plants, their land adaptations are:
  - Possess root like rhizoids to absorb water from soil
  - Free surface of epidermis is coated with water proof waxy coating to prevent water lose and protect against desiccation
  - Possess stomata like structures for gaseous exchange
  - Possess multicellular sex organs surrounded by sterile jacket
  - After fertilization the zygote is left inside the archegonium to provide nutrition for the sporophyte development

These features helps bryophytes to live in land condition

BRYOPHYTES: CHARACTERISTICS

Why Bryophytes the Amphibians of Plant Kingdom?

- Amphibians in the animal kingdom lives in water as well as in land
- Similarly bryophytes represented by liverworts, hornworts and mosses grow well in the areas between water and terrestrial habitats (amphibious zone)
- Bryophytes are dependent on water to complete their life cycle

BRYOPHYTES: CHARACTERISTICS

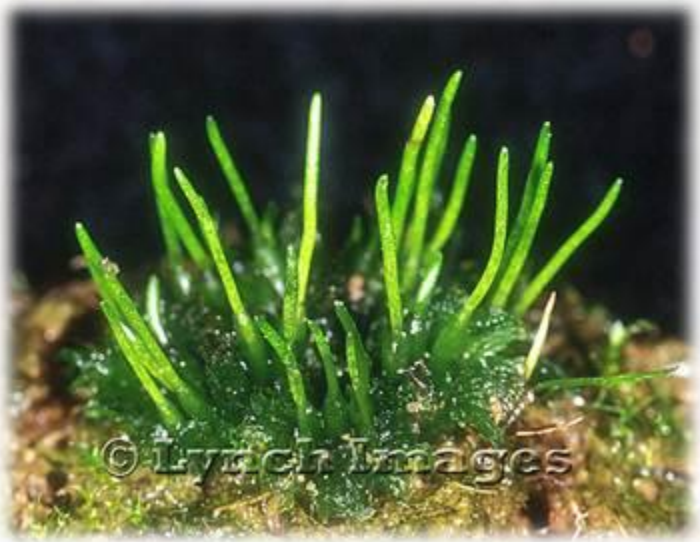
Why Bryophytes the Amphibians of Plant Kingdom?

- Bryophytes are dependent on water to complete their life cycle
- Presence of water is required and essential for the:
  - *Dehiscence of mature antheridia*
  - *Liberation of antherozoids form antheridia*
  - *Transfer of antherozoids form antheridia to archegonia*
  - *Opening of archegonial neck*
  - *Movement of flagellated antherozoids into the archegonial neck*
- Life cycle of bryophytes will not complete in the absence of water
- Thus they are called as the amphibians of plant kingdom.

BRYOPHYTES: CHARACTERISTICS

Gametophyte of bryophyte

- Life cycle consists of gametophytic and sporophytic phases (generations)
- Gametophytic and sporophytic generations are physically connected
- Gametophytic and Sporophytic phases are Heteromorphic (morphologically distinct)



BRYOPHYTES: CHARACTERISTICS

Characteristic of gametophytic generation of Bryophyte:

- Gametophytic generation is more conspicuous phase in life cycle
- Gametophytic generation is long lived and prominent phase
- It is independent, green autotrophic phase
- Gametophytic plant is fleshy
- In lower forms gametophyte is undifferentiated and thalloid
- In higher forms, gametophyte is differentiated into root like, leaf like and stem like structures



BRYOPHYTES: CHARACTERISTICS

Characteristics of sporophytic generation of Bryophyte:

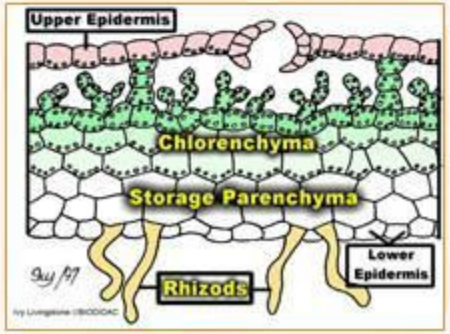
- Sporophytic generation is less conspicuous phase in life cycle
- Sporophytic generation is short lived
- Sporophyte is completely dependent on gametophytic plant for nutrition
- Usually differentiated into foot, seta and capsule

Capsule of *Physcomitrella patens*

BRYOPHYTES: CHARACTERISTICS

Gametophyte of bryophyte

- In primitive forms (*Riccia* and *Marchantia*) gametophyte is undifferentiated, prostrate and thalloid
- In advanced forms (mosses) plant body is erect, differentiated into stem (axis), lateral appendages (leaves) and rhizoids
- True roots are absent in bryophytes
- Rhizoids are present, rhizoids helps in anchorage and absorption
- Rhizoids may be unicellular and un-branched to multicellular branched
- Sometimes multicellular scales may be present
- Scales helps to protect growing region of the thallus



BRYOPHYTES: CHARACTERISTICS

Gametophyte of bryophyte

- Plant body consists of parenchymatous cells only
- Thick walled and lignified cells are completely absent in all phases
- Vascular tissue are completely absent
- Plant body sometimes internally differentiated into photosynthetic and storage zone (labour division)
- Xylem and phloem are absent

BRYOPHYTES: CHARACTERISTICS

Bryophyta reproduction:

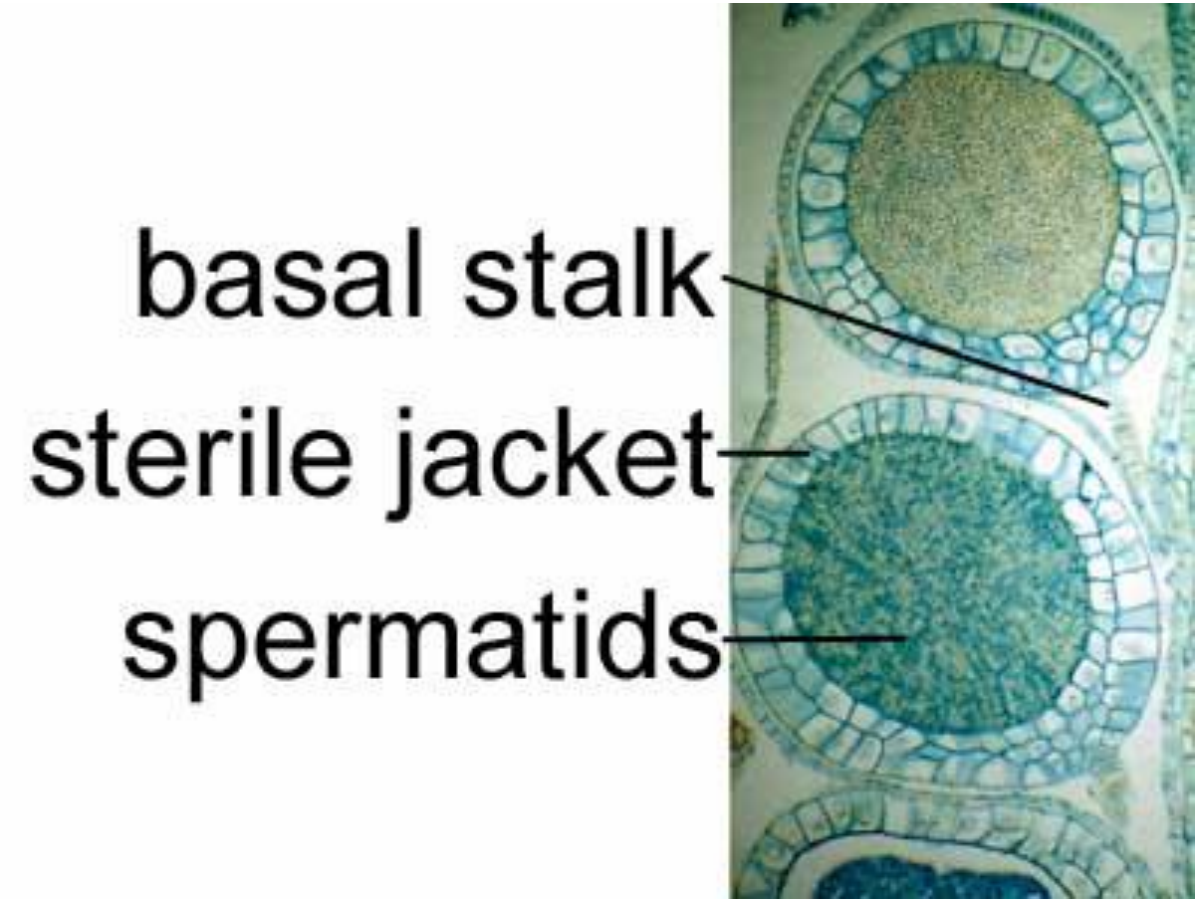
- They reproduce by vegetative and sexual reproduction
- Vegetative multiplication takes place by:
  - Death and decay of older parts
  - Fragmentation of thallus
  - Adventitious branches
  - Tuber formation
  - Production of gemmae on gemmae cups

Marchantia with Gemmae

BRYOPHYTES: CHARACTERISTICS

Sexual reproduction in bryophytes:

- Sexual reproduction is oogamous type
- Sex organs are multicellular
- Sex organs are more complex than thallophytes (algae, fungi and lichens)
- Male sex organ is called antheridia
- Antheridia are stalked and globose
- They have one cell thick sterile jacket around it for protection
- Jacket surrounds a solid mass of fertile cells called antherocytes

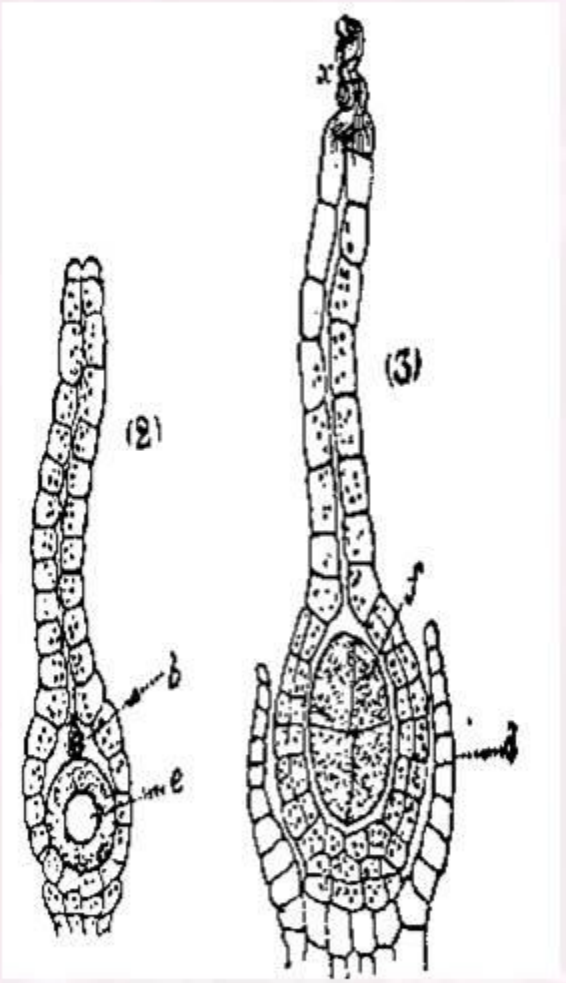


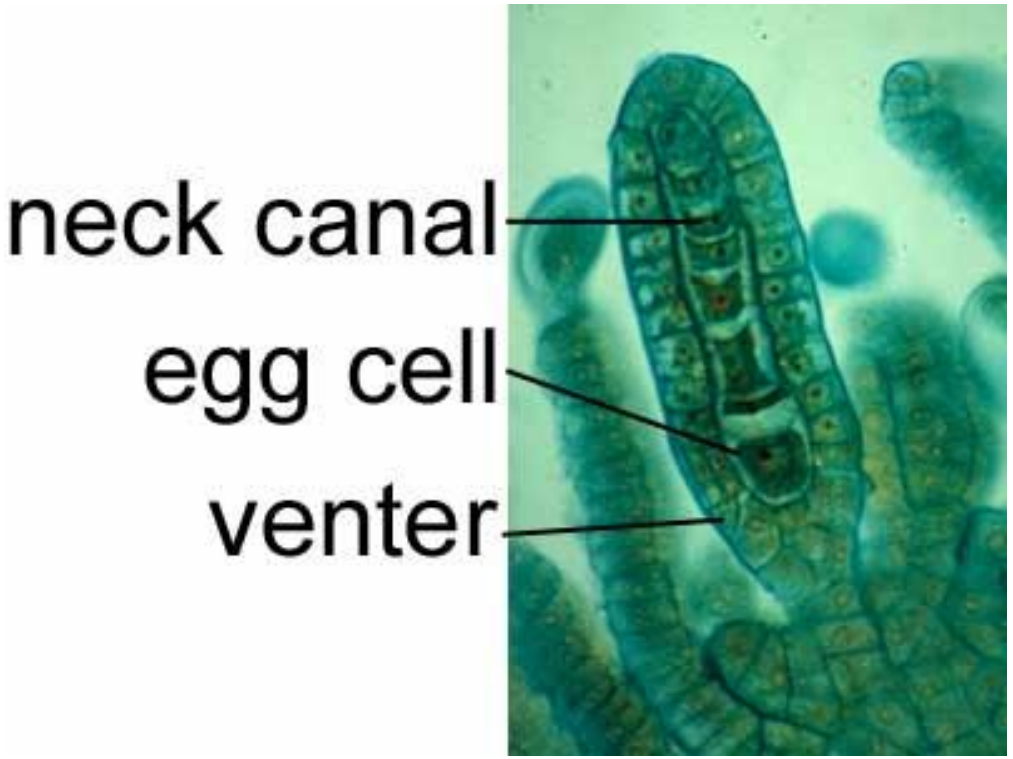
Antheridia of *Porella*, a leafy liverwort

BRYOPHYTES: CHARACTERISTICS

Sexual reproduction in bryophytes:

- Antherocytes metamorphose into antherozoids
- Antherozoids are biflagellate and thus they are motile (can swim in water)
- Female sex organs is called archegonia
- Archegonia is a flask shaped structure
- Archegonia have basal swollen venter and an elongated upper part called neck
- The ventre and neck are surrounded by one layer thick sterile jacket cells
- Four to six neck canals cells and one venter canal cell is





Archegonium of *Porella*, a leafy liverwort.

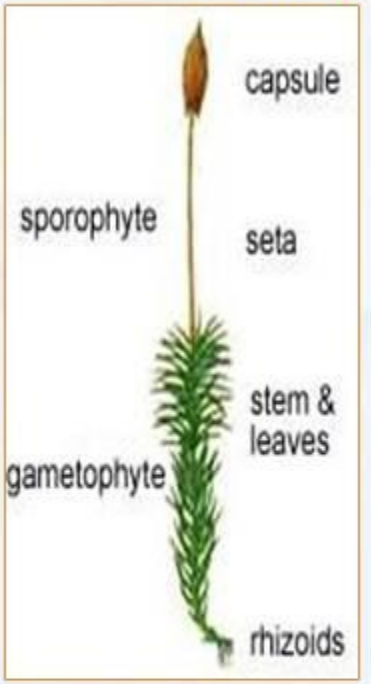
BRYOPHYTES: CHARACTERISTICS

Fertilization in bryophytes

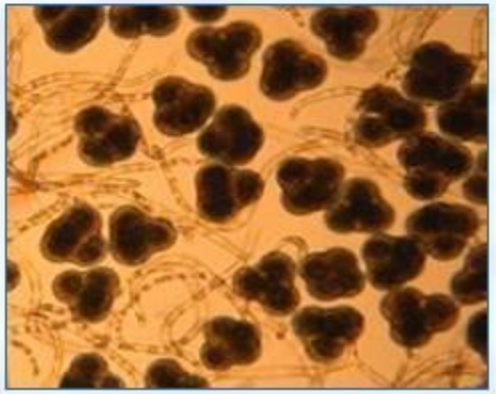
- Water is necessary for fertilization
- When antheridia matures, their sterile jacket disintegrate and liberate the motile anthropoids to the surrounding thin film of water
- When archegonia matures, the neck canal cells and venter canal cell disintegrate and forms a mucilage mass
- Antherozoids are attracted by chemicals present in the mucilage and move towards it by chemotaxis through the thin film of water
- Antherozoids enters into the archegonium through neck and venter
- Antherozoids fuse with egg to from a diploid zygote

BRYOPHYTES: CHARACTERISTICS

Sporophyte of bryophyte



- Sporophyte develop from embryo
- Zygote is the first stage in the diploid sporophytic generation
- Zygote does not have any resting period
- Zygote mitotically divide immediately after fertilization
- Bryophyts shows exoscopic mode of embryo development
- First division of zygote is always transverse to produce two cells (outer cell and inner cell)
- Outer cell give rise to embryo



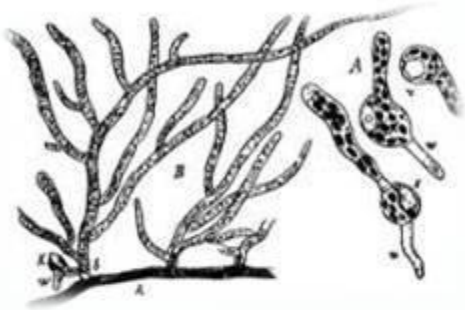
BRYOPHYTES: CHARACTERISTICS

Sporophyte of bryophyte

- Embryo develops within the ventre of archegonium
- Sporophyte is simple structure without rhizoids stem or leaves
- Sporophyte is completely dependent on gametophyte for nourishment
- Sporophyte is s projecting structure in most of the forms, it project out from the gametophytic tissue
- Sporophyte is differentiated into foot, seta and capsule
- Sporogenous cells present in the capsule divide meiotically to produce haploid spores
- All spores are similar in shape and size (homosporous)

BRYOPHYTES: CHARACTERISTICS

Sporophyte of bryophyte



- Sometimes elaters are present
- Elaters are hygroscopic and they helps in spore dispersal
- Spores are non-motile and they disperse exclusively by wind
- Under favorable condition the spores germinate to form the gametophye
- In lower forms, the germination of spores is by the formation of a germ tube which later divide to give rise the younger gametophyte (Riccia, Marchantia)
- In advanced forms (mosses) spores germinate to form a filamentous branched protonema
- From the protonema, many gametophytic plants arises

BRYOPHYTES: CHARACTERISTICS

Bryophyta Life Cycle (Life cycle of mosses)

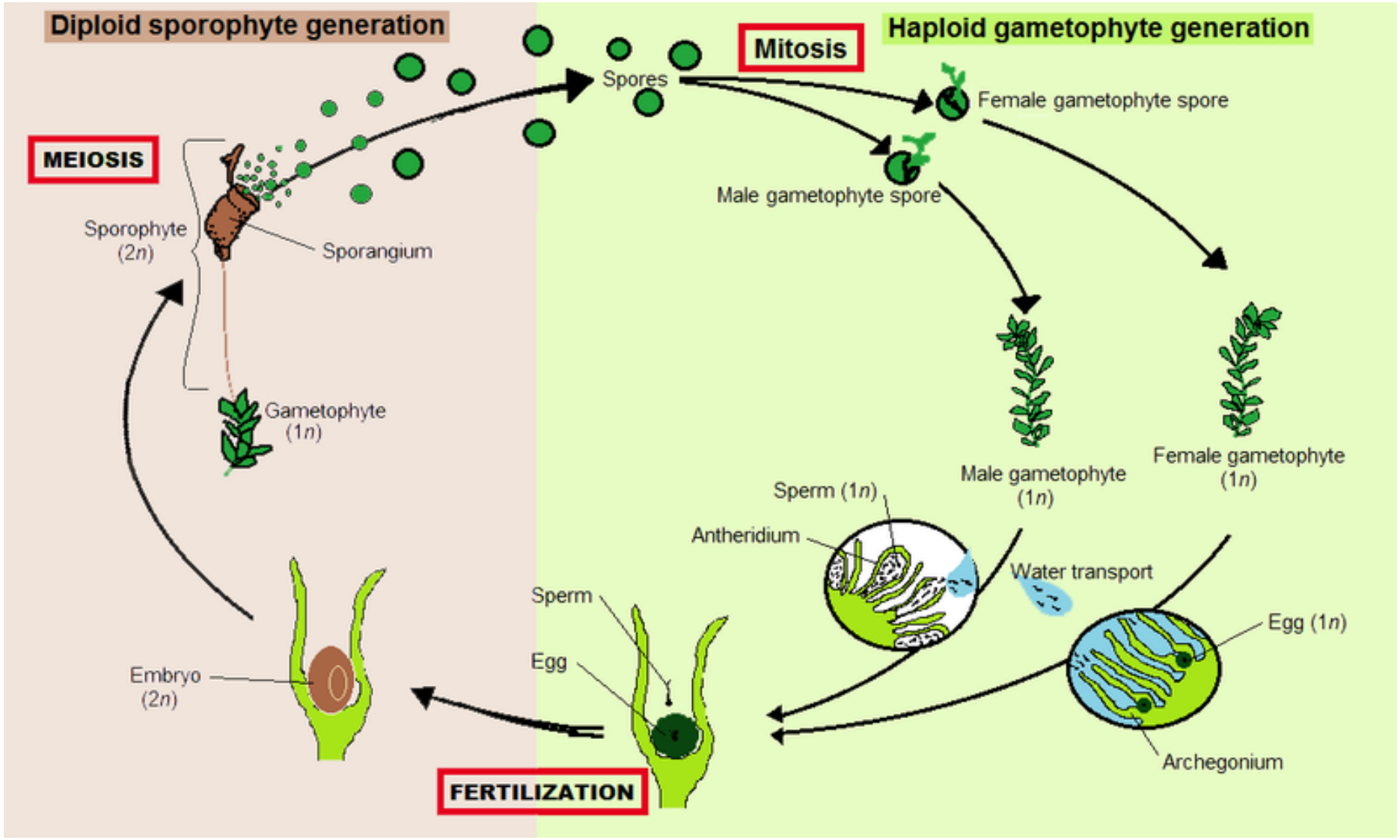
- Life cycle of bryophytes is characterized by the alternation of two morphologically distinct phases
- One phase is haploid gametophyte
- Other phase is diploid sporophyte
- Gametophytic phase is independent, autotrophic haploid and bears gametes
- It develops from the spores produced by sporophyte
- Male and female gametes represent the last phase of gametophytic generation
- Haploid male and female gametes fuse to forms a diploid zygote

Bryum Gametophyte & Sporophyte

BRYOPHYTES: CHARACTERISTICS

Bryophyta Life Cycle (Life cycle of mosses)

- Zygote represent the first phase of sporophytic generation
- Sporophyte is simple, completely dependent on gametophyte for nutrition
- Sporogenous tissue in the sporophyte divide meiotically to produce haploid spores
- The spores germinate to form haploid gametophyte



Bryophyte alternation of generations.

A moss is used as the example. The haploid (gametophyte) structures are shown in green. The diploid (sporophyte) structures are shown in brown.

BRYOPHYTES: CHARACTERISTICS

Economic importance of Bryophytes:

- Mosses used for soil conditioning
- Helps to increase aeration & water holding capacity of soil
- Sphagnum moss is used extensively in potting mixtures
- Sphagnum moss is also used in air layering
- Bryophytes are ecological indicators
- Bryophytes indicate moist, and wet weather condition
- Some mosses are air pollution indicators, absence indicate air pollution
- Some bryophytes indicate copper in the soil (*Mielichhoferia elongata*)
- *Sphagnum* indicate acid condition in the soil

BRYOPHYTES: CHARACTERISTICS

Economic importance of Bryophytes:

- Used to prevent soil erosion (Barbula, Bryum)
- *Anthoceros* can fix nitrogen and can enrich the soil nutrients
- Many mosses are attractive and they are used in gardening
- Some mosses are used as packing materials
- Peat moss is a good fuel, it is extensively used in many European countries
- Sphagnum moss is used for the preparation of absorbent bandages, they also have good antiseptic properties.
- *Marchantia polymorpha* is used in the treatment of pulmonary tuberculosis
- *Polytrichum* has been used for the treatment of kidney stones

Polytrichum strictum

BRYOPHYTES: CHARACTERISTICS

Key questions:

1. What is bryophyte and what are bryophytes?
2. What are the characteristics of bryophytes?
3. Explain the life cycle of bryophytes.
4. Explain the reproduction in bryophyte.
5. Explain the structure of Antheridium and Archegonium of Bryophyta.
6. Explain alternation of generation in bryophytes.
7. What are the economic importance of bryophytes?
8. What are the ecological importance of bryophytes?


Thank You...