YAKEEN NEET 2.0

2026

Plant Kingdom

BOTANY | Lecture: 01

By: Vipin Sharma Sir

Plant Kingdom

- R.H. Whittaker (1969) classified all organisms in 5 kingdoms namely: 1. Monera, 2. Protista, 3. Fungi, 4. Plantae & 5. Animalia

  Definition of Plants got CHANGED OVER TIME

- In early systems: Bacteria. BGA, Fungi were all included in plants

  BUT NOW

  only Algae, Bryophytes, Pteridophytes, Gymnosperms & angiosperms are included in plants

NOTE: Blue-green algae are NOT ALGAE anymore

NOTE: Features of Plants:

1. Eukaryotic
2. Cellulosic cell wall
3. Photosynthetic
4. Mostly multicellular

   Chlorella, chlamydomonas

   Unicellular

Artificial System

- Angiosperms are the MOST ABUNDANT, most adapted, widely spread plants

∵ Their no. is MAXIMUM,

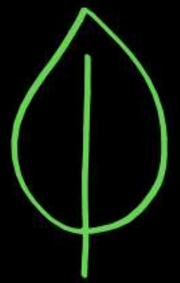
∴ They need to be classified efficiently

- Earliest System for Angiosperms classification
- Given by: Carolus Linnaeus
- Based on: Gross superficial morphological characters (outer structure)

Vegetative str.
- no., colour, size of leaf ;
habit of plant
Herb,
Shrub,
Trees

Change with time & with environmental conditions:

Plant ⊗ H_2O ↑



Plant ⊗ H_2O ↓

Reproductive str.
(Androecium str.)
(♂)
↓
Counted no. of stamens & divided angiosperms into 24 classes

NOTE: Linnaeus gave equal importance to vegetative & Reproductive features

adversely affected by environment
∴ They might change

- DRAWBACK-2: He took only a few characters into consideration for classification

∴ Linnaeus placed closely related plants into different categories & different plants or non-related plants into same categories

Natural System

- Given by Bentham & Hooker
- Better than Artificial system
- Based on: Morphology (outer str.) + Anatomy (inner str.) + ultra-structure (cell str.) + Embryology (zygote → embryo) + Phytochemistry (chemicals)

Based on 'Natural affinities' among plants

NATURAL SYSTEM :-

- Given By Bentham & Hooker.
- Better than Artifical System.
- Based On :- Morphological , Anatomy , Ultrastructure , Embryology , Phyto chemistry

Natural affinities among plant

Morphological → Outer Struc.

Anatomy → Inner Struc.

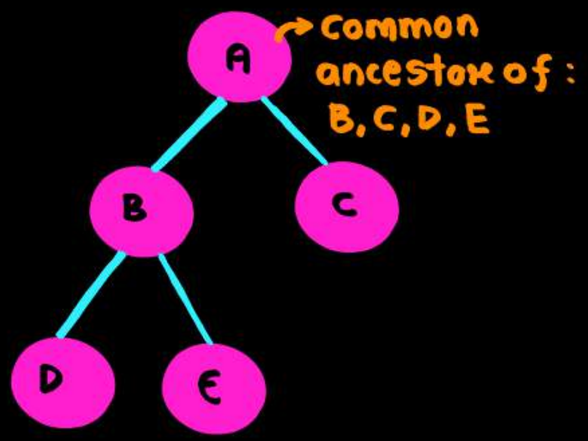
Ultrastructure → Cell structure

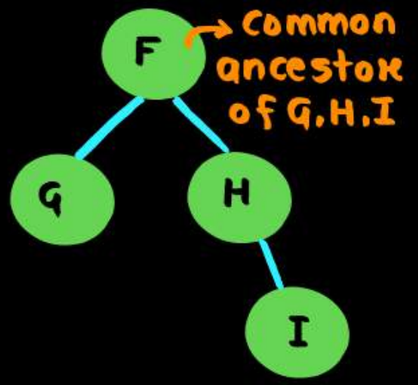
Embryology → zygot struc.

Phyto chemistry → chemical

Phylogenetic System

- Based on: Evolutionary relationships
- Given by: Engler & Prantl
- Assumption: All the members of same TAXA must have had common ancestor





- 'C' is more similar to:
  1. ~~E~~
  2. I

- 'G' is more similar to:
  1. ~~I~~
  2. C

- Currently most accepted system

Numerical, Cyto and Chemotaxonomy

Hundreds of characters are listed & analysed by computers

- Every character was given no. or codes

Characters	Plant-1	Plant-2	
Character-1	+	+	1
Character-2	+	−	0
Character-3	+	+	1
Character-4	−	+	0
Character-5	+	+	1
Character-6	−	−	1
⋮			
Character 100*	+	+	1

} Equal importance is given to 'ALL CHARACTERS'
∵ all characters are given 1 mark only, this is not an apt system

49 similar

NOTE: also called Adansonian Taxonomy / Phenetics
- Given by Adanson

Cell has nucleus & nucleus has chromosomes
- Based on: Chromosome's no., structure & behaviour

Based on chemical constituents of Plants
e.g., Rauwolfia: contains reserpine (Cure ↑ B.P)
- Broccoli contains Sulphoraphen (anti-cancerous)

Comparison of Plants

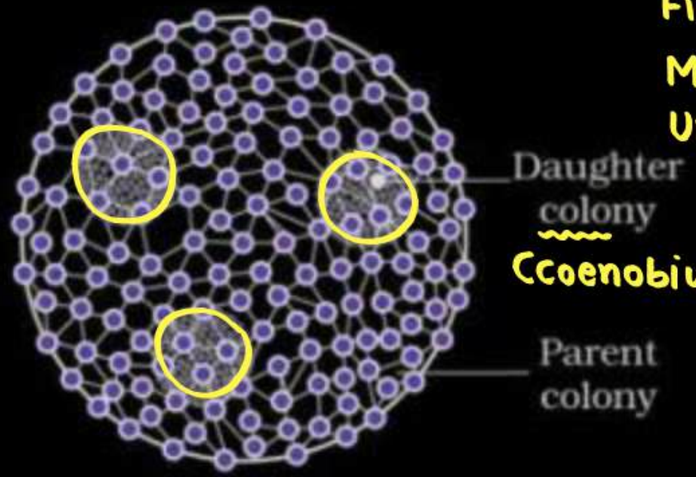
Simple Plants to Complex Plants

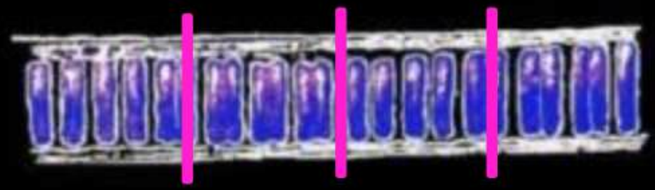
Character	Algae	Bryophyte	Pteridophyte	Gymnosperm	Angiosperms
Body Level	Simplest plant • Thalloid (True root, stem & leaf ⊖nt)	⇒ SAME	True root, stem & leaves ⊕nt	⇒ SAME	complex plants ⇒ SAME
Main plant body	Gametophytic (n)	⇒ SAME	Sporophytic (2n)	⇒ SAME	⇒ SAME
Life Cycle	Gametophytic	Gametophytic	Sporophytic	Sporophytic	Sporophytic
Independent Part	Sporophyte depend on Gametophyte ∴ Gametophyte is independent (photos)	Sporophyte depend on gametophyte for food	Pteridophyte ↓ Both Spo and gametophyte shows photosynthesis	Gametophyte depend on Sporophyte (∴ Sporophyte is INDEPENDENT)	⇒ SAME
Vascular Tissues (Xylem & Phloem)	⊖nt	⊖nt	⊕nt	⊕nt	⊕nt

Algae

- Simplest plant ; has thalloid body ; photosynthesis↑ ;
  Largely aquatic : Fresh H_2O, marine H_2O, moist soil, moist rock, tree (mostly)
- Algae shows different association
  - LICHEN (Algae + Fungi)
  - with SLOTH BEAR + Algae
    - ⇓ becomes green for camouflage
    - ⇓ live in wet hair of bear

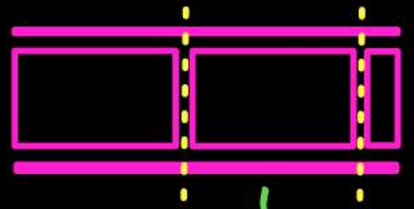
- HABIT : very diverse e.g., Colonial : Volvox
  Filamentous : Ulothrix, Spirogyra
  Massive : Marine (Kelp) : 100 meter
  Unicellular : Chlamydomonas





Reproduction in Algae

1. Vegetative: by Fragmentation e.g., Filamentous Ulothrix & Spirogyra



Fragment or filament can give rise to new algae

2. Asexual: most common spores are flagellate Zoospores (motile)
   - germinate & give rise to new Algae

** 3. Sexual:
- Isogamous: (Same) gametes
  - Non-flagellated isogamous: ○ ○ e.g., Spirogyra
  - Flagellated isogamous: ♂ ♂ e.g., Ulothrix
- Anisogamous: (Non-Similar) ♂ ○ e.g., Eudorina
- Oogamous: ♀ ♂ e.g., Volvox & Fucus

Economic Importance of Algae

$6CO_2 + 6H_2O \xrightarrow[\text{Chlorophyll}]{\text{Sunlight}} C_6H_{12}O_6 + 6O_2 \uparrow$

They do around half of total photosynthesis on carbon fixation on Earth

$C_6H_{12}O_6$ — Food

- It is the main component/ producer of aquatic food chains
- > 70 marine algae species can make high amount of food e.g., LPS
  - Laminaria
  - Porphyra
  - Sargassum

↑ the amount of dissolved O_2 in their immediate environment

NOTE:
- Some marine algae can make hydrocolloids (CH_2O holding substances)
  - e.g., Algin : Brown Algae (AB)
  - Carrageen : Red Algae (RRR)
- Chlorella : rich in protein (used by space travellers)

NOTE : Agar
⇓
derived from Gelidium & Gracilaria

- It is a SOLIDIFYING AGENT
  - e.g., Ice-cream, jellies
  - e.g., to solidify culture medium to grow bacteria

Classification of Algae

Algae can be divided into 3-categories

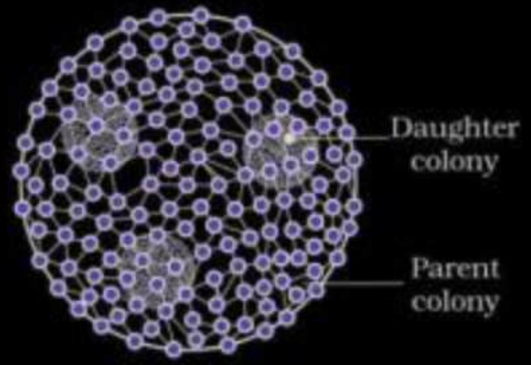
Chlorophyceae
(Green algae)
(simplest)
- Grassy green
- ⇓
- Chlorophyll a, b

Phaeophyceae
(Brown algae)
- Xanthophyll e.g., Fucoxanthin
- Fucoxanthin ↑; dark brown ↑

Rhodophyceae
(Red algae)
(most complex)
- R-phycoerythrin ↑

Classes	Common name	Pigments	Stored food	Cell Wall	No. of flagella and insertion position	Habitat
Chlorophyceae	Green Algae ⇓ Grassy green	Chl-a, b	• Most: starch • some: oil droplets	• Innen: cellulose Outen: Pectose	 Apical, equal, 2-8 in number	• Fresh H_2O (↑); Brackish (medium salt); marine H_2O
Phaeophyceae	Brown Algae ⇓ olive green, various shades of Brown	Chl-a, c; carotenoid; xanthophyll (fucoxanthin)		• Innen: cellulose Outen: ALGIN	Pyriform (pear like spores and gametes)  Lateral; 2; unequ.	• Fresh H_2O (rare) Brackish (↑); Marine (↑)
Rhodophyceae	Red Algae ⇓ Reddish	Chl-a, d; R-phycoerythrin	• Floridean starch (branched); like glycogen & amylopectin	• Cellulose + Pectose + polysulphate esters	• Flagella ⊖nt	• Fresh (some); Brackish; Marine (most)

Classes	Examples
Chlorophyceae	 Classy CAM - SUV → Ulothrix, Volvox (colonial), Chara, Spirogyra (filamentous), Chlamydomonas (unicellular): simplest
Phaeophyceae (KELP) ↓ loom	E.g., SELF-Defence → Dictyota, Fucus, Laminaria, Sargassum, Ectocarpus
Rhodophyceae	P: Porphyra G: Gelidium P: Polysiphonia G: Gracilaria



(a-i)

↓

Volvox

(a-ii)

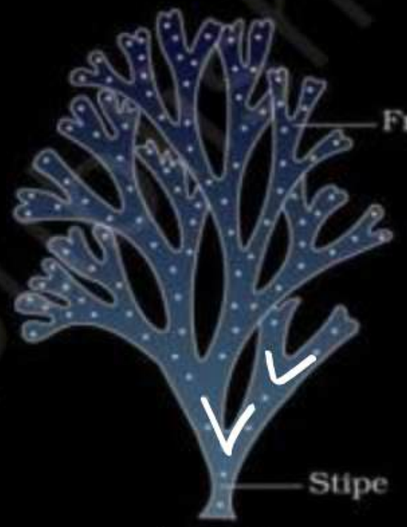
↓

Ulothrix

(b-i) ⇒ Laminaria

(b-ii)

↳ Fucus



(b-iii)

↳ Dictyota

Porphyra

(c-i)

Polysiphonia

(c-ii)

Green Algae

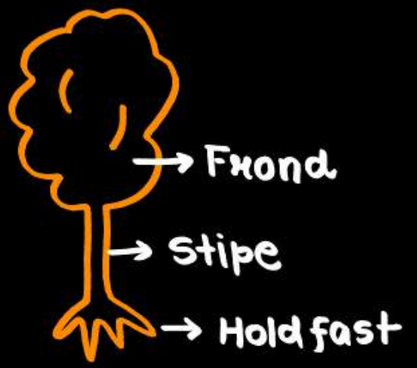
- May be Unicellular, Colonial and Filamentous
  - Unicellular → Chlamydomonas
  - Colonial → Volvox
  - Filamentous → Spirogyra & Ulothrix
- Chloroplasts of different shapes: like- cup, reticulate, girdle (belt), spiral shape, star shaped
  - cup → Chlamydomonas
  - reticulate → Oedogonium
  - girdle → Ulothrix
  - spiral shape → Spirogyra
  - star shaped → Zygonema
- Pyrenoids: Most of green algae have "one on more" storage structure in chloroplasts kya pyrenoids
  - Protein beside starch

- Reproduction:
  1. Vegetative: Fragmentation, vegetative spore (lower level)
  2. Asexual: Zoospore: 2-8, equal, apical flagella
  3. Sexual: Iso/aniso/oogamous

Brown Algae

- **Great variation in form and size:** They can be simple, branched, filamentous : Ectocarpus
  They can be profusely (heavily) branched : Kelp (100m height)

- **Structure:** → Root like: Holdfast → Hold substratum (surface)
  Stem like: Stipe → support
  Leaf like: Frond → photosynthesis



- **Reproduction:** Vegetative : Fragmentation
  Asexual : Spores (pyriform)

  Sexual : Iso/aniso/oogamous
  (pyriform gametes are seen)

NOTE : Fertilisation can occur in H_2O & in oogonium also (in oogamous species) **

Red Algae

- Found at: marine & warmer areas

  ⇓

  It can be found in upper areas of ocean (well lighted); they can also be found in great DEPTH

- Thallus is mostly multicellular: most complex algae
- After fertilisation, MOST complex post fertilisation events are seen in red algae
- Reproduction:
  1. Vegetative: Fragmentation*
  2. Asexual: Non-motile spore (flagella ⊖nt)
  3. Sexual: MOSTLY OOGAMOUS (flagella ⊖nt)

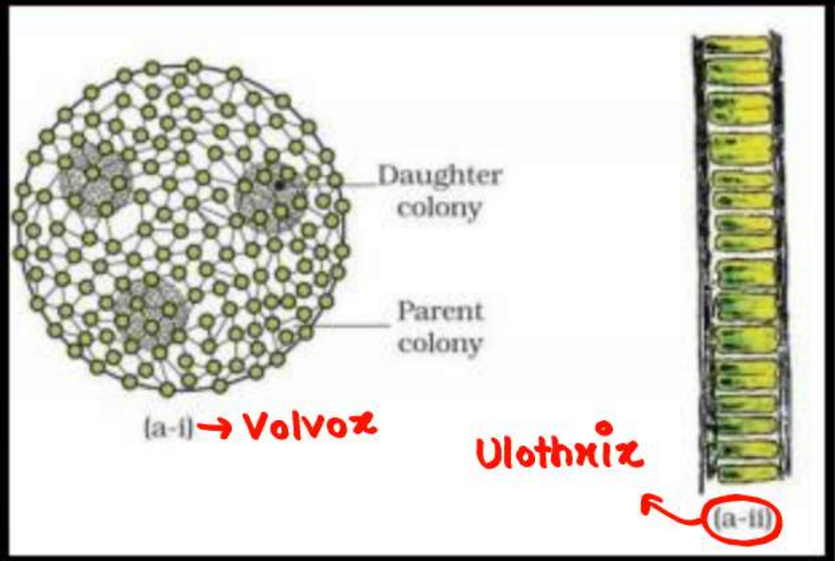
VIBGYOR

wavelength (λ) ↑

frequency (ν) ↓

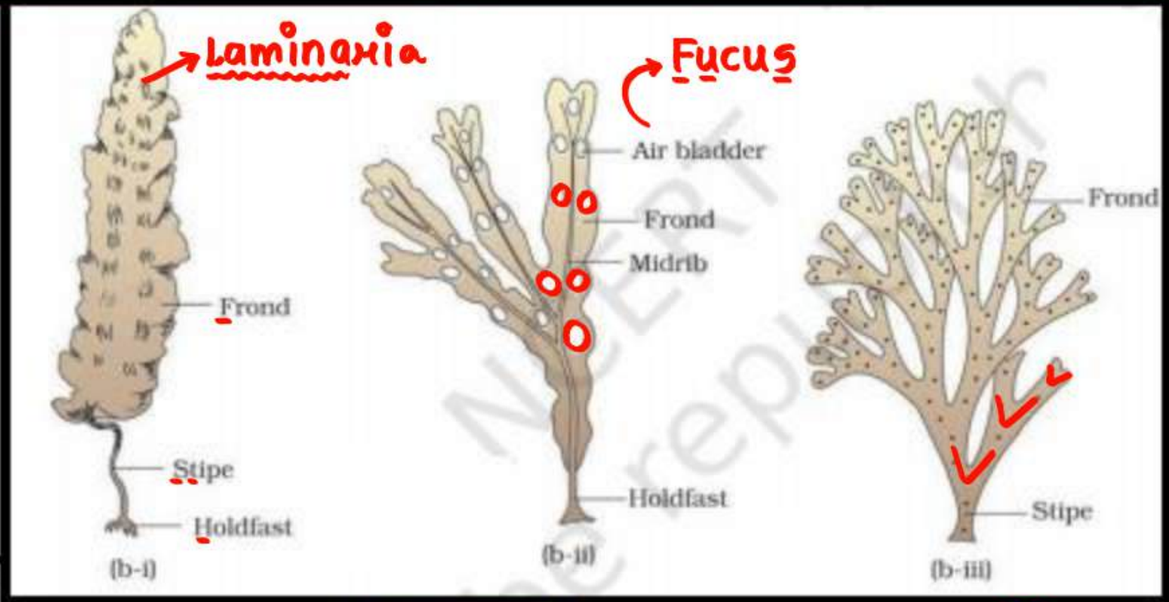
- V, I, B, can go in great depth due to high frequency
- ∴ Red algae can also be found in depth

NCERT LINE by LINE | CRITICAL POINTS



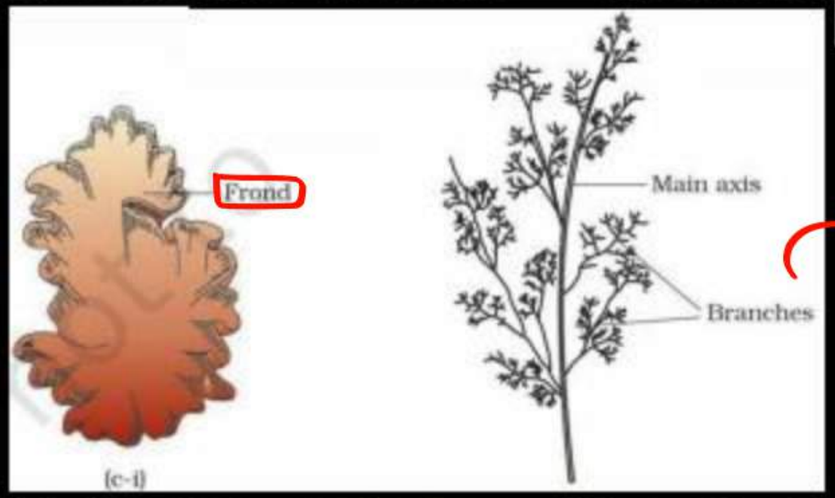
(a) Green algae (i) *Volvox* (ii) *Ulothrix*

→ Volvox



(b) Brown algae (i) *Laminaria* (ii) *Fucus* (iii) *Dictyota*

→ Dictyota
= (2)



(c) Red algae (i) *Porphyra* (ii) *Polysiphonia*

→ Polysiphonia
(>1)
needle like

Comparison of Plants

Simple Plants to Complex Plants

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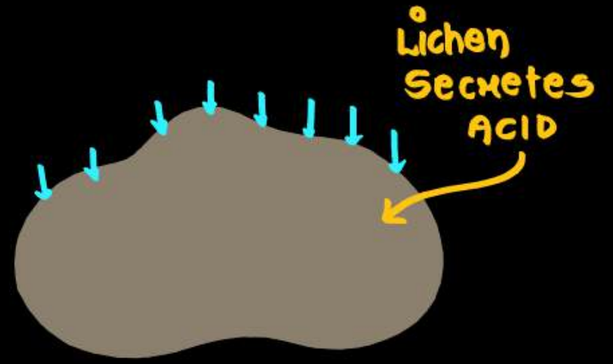
Main plant body	Gametophytic (n)	⇒ SAME	Sporophytic (2n)	⇒ SAME	⇒ SAME
Life Cycle	Gametophytic	Gametophytic	Sporophytic	Sporophytic	sporophytic
Independent Part	Sporophyte depend on Gametophyte ∴ Gametophyte is independent (photos)	Sporophyte depend on gametophyte for food	Pteridophyte ↕ Both sporo and gametophyte shows photosynthesis	Gametophyte depend on sporophyte (∴ sporophyte is INDEPENDENT)	⇒ SAME
Vascular Tissues (xylem & Phloem)	⊖nt	⊖nt	⊕nt	⊕nt	⊕nt

Bryophytes

- **Habitat:** Moist/humid/damp, Shady in Hills → Cold
- **Also called:** Amphibians of plant Kingdom (dual) ∵ they can live in Soil BUT they need H_2O for their sexual reproduction (transfer of ♂-gamete)
- **Body is:** Thalloid → they lack true root, stem & leaves
  - BUT they can have root like, stem like, leaf like structure
  - Thallus of bryophyte is more differentiated/advance than thallus of Algae
  - Thallus of bryophyte can be erect or prostate
  - Rhizoid (root like str.) may be unicellular or multicellular
  - Main body (n) : Gametophytic : Photosynthetic/independent
  - Sporophyte (2n) depends on Gametophyte

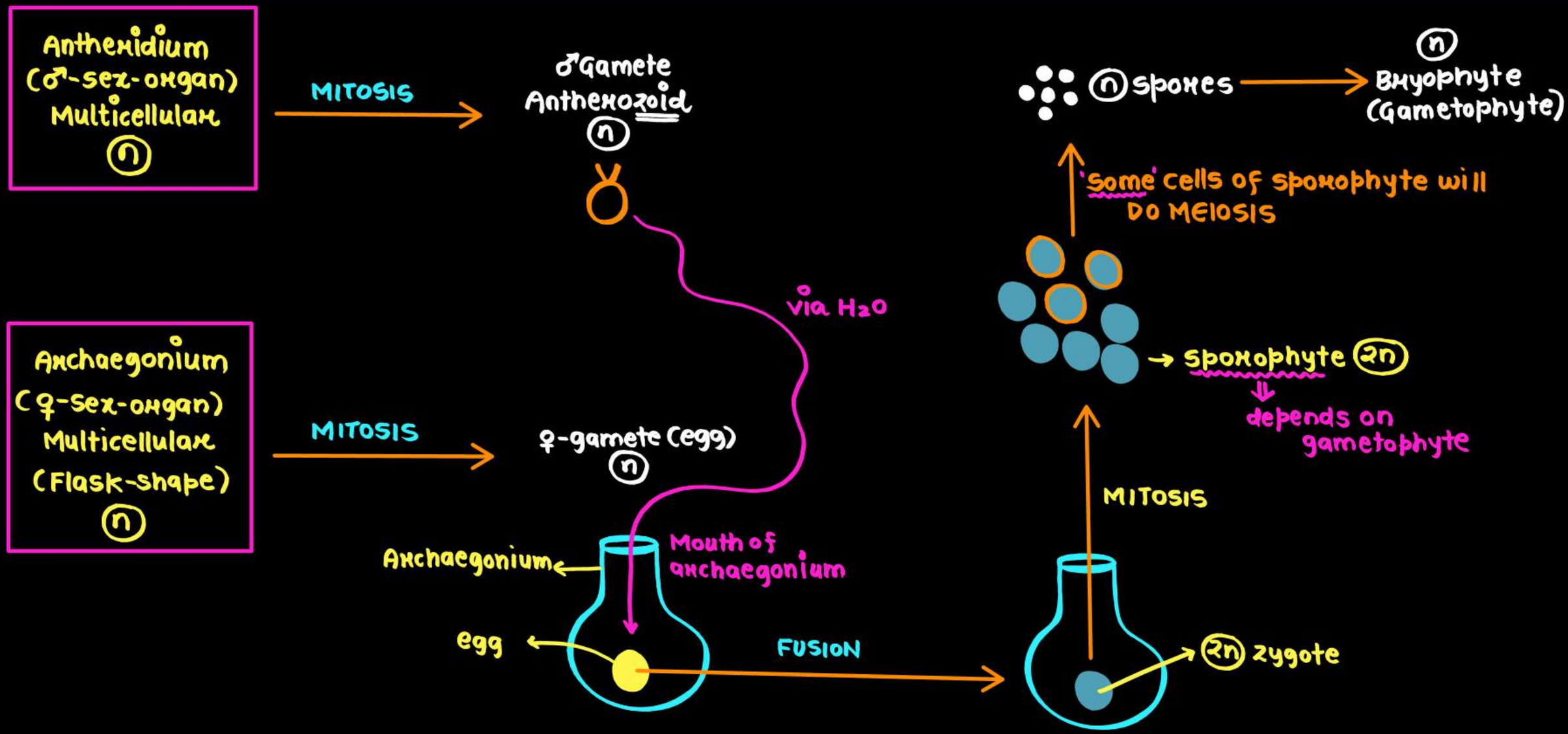
Bryophytes

- **Sex organs:** (Multicellular) → ♂ : Antheridium ⇝ Biflagellated Antherozoid
  ♀ : Archaegonium ⇝ single egg (Flask shape)



- **Classified as:**
  - Liverwort
  - Mosses (advance)
- **Economic Importance:** less economic importance
  - Food: For mammals, birds & other animals
  - Moss
  - Sphagnum (peat moss): it gives us peat ⇝ earlier used as FUEL
    Now used as TRANS-SHIPMENT material
    ∵ it is water holding substance
- Helps in succession on Rock: (Moss) Bryophytes made dense mats on soil
  Soil erosion ↓

Bryophytes (General Life Cycle)



Liverworts

- **Habitat:** Moist/damp/humid & shady places ; bank of streams, marshy area, damp soil, moist bark of tree, moist wood
  (H_2O↑)
- **Thallus:** True root, stem, leaves ⊖nt
  Root like, stem like & leaf like stm. can be ⊕nt
  e.g., Marchantia & Riccia
- **Reproduction:** Asexual: ① Budding

Gemmae: asexual, green, multicellular buds = BUDDING → Gemmae detach from main plant body & grow to generate NEW PLANT

Receptacle / Platform = Gemma cup
(कटोरी)

② Fragmentation of thallus

Liverworts (Life Cycle)

♂-sex-organ
Antheridium
(n)

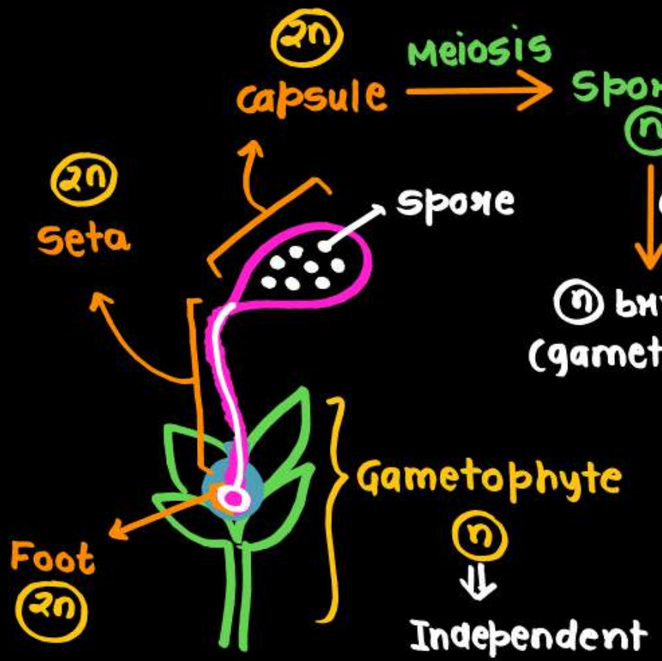
MITOSIS → (n) Antherozoid

♀- sex-organ
Archaegonium
(n)

MITOSIS → (n) egg

Antherozoid + egg → 2n Zygote

MITOSIS → Sporophyte (2n)

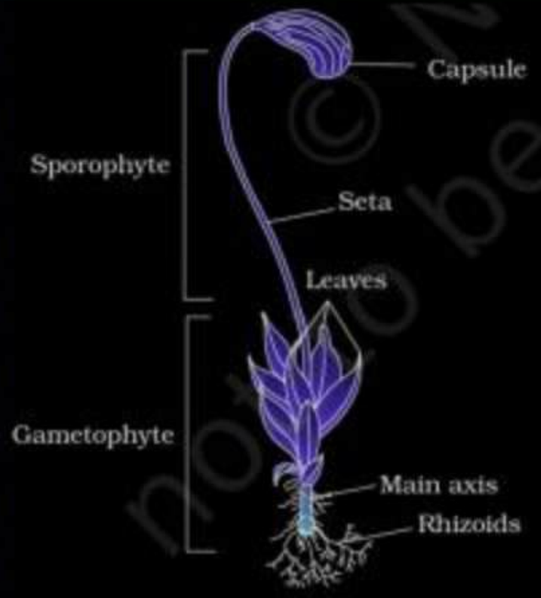


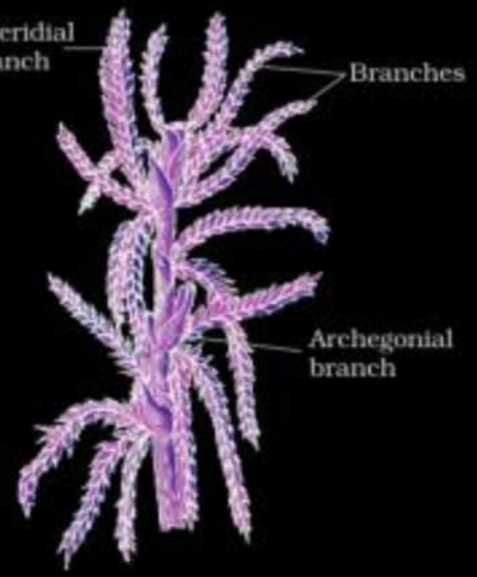
Foot + Seta + Capsule = Sporophyte
⇓
depends on gametophyte

Liverwort

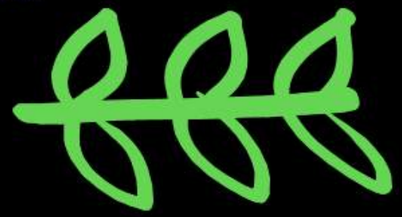
- Marchantia: Unisexual / di-oecious
- Thallus is closely appressed to the substratum
- Thallus is dorsoventral
  - unicellular rhizoids
  - Archae & antheridiophore
  - Gemmae: green, multicellular, asexual bud (budding)

Moss

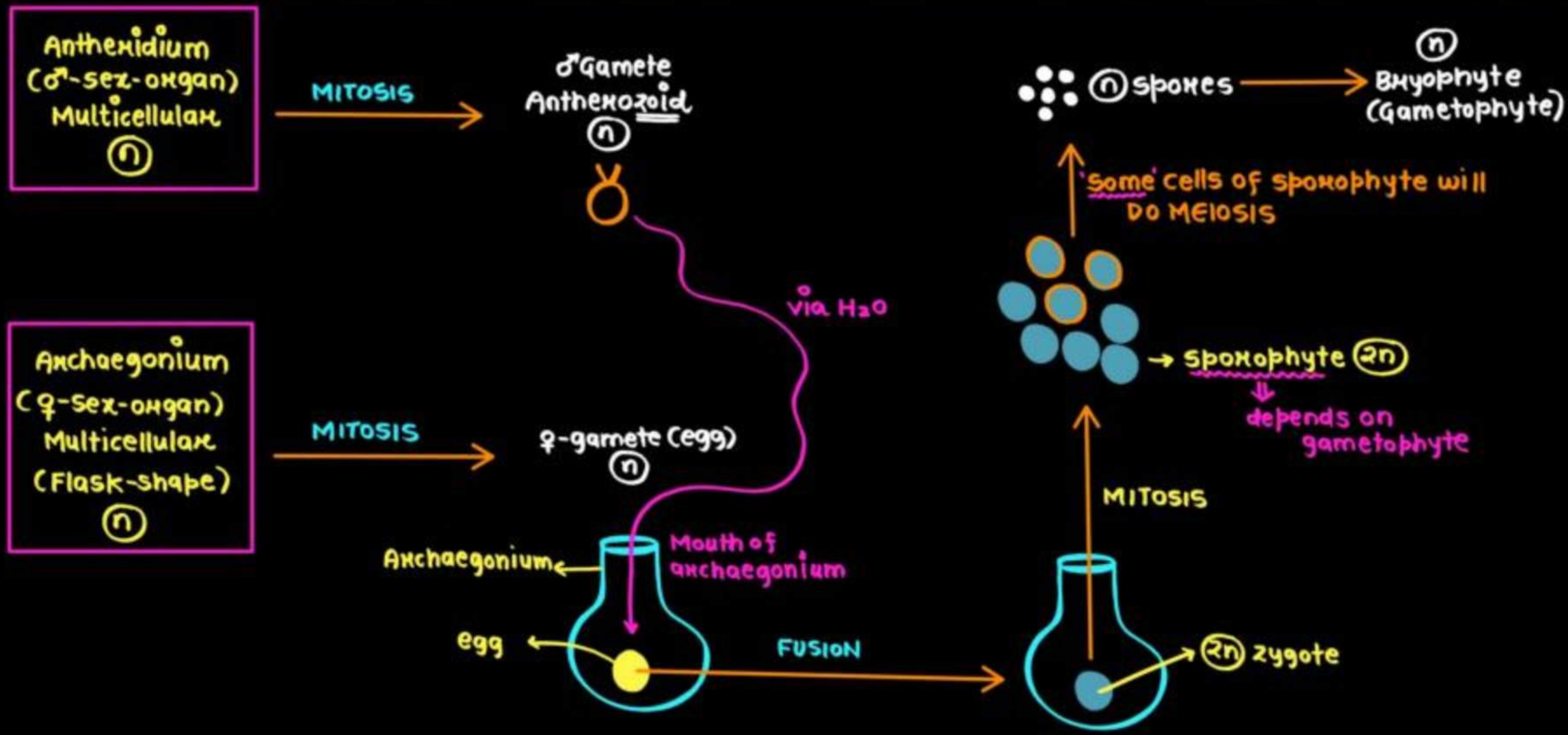




leafy members have 2 rows of leaf like str. on stem like str.



Bryophytes (General Life Cycle)



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Receptacle / Platform = Gemma cup
(कटोरी)

② Fragmentation of thallus

Liverworts (Life Cycle)

♂-sex-organ
Antheridium
(n)

MITOSIS

(n) Antherozoid

♀- sex-organ
Archaegonium
(n)

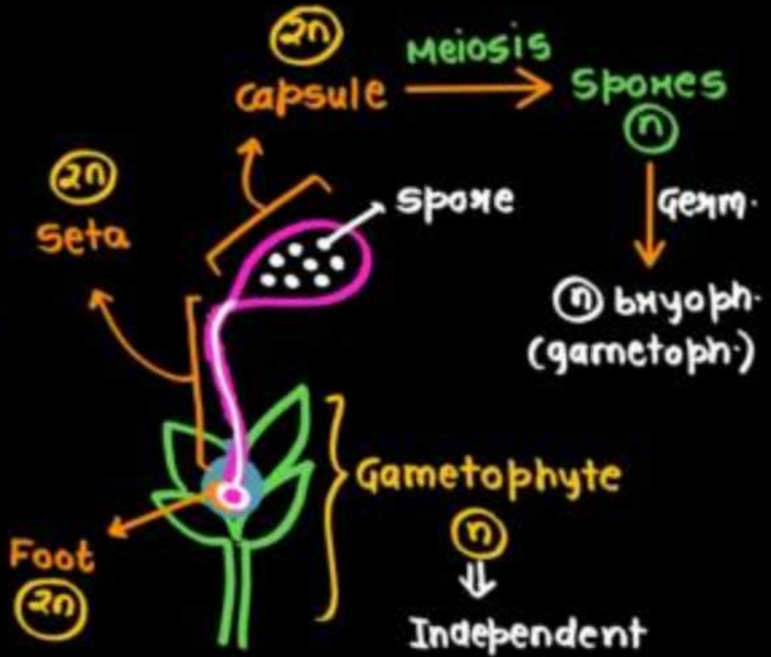
MITOSIS

(n) egg

2n Zygote

MITOSIS

Sporophyte (2n)

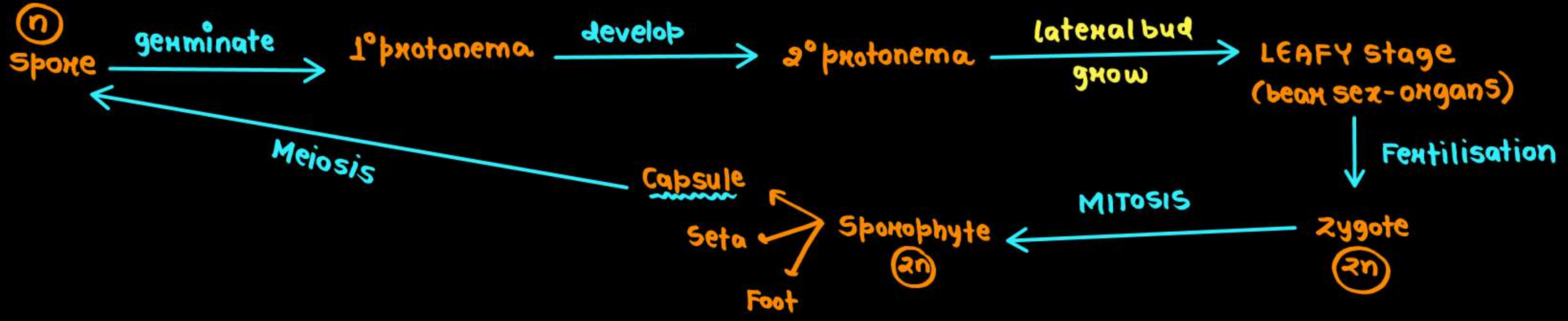


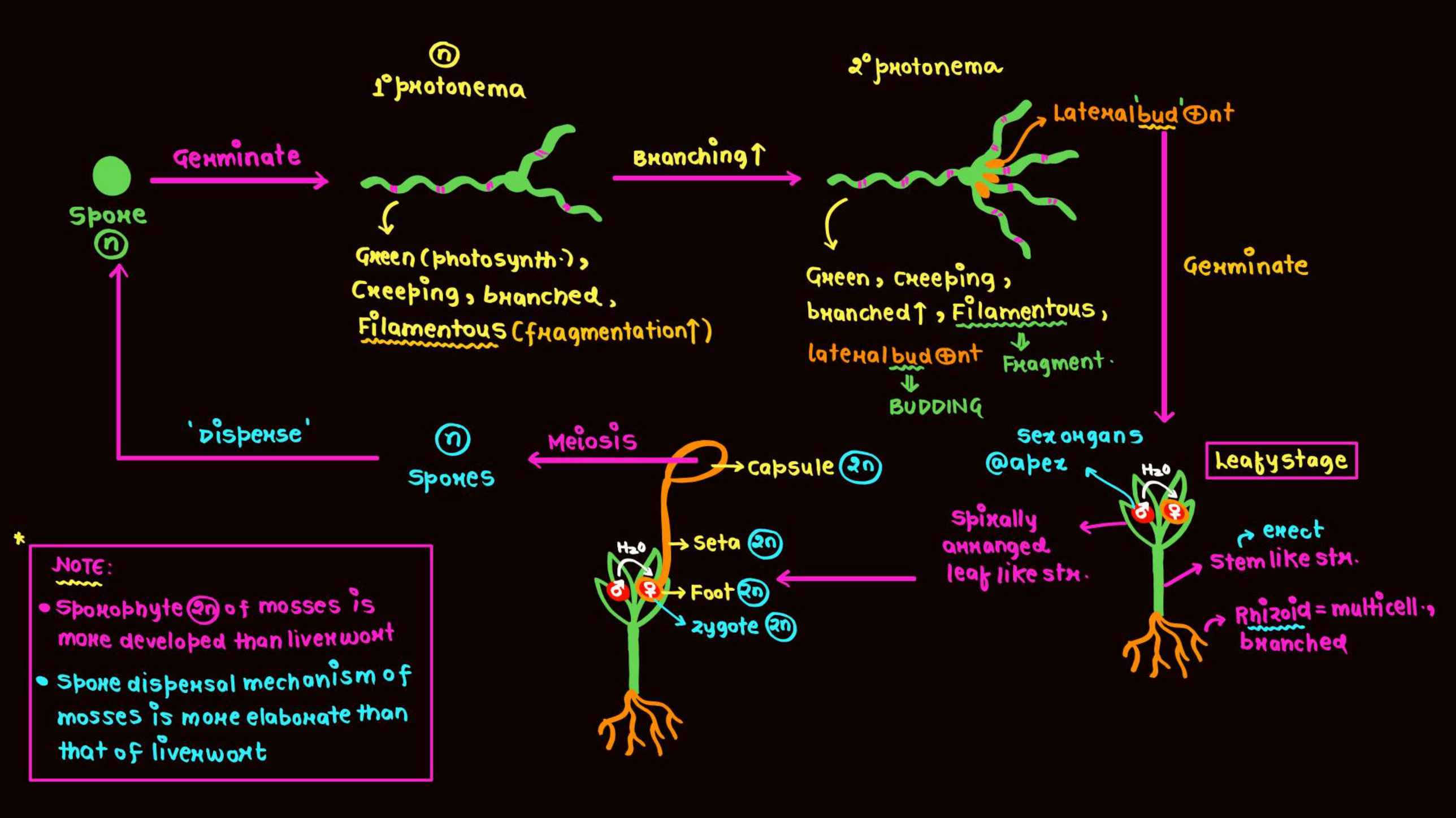
Foot + Seta + Capsule = Sporophyte
⇓
depends on gametophyte

Life Cycle of Mosses

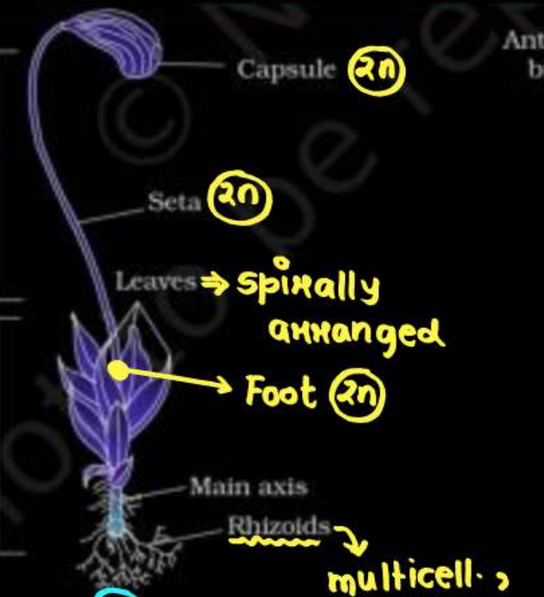
- Main plant body of mosses is (n)
- Life cycle of mosses have 2 phases: 1. Protonema of mosses → 1° protonema, 2° protonema
  2. Leafy stage

- **Rough Life cycle**

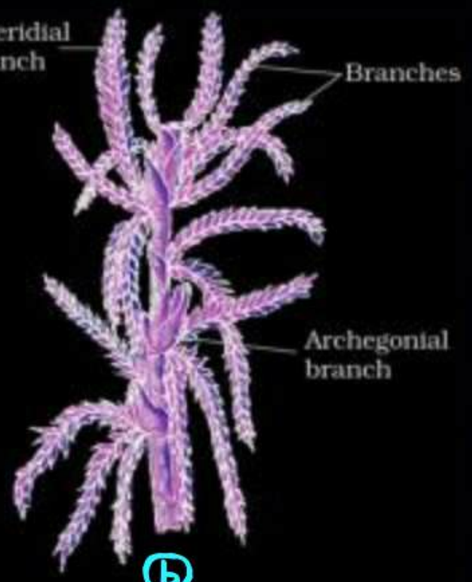



(n)
1° protonema
2° protonema
Spore
(n)
Germinate
Branching ↑
Green (photosynth.), Creeping, branched, Filamentous (fragmentation ↑)
Green, Creeping, branched ↑, Filamentous, lateral bud ⊕nt
Fragment.
BUDDING
lateral bud ⊕nt
Germinate
'Dispense'
(n) Spores
Meiosis
Capsule (2n)
Seta (2n)
Foot (2n)
zygote (2n)
H2O
♂
♀
Sex organs @apex
Spirally arranged leaf like stx.
Leafy stage
erect Stem like stx.
Rhizoid = multicell., branched
* NOTE:
• Sporophyte (2n) of mosses is more developed than liverwort
• Spore dispersal mechanism of mosses is more elaborate than that of liverwort

Moss



ⓐ Funaria



ⓑ Sphagnum ⇓ Bisexual / Monoecious

e.g., of mosses : F : Funaria
P : Polytrichum
S : Sphagnum

Comparison of Plants

Simple Plants to Complex Plants

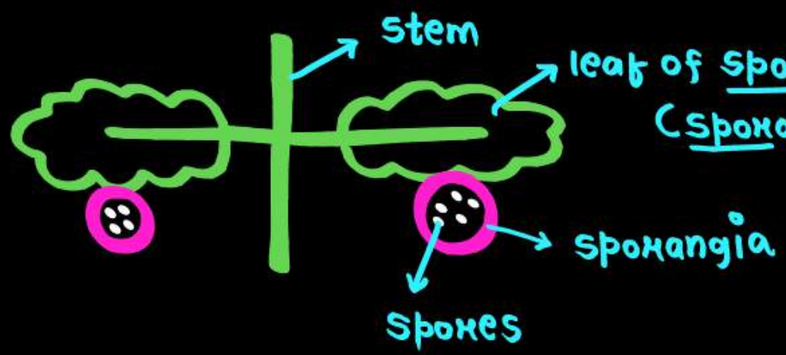
Character	Algae	Bryophyte	Pteridophyte	Gymnosperm	Angiosperms
Body Level	Simplest plant • Thalloid (True root, stem & leaf ⊖nt)	⇒ SAME	True root, stem & leaves ⊕nt	⇒ SAME	complex plants ⇒ SAME
Main plant body	Gametophytic (n)	⇒ SAME	Sporophytic (2n)	⇒ SAME	⇒ SAME
Life Cycle	Gametophytic	Gametophytic	Sporophytic	Sporophytic	sporophytic
Independent Part	Sporophyte depend on Gametophyte ∴ Gametophyte is independent (photos)	Sporophyte depend on gametophyte for food	Pteridophyte ↕ Both sporo and gametophyte shows photosynthesis	Gametophyte depend on sporophyte (∴ sporophyte is INDEPENDENT)	⇒ SAME
Vascular Tissues (xylem & Phloem)	⊖nt	⊖nt	⊕nt	⊕nt	⊕nt

Pteridophytes

- **Includes:** Horsetails and Ferns
- **Vascular Tissues:** ⊕nt ; First vascular plants on Earth (xylem & phloem ⊕nt)
- **Habitat:** Moist/damp/humid , cool & shady places (some are also seen in SANDY SOIL)
- **Main body:** Sporophytic (2n)
  - Non-thalloid : True root, stem & leaf ⊕nt
    - Macrophyll (BIG) (Leaf): Ferns
    - Microphyll: Selagenella

⇓

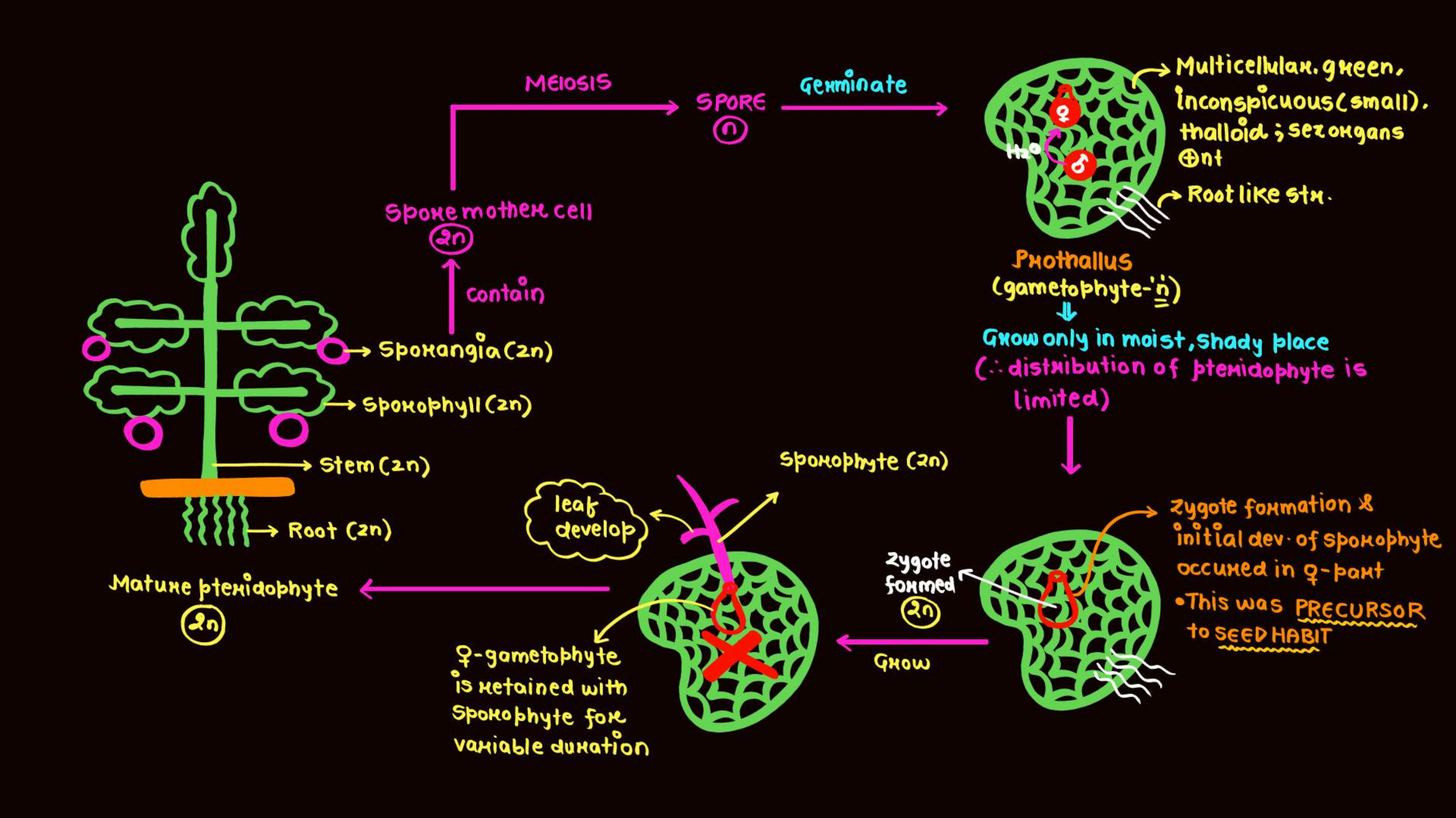
They subtends sporangia

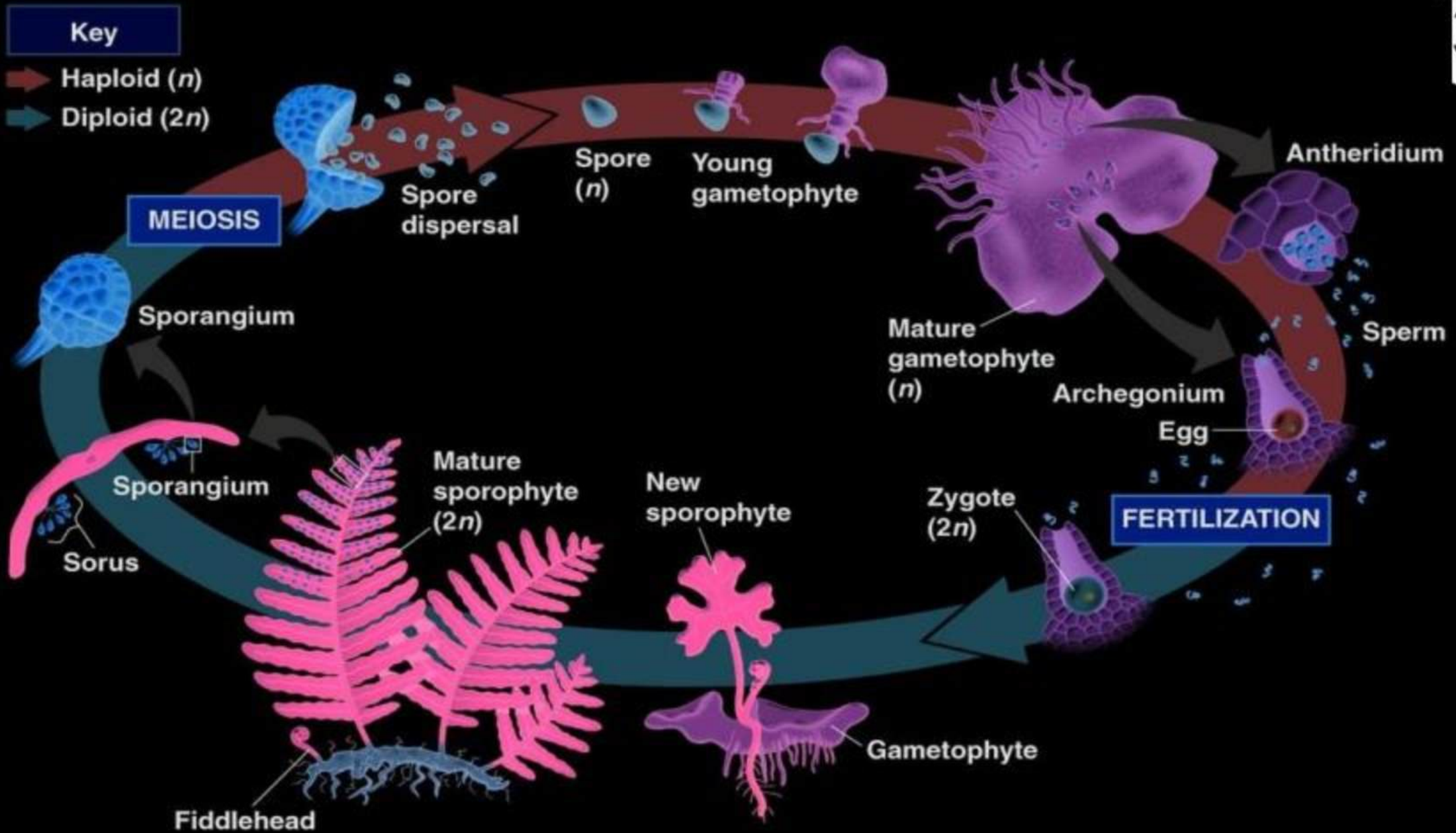


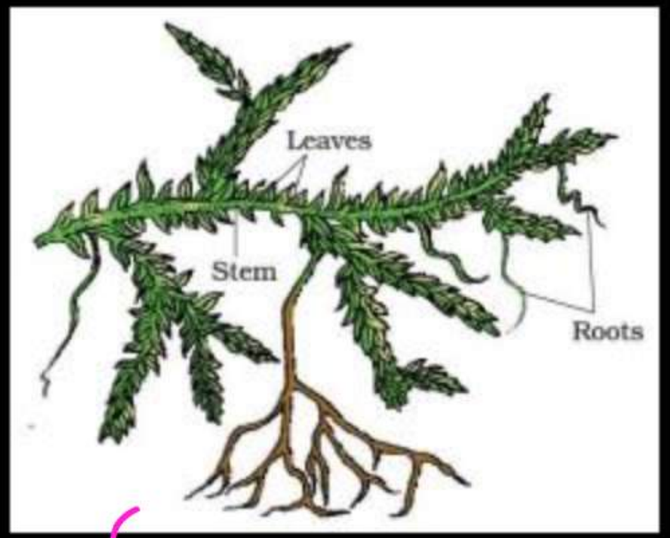
May get condensed make compact str. called cone/strobilus
e.g., selaginella, Equisetum

* Economic importance :

1. Soil binders : pteridophytes come after bryophytes
2. Ornamentals: Adiantum, Humohra
3. Medicinal: Selagenella (sanjeevani booti)

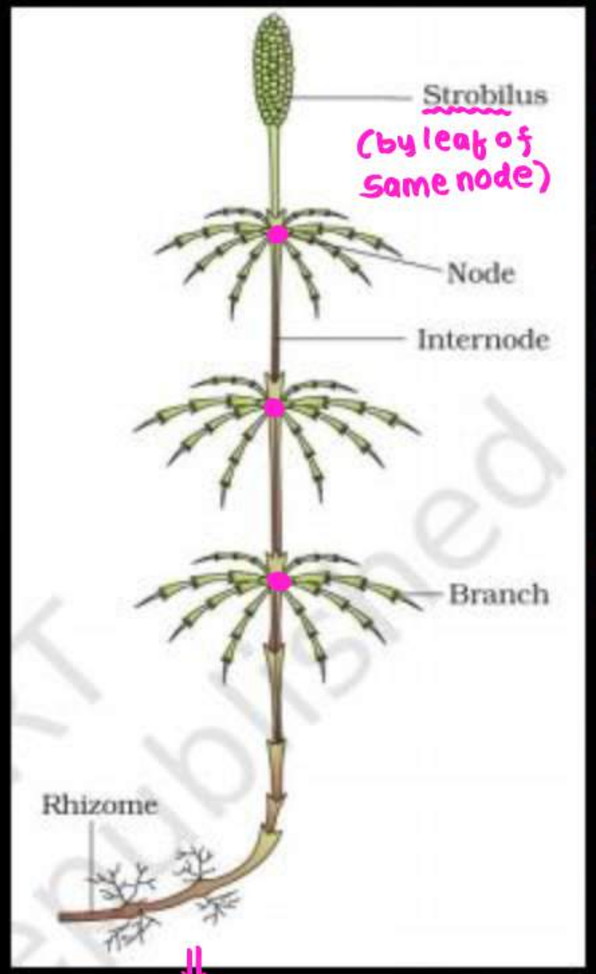

MEIOSIS
SPORE
(n)
Germinate
Multicellular, green, inconspicuous (small), thalloid; sex organs present
Root like str.
Prothallus
(gametophyte-'n')
Grow only in moist, shady place
(∴ distribution of pteridophyte is limited)
Spore mother cell
(2n)
contain
Sporangia (2n)
Sporophyll (2n)
Stem (2n)
Root (2n)
Mature pteridophyte
(2n)
leaf develop
Sporophyte (2n)
♀-gametophyte is retained with sporophyte for variable duration
Zygote formed
(2n)
Grow
Zygote formation & initial dev. of sporophyte occured in ♀-part
•This was PRECURSOR to SEED HABIT


Key
Haploid (n)
Diploid (2n)
MEIOSIS
Spore dispersal
Spore (n)
Young gametophyte
Antheridium
Sporangium
Mature gametophyte (n)
Sperm
Archegonium
Egg
Sporangium
Sorus
Mature sporophyte (2n)
New sporophyte
Zygote (2n)
FERTILIZATION
Gametophyte
Fiddlehead



Selaginella

- Microphyll
- Medicinal
- Heterosporous
- Cones ⊕nt



Equisetum

- Cones ⊕nt

Fern

- Macrophyll

Salvinia

- Heterosporous

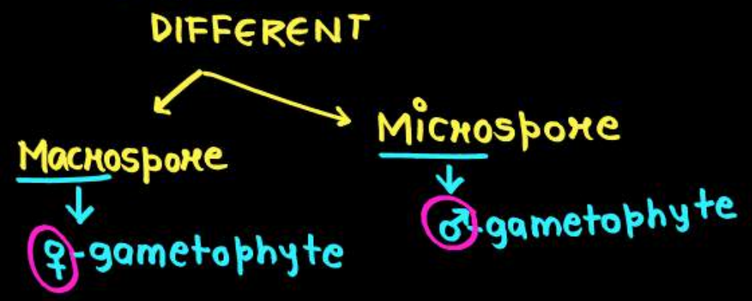
Pteridophytes

Classification of Pteridophytes

- The pteridophytes are further classified into four classes:
  - Psilopsida (*Psilotum*)
  - Lycopsida (*Selaginella*, *Lycopodium*) → Life-science → Selaginella
  - Sphenopsida (*Equisetum*)
  - Pteropsida (*Dryopteris*, *Pteris*, *Adiantum*) → DAP

- Majority of pteridophytes are homosporous: contain only one type of spores (homo = same)

- Some exceptional cases like Selaginella & Salvinia are HETEROSPOROUS (hetero = different)



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Gymnosperms

- **Gymnosperms:** ovule was 'Naked' before & after fertilisation
  - Naked
  - Seed
  - before → ovary ⊖nt
  - after → fruit ⊖nt

NOTE:
ovule → seed
ovary → Fruit

- **Dominant phase is:** Sporophyte (2n) ; Gametophyte depends on sporophyte
- **Body is:** Non-thalloid : True root, stem and leaves ⊕nt
  - Unbranched : Cycas
  - Branched : Pinus, cedrus
- **Habit:** Medium to tall trees & shrubs
  - Tallest one is Giant redwood tree called SEQUOIA gigantica
  - ∴ TAP ROOTS ⊕nt
- **Modification of Gymnosperm root:**
  1. Mycorrhiza (Fungi + Root = PINUS)
  2. Coralloid root : Cycas + Cyanobacteria (BGA) (N_2-fixation)

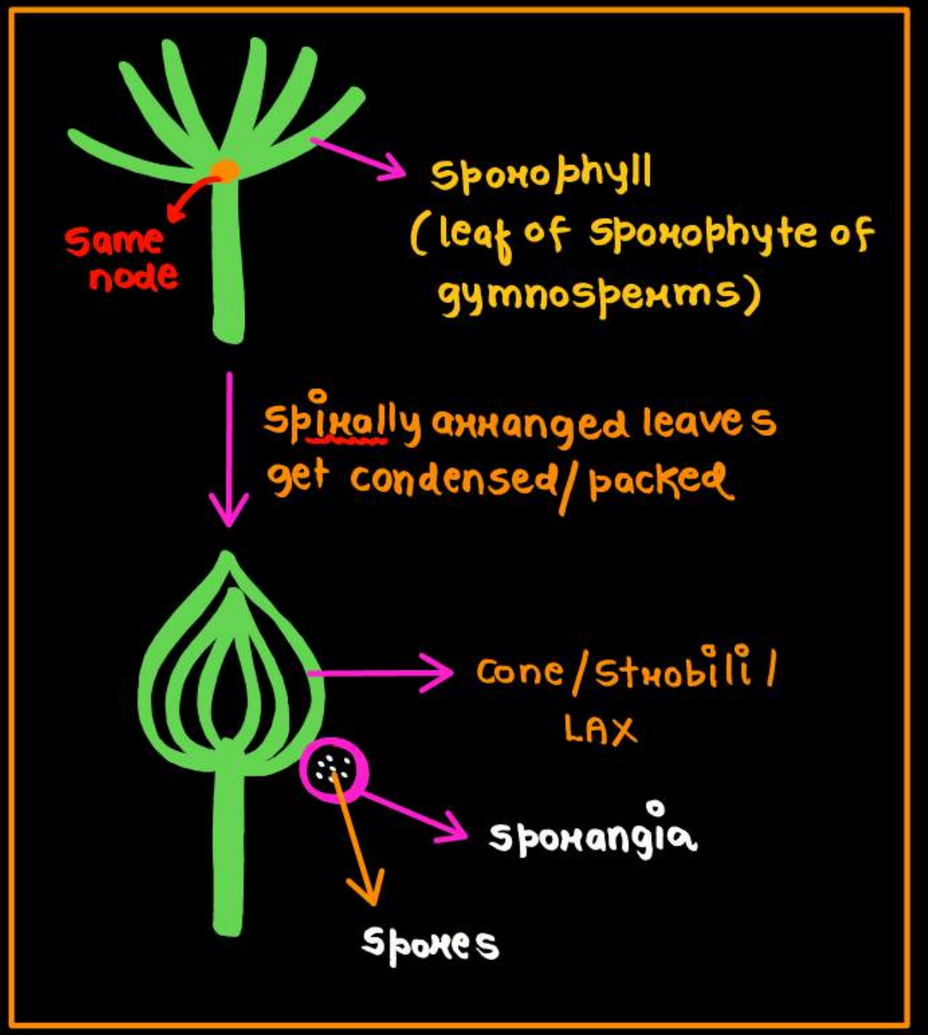
Leaf
- Adapted to withstand ↑Temp., ↑Humidity, ↑wind & conserve more H_2O
- Cycas : Pinnate leaves
  - Surface area ↓↓
  - water conserve ↑↑
- Conifers : 
  - Needle like leaves ⊕nt

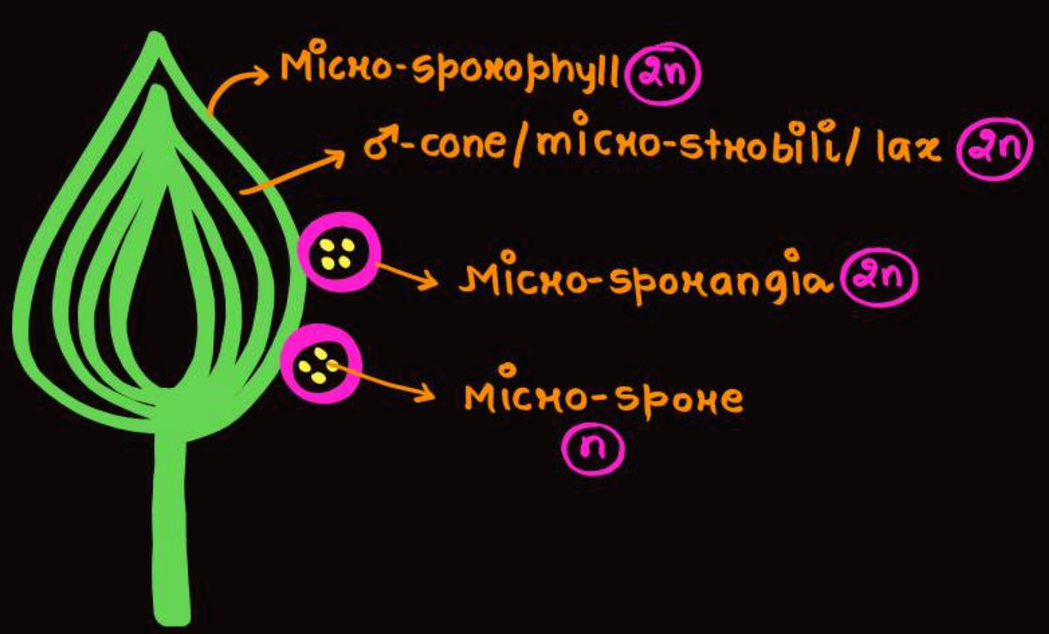
Surface area ↓ ; cuticle (wax) ⊕nt on leaf ; sunken / deep pitted stomata ⊕nt to conserve H_2O

Gymnosperms are HETEROSPOROUS

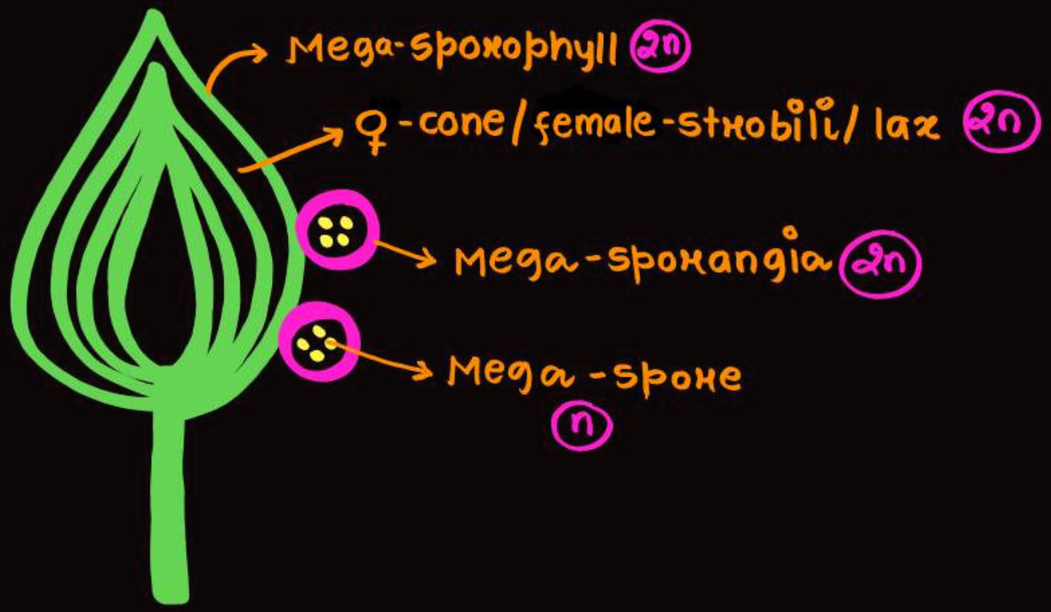
Here, 2 different types of spores are seen

- Microspore → (n) → ♂ gametophyte
- MegaSpore → (n) → ♀-gametophyte





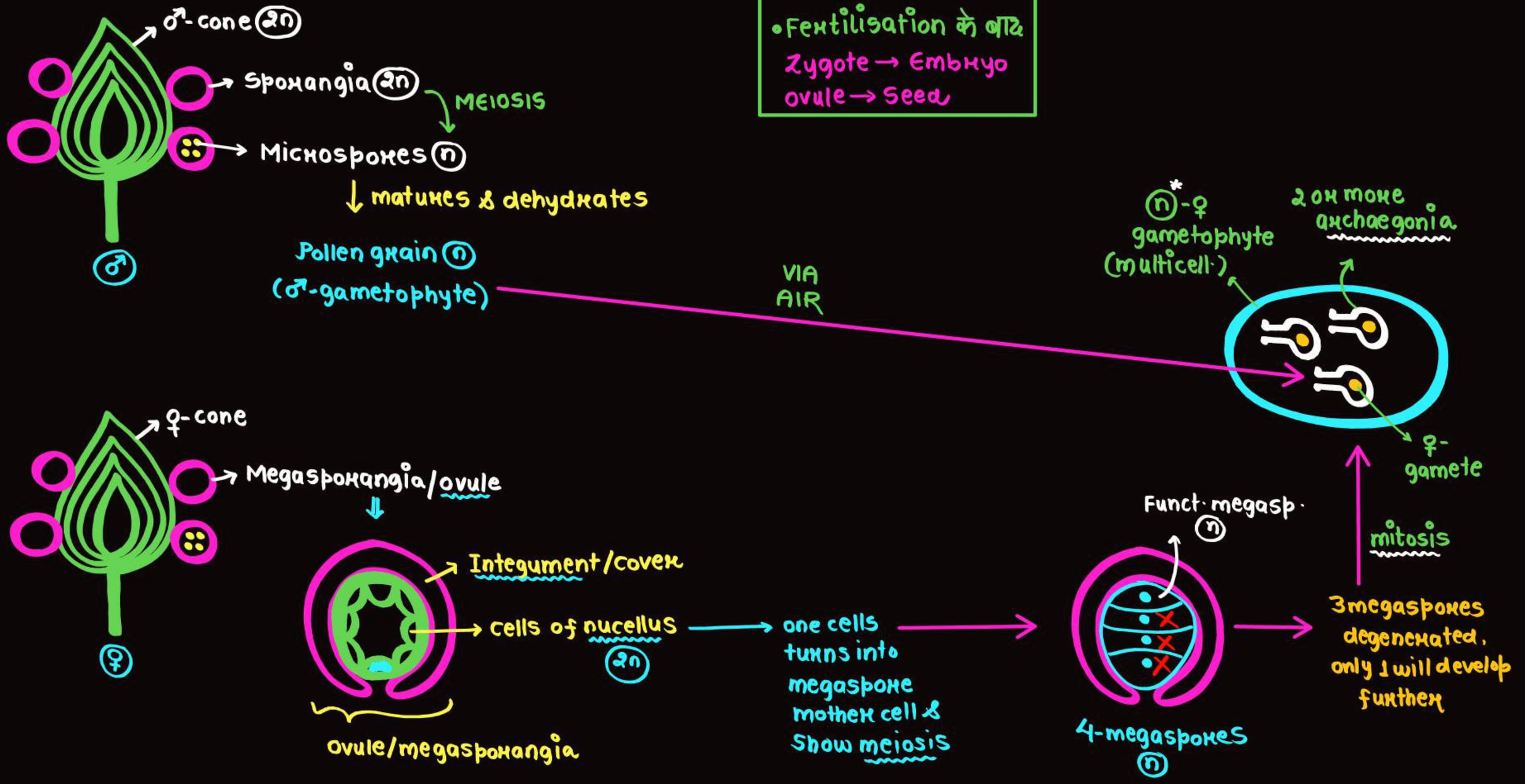
♂-gymnosperm
⇓
MICRO



♀-gymnosperm
⇓
MEGA

e.g., Pinus is BISEXUAL (Monoecious)

e.g., Cycas is UNISEXUAL (Dioecious)


♂-cone (2n)
Sporangia (2n)
MEIOSIS
Microspores (n)
matures & dehydrates
Pollen grain (n)
(♂-gametophyte)
VIA AIR
• Fertilisation के बाद
Zygote → Embryo
ovule → Seed
n* ♀ gametophyte (multicell.)
2 or more archaegonia
♀-gamete
♀-cone
Megasporangia/ovule
Integument/cover
cells of nucellus (2n)
Ovule/megasporangia
one cells turns into megaspore mother cell & show meiosis
Funct. megasp. (n)
4-megaspores (n)
mitosis
3 megaspores degenerated, only 1 will develop further

NCERT LINE by LINE

Unlike bryophytes and pteridophytes, in gymnosperms the male and the female gametophytes do not have an independent free-living existence. They remain within the sporangia retained on the sporophytes. The pollen grain is released from the microsporangium. They are carried in air currents and come in contact with the opening of the ovules borne on megasporophylls. The pollen tube carrying the male gametes grows towards archegonia in the ovules and discharge their contents near the mouth of the archegonia. Following fertilisation, zygote develops into an embryo and the ovules into seeds. These seeds are not covered.

CRITICAL POINTS

→ Ginkgo biloba (living fossil)
↓
Cycas also