

- Classification: Based on Pigments, Wall Compositionn, Stored Food, etc.

CHLOROPHYCEAE	PHAEOPHYCEAE	RHODOPHYCEAE
Wall Inner Cellulose + Outer Pectose	Wall Inner Cellulose + Outer Algin like Phycocolloids	Wall Inner Cellulose + Outer Pectin & Polysulphate Esters like Agar
Main Pigments Chlorophyll A, B	Main Pigments Chlorophyll A, C, Fucoxanthin	Main Pigments Chlorophyll A, D, Phycoerythrin
Reserve Food Starch (in Paramylon Bodies) Mnemonic: <u>Green</u> Plants make <u>Starch</u>	Reserve Food Mannitol + Laminarin	Reserve Food Floredean Starch Mnemonic: flo<u>RE</u>Dean Starch
Flagellation Biflagellate Isokont 2-8 Equal & Apical Flagella only seen in Zoospores	Flagellation Biflagellate Hererokont 2-8 Unequal & Lateral Flagella only seen in Zoospores	Flagellation No Flagella @ any stage
Sexual Reproduction All 3 types seen <i>Chlamydomonas</i> : complete evolution of sexual reproduction	Sexual Reproduction All 3 Types senn Pyriform gametes & zoospores Fertilisation in H ₂ O / Oogonia	Sexual Reproduction Oogamy seen ♀ Sex Organ: Carpogonium ♂ Sex Organ: Spermatangium
Other Modes of Repro Not so peculiar	Other Modes of Repro Not so peculiar	Other Modes of Repro Veg Propag: Fragmentation Asexual: Non-Motile Spores

<p style="text-align: center;">Facts</p> <ul style="list-style-type: none"> • Pyrenoids = Central Protein Body + Outer Starch Sheath • Chloroplast Shapes: <ul style="list-style-type: none"> ◦ Cup: <i>Chlamydomonas</i> ◦ Girdle: <i>Ulothrix</i> ◦ Spiral: <i>Spirogyra</i> ◦ Discoid: <i>Chara</i> ◦ Band: <i>Hydrodictyon</i> ◦ Reticulate: <i>Oedogonium</i> ◦ Stellate: <i>Zygnema</i> ◦ Mnemonic: ROSZ / Roses 	<p style="text-align: center;">Facts</p> <ul style="list-style-type: none"> • Central Nucleus & Vacuole • Rarely found in Fresh Water • <u>Have Trumpet Hyphae for Food Conduction (analogous to Sieve Tubes of Angiosp.)</u> • <u>Holdfast: Attaches to Substrate</u> • <u>Stipe: Joins Holdfast & Fronds</u> • <u>Fronds: Leaf like Organs</u> • Phycocolloids: <ul style="list-style-type: none"> ◦ Ex: Fucoidin, Algin ◦ Prevent them from Dessication & Shock ◦ Used in Ice Cream Thickening 	<p style="text-align: center;">Facts</p> <ul style="list-style-type: none"> • They're called <u>Ancient Algae</u> • Mostly marine except one - <i>Batrachospermum</i> (Fresh Water Alga) • Mostly Multicellular except <i>Poryphyridium</i> (Unicellular) • <u>Share similarities with BGA like Pigments, Gaidukov's Phenomenon, etc.</u>
<p style="text-align: center;">Examples</p> <ul style="list-style-type: none"> • <i>Chlamydomonas</i>: Palmella Stage seen • <i>Ulothrix</i>: <ul style="list-style-type: none"> ◦ Filamentous, Colourless ◦ shows Division of Labour with Rhizoidal Cell acting as Holdfast • <i>Volvox</i>: <ul style="list-style-type: none"> ◦ Colonial ◦ Thallus is called Coenobium • <i>Chlorella</i>: <ul style="list-style-type: none"> ◦ in Sewage Oxidation Tanks ◦ in Space Flights as food • <i>Chara</i>: <ul style="list-style-type: none"> ◦ Monoecious ◦ Globule: Lower Antheridium ◦ Nucule: Upper Archegonium • <i>Spirogyra</i> (Pond Silk): <ul style="list-style-type: none"> ◦ Morphological Isogamy ◦ Pjysiological Anisogamy • <i>Oedogonium</i>: Cap Cells seen 	<p style="text-align: center;">Examples</p> <ul style="list-style-type: none"> • <i>Ectocarpus</i>: Simple Branched Filamentous • <u><i>Macrocystis</i> (Giant Kelps):</u> <ul style="list-style-type: none"> ◦ Profusely Branched ◦ Height upto 100 m • <i>Fucus</i>: Diplontic • <i>Sargassum</i> (Gulf Weed): <ul style="list-style-type: none"> ◦ Threat to Ships in the Sargasso Sea in the North Atlantic Ocean • <u><i>Laminaria</i> (Devil's Apron):</u> <ul style="list-style-type: none"> ◦ <u>Iodine</u> & a Japanese Dish Kombu is obtained 	<p style="text-align: center;">Examples</p> <ul style="list-style-type: none"> • <i>Chondrus</i> (Irish Moss): <ul style="list-style-type: none"> ◦ Gelatinous Carragenin from it is used to make capsules • <i>Rhodomella</i>: Bromine obtained from it • <i>Harveyella</i>: Colourless Parasite • <i>Polysiphonia</i>: shows Triphasy <ul style="list-style-type: none"> ◦ Carposporophyte ◦ Tetrasporophyte ◦ Gametophyte • <i>Poryphyra</i>: Edible • <i>Gelidium & Gracillaria</i>: Agar-Agar is obtained from it • <i>Batrachospermum</i>: Colour varies from Red to Blue - Green

BRYOPHYTES

- Term: **Robert Brown**
- Father of Bryology: **Hedwig / Cavers**, Indian Bryology: **SR Kashyap**
- Called **Amphibians of the Plant Kingdom**
- Mostly seen in shady places, so called **Sciophytes**
- They're **Terrestrial Autotrophs & Non-Vascular Embryophytes**
- No True Roots, Stems, Leaves. But alike structures found

- **Gametophyte:** Body is a Free Living Autotrophic Haploid Gametophyte
- **Sporophyte:** It's Diploid, Nutritionally dependent on Gametophyte. It gives rise to Gametophyte
- **Rhizoids:** Unicellular (*Riccia*), Multicellular with Oblique Septa (*Funaria*)

- **NCERT Facts:**
- **Bryophytes: Little Economic Importance, Great Ecological Significance**
 - Reduce the impact of rains & erosion
 - Mosses form a dense mat on the soil
 - Crustose Lichens + Mosses = **Pioneers of Xerarch Succession** (see Ecology)
 - *Sphagnum* (**Bog/Peat Moss**): used as a Trans-shipment Packaging Material due to its capacity to hold water

- **General Life Cycle:**
- Sporophyte > Spores > Germination > Gametophyte > Fertilisation > Sporophyte

- **Veg Reproduction:**
- **Tubers:** *Riccia, Anthoceros*
 - **Gemmae:** *Liverworts*
 - **Protonema:** *Mosses*

LIVERWORTS / HEPATICOPSIDS

- **Body**

- Foot + Seta + Capsule (except in *Riccia*, which only has a capsule)
- Multicellular Scales + Unicellular Unbranched Rhizoids
- Dichotomously branched, Prostrate, Thalloid, Dorsiventral
- Closely appressed to substrate
- Tiny leaf like appendages on stem-like structures in 2 rows

- **Sporophyte**

- Fully Parasitic on Gametophyte
- Less Elaborate than Mosses
- Elaters seen for spore dispersal in *Marchantia* only

- **Gametophyte**

- Chemo-attractant for Antherozoids: Proteins/K⁺
- Antherozoids are short, curved, coiled, comma-shaped & biflagellate
- Archegonium: 1 Egg + 1 VCC (Venter Canal Cell) + 4-6 NCC (Neck Canal Cells)

- **Veg Reproduction**

- Fragmentation
- Gemmae
 - Green Multicellular Asexual Buds
 - Develop in Small Receptacles called Gemmae Cups (located on thallus)

- **Examples:**

- *Marchantia*
- *Riccia* (its spores are smooth & tetrahedral)
- *Porella*
- *Pellia*
- *Cryptothallus*

HORNWORTS / ANTHROCEROTOPSIDA

- **Body**
 - Foot + Capsule
 - No Scales + Unicellular Unbranched Rhizoids
- **Miscellaneous**
 - Sporophyte is semi-parasitic & shows Symbiosis with BGA like *Nostoc*
- **Example: *Antheroceros***

MOSSES / BRYOPSIDA

- **Body**
 - Foot + Seta + Capsule
 - No Scales + Multicellular Branched Rhizoids
- **Sporophyte**
 - Semi Parasitic on Gametophyte
 - More Elaborate than Liverworts
 - Elaters absent
 - Elaborate Mechanism for Spore Dispersal
 - Capsule Structure:
 - **Upper: Operculum + Annulus + Peristome (Hygroscopic Teeth)**
 - **Middle: Theca (has spores) + Nurse Cells + Columella (central sterile part)**
 - **Lower Part: Apophysis (assimilatory & bears stomata)**
- **Gametophyte**
 - Chemottractant for Antherozoids: **Sucrose**
 - Antherozoids are **biflagellate**
 - **Archegonium: 1 Egg + 1 VCC (Venter Canal Cell) + 6-10 NCC (Neck Canal Cells)**
 - **Calyptra develops from Venter Wall & is nutritive for young sporophyte**

- **Protonema / Gametophyte Stage 1**
 - Creeping green, branched, frequently filamentous
 - Develops directly from a spore
 - Veg Propag occurs by Budding & Fragmentation in Secondary Protonema
- **Ploidy Levels**
 - All parts of Sporophyte (Operculum, Annulus, Endothecium, Theca, Nurse Cells, Columella): **Diploid**
 - All parts of Gametophyte (Calyptra, NCC, VCC): **Haploid**
- **Examples**
 - *Funaria* (monoecious, male surrounded by Perigoneal & female by Perichaetal Leaves)
 - *Sphagnum* (has Hadrome & Retort Cells) Mnemonic: SRH (Sun Risers Hyderabad)
 - *Marchantia*: Irregular looking is a male one. Sunflower / Daisy like looking is a female one. *Marchantia* is dioecious while *Funaria* is monoecious.

PTERIDOPHYTES

- Term: Haeckel
 - called the "Reptiles of Plant Kingdom"
 - 1st terrestrial tracheophytes (vascular tissue seen)
 - Sporophyte is dominant phase.
 - True Shoot, Root, Leaves found for the 1st time
 - Secondary Growth is absent since cambium is absent. But it's found in *Isoetes*
 - Vascular Tissues:
 - Xylem: Tracheids present but true Vessels are absent (vessels are a characteristic of angiosperms only)
 - Phloem: Companion Cells are absent, but Sieve Cells are present
 - Jacketed multicellular gametangia with flagellated sperms
 - Independent Sporophyte & Gametophyte
 - Gametophyte / Prothallus
 - Small, Inconspicuous, Multicellular, Free Living, Thalloid, Photosynthetic / Saprobic
 - gametophyte development may be Endosporic (inside spore walls) / Exosporic
 - spread of pteridophytes is narrowly restricted due to their need of water for fertilisation.
 - Female Gametophytes retained on parent sporophytes for variable periods
 - Sporophyte
 - Sporangia are subtended by leaves called Sporophylls
 - Sporophylls are photosynthetic: a unique feature of Pteridophytes
 - Meiospores are formed inside sporangia
 - Sporocarps are found in aquatic ferns like *Marsilea*, *Salvinia*
 - In some cases sporophylls form distinct, compact structures called Cones / Strobila
- Ex: *Selaginella*, *Equisetum*

- **Leaves**
 - **Microphylls**
 - Small leaves as in *Lycopodium*, *Equisetum*, *Selaginella* (Mnemonic: LESS)
 - **Megaphylls**
 - Large Leaves as in *Pteridium*, *Pteris*, *Marsilea* (Mnemonic: PPM)
- **Classification based on Spore Types**
 - **Heterosporous** / 2 types of spores / *Selaginella*, *Salvinia*, *Azolla*, *Marsilea*, *Cyathium*
 - (Mnemonic: Uncle **SAM** falls under **SC** category)
 - Their gametophytes aren't called Prothallus !!
 - **Homosporous** / 1 type of spore only / majority of pteridophytes are homosporous
 - *Adiantum*
 - *Dryopteris*
- **Stele / Vascular Cylinder**
 - **Protostele**
 - primitive type as in *Psilotum*, *Selaginella*, *Lycopodium*, *Rhynia* (Mnemonic: PSLR - which sounds similar to your DSLR cameras !!)
 - **Ectophloic Siphonostele / Eustele**
 - *Equisetum*
 - **Amphiphloic Siphonostele**
 - *Adiantum*
- **Classification of Pteridophytes:**

PSILOPSIDA

- Most Ancient Plants
- Examples:
 - Fossils: *Rhynia*, *Horneophyton*, *Cooksonia*
 - The only living species: *Psilotum*

LYCOPSIDA

- **Club Mosses** are placed under this category
- Examples:
 - *Lycopodium* (common club moss / ground pine / trailing evergreen)
 - *Isoetes* (secondary growth seen)
 - *Selaginella* (resurrection plant / little club moss / spike moss / bird's nest moss)
 - Heterospory
 - **Rhizophores / Organ-sui-generis** present (intermediate b/n root & stem)
 - 13 celled male gametophyte (12 celled antheridium + 1 celled prothallus)
 - has **Ligulate Leaves (tongue like)** (have a basal swollen part called **Glossopodium**)
 - **Sanjeevani** obtained from *Selaginella bryopteris*

SPHENOPSIDA

- **Horsetails** are placed under this category
- Their stems & leaves have a **siliceous epidermis**, so if rubbing b/n 2 horsetails occurs, a forest fire may be produced
- Examples: *Equisetum*

PTEROPSIDA

- **Largest group of pteridophytes**
- **Ferns** are placed here
- They have large leaves called **Fronds**
- Immature Leaves show **Furcate Venation & Circinate Ptyxis** (Arrangement of Leaves in buds)
- **Malic Acid** is the chemo-attractant here
- Leaves & Rhizomes are protected by hair like **Scales / Ramenta**
- **Cones are not produced in ferns**
- **Inducium** (a diploid sheath covering bean-shaped sori)
 - **True Inducium** is seen in *Dryopteris*
 - **False Inducium** is seen in *Adiantum*

- Examples:

- *Adiantum* (Maiden Hair Fern / Walking Fern: as it spreads vegetatively through leaf tips)
- *Pteridium* (Bracken Fern / Sun Fern)
- *Dryopteris* (Male Shield Fern / has Multiflagellated Spirally Coiled Antherozoids)
- *Ophioglossum* (Adder's Tongue Fern / plant with the largest no. of chromosomes = 1260)
- *Osmunda* (Royal Fern)
- *Salvinia, Azolla, Marsilea* (aquatic ferns) (Mnemonic: Uncle SAM)
- *Alsophila* (Tree Fern)
- *Cyatium* (Tree Fern)

GYMNOSPERMS

- called "Phanerogams without Ovaries" or "Tracheophytes without Womb"
- they are the **smallest group in Plantae**. They have only 900 species living today.
- **Habitat**
 - Found in Temperate Regions mainly except *Cycas* (found in warmer regions)
- **Types**
 - Mainly they are Perennial Woody Medium to Tall Trees except:
 - *Gnetum* which is a liana or a woody climber
 - *Ephedra* which is a shrub
- **Roots**
 - Tap Root System is seen
 - *Cycas - Anabeana* = Coralloid Roots
 - *Pinus - Boletus* (a toadstool fungus) = Ectomycorrhizae
 - *Pinus - Glomus* (a fungus) = VAM (Vesicular Arbuscular Mycorrhizae)

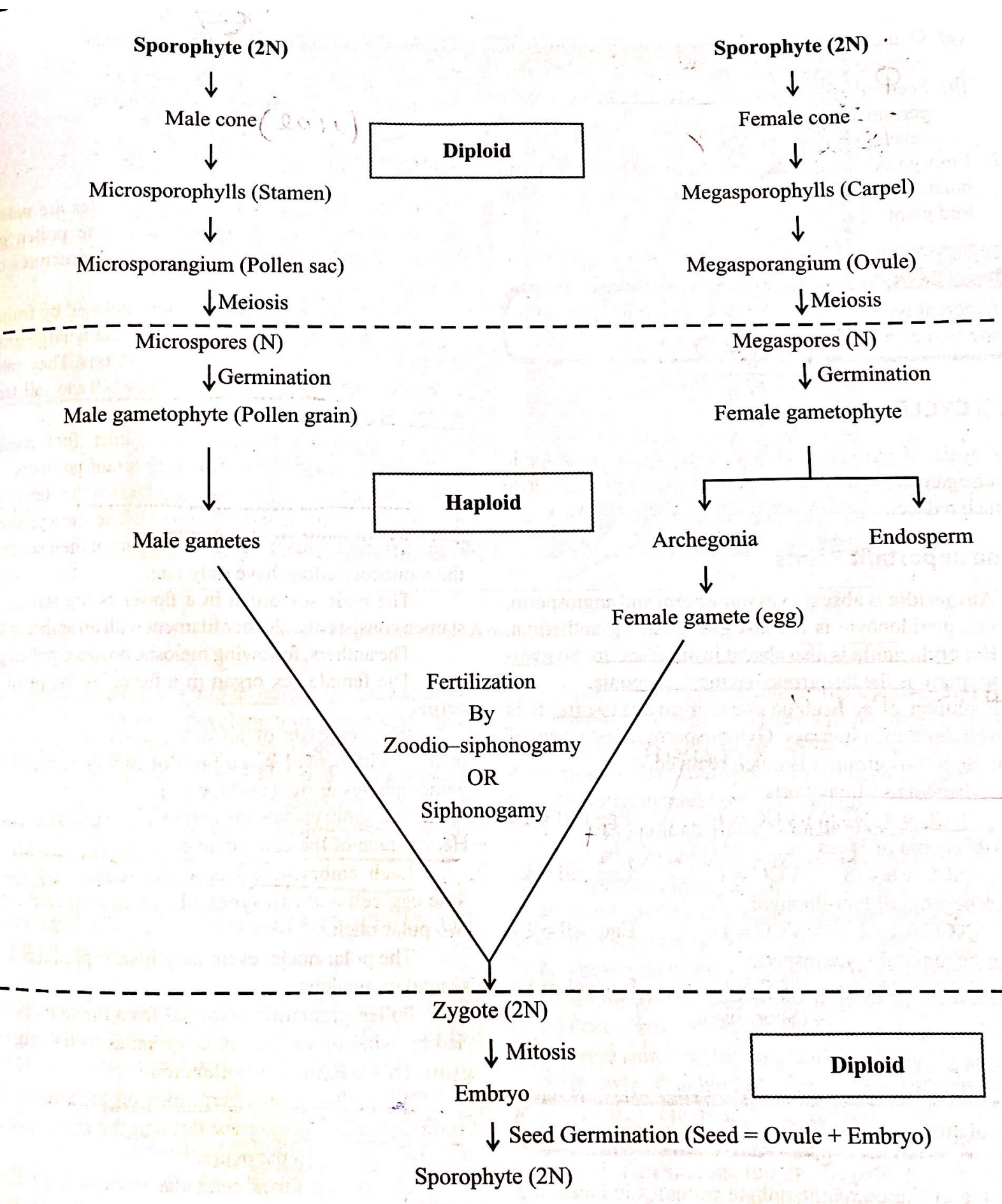
- **Leaves**
 - Simple leaves in *Pinus* have these features:
 - **needle like shape to reduce surface area**
 - **thick cuticle & sunken stomata to reduce water loss**
 - Compound Pinnate Leaves in *Cycas* persist for a few years

- **Stem**
 - Branched in *Pinus, Cedrus*
 - Unbranched in *Cycas*

- **Vascular Bundles**
 - **Xylem:** Tracheids present & Vessels absent (but vessels seen in advanced order *Gnetales*)
 - **Phloem:** Sieve Cells present, but Sieve Tubes & Companion Cells absent

- **Secondary Growth**
 - It is definitely found in them, since their stems are extremely woody
 - Generally, it is **found in all gymnosperms, some monocots & most dicots**

- **Miscellaneous**
 - **Gametophytes don't have a free living existence;** they're retained in sporangia
 - Pollens need **Anemophily** (air dispersal) & reach the female through Pollen Tubes (**siphonogamy**) & get **discharged near the mouth of archegonia**
 - Gymnosperms are Heterosporous i.e. they form micro & megaspores



For Your Information

Algae

- 50% of the total CO₂ fixation on Earth is done by algae, thus increase the Dissolved Oxygen (DO) Level in their surroundings.
- 70 species of marine algae are used as food. For example:
 - *Poryphyra* (red)
 - *Laminaria* (brown)
 - *Sargassum* (brown)
 - *Chlorella* (green)
 - *Spirulina* (green)
- Algin is a non-sulphate hydrocolloid unlike carrageenin

Bryophytes

- Smallest Bryophyte = *Zoopsis*
- Largest Bryophyte = *Dawsonia*

Pteridophytes

- Smallest Pteridophyte = *Azolla* (aquatic fern)
- Largest Pteridophyte = *Alsophila* (tree fern)

Gymnosperms

- Smallest Gymnosperm = *Zamia pygmaea*
- Largest Gymnosperm = *Sequoia simpervirens* (Giant Redwood Tree)

Angiosperms

- Smallest Angiosperm = *Wolffia*
- Tallest Angiosperm = *Eucalyptus*

✓ * **Important Points:**

- Antheridia are absent only in Gymnosperms & Angiosperms.
- Archegonia are absent only in Angiosperms
- The only cell of sporophytic generation is Zygote in Haplontic Cycles
- The 1st cell of sporophytic generation is Zygote in Diplontic Cycles
- The only cell of gametophytic generation is Spore in Diplontic Cycles
- The 1st cell of gametophytic generation is Spore in Haplontic Cycles
- Alternation of Generation in plants isn't the same as Metagenesis in Animals

Cycas	Pinus
Unbranched Stems	Branched Stems
Dioecious (gametophytes on different trees)	Monoecious (gametophytes on the same trees)
Manoxylic & Polyxylic	Monoxylic & Pycnoxylic (Py = Pinus)
2 cotyledons	Many cotyledons
Coralloid Roots	VAM found in roots
Simple Pinnate Leaves	Compound Needle like Leaves
Miscellaneous Sperms are top shaped & multiflagellated Pollination @ 3 celled stage	Miscellaneous Resin Ducts are seen in cortex 2 prothallial cells in male gametophyte 2 archegonial cells in female gametophyte Wings in seeds are from ovuliferous scales Wings in pollens are from exine layer