Ferns, club mosses, horsetails, and whisk ferns are seedless vascular plants that reproduce with spores and are found in moist environments. Water is required for fertilization of seedless vascular plants; most favor a moist environment.

CLASSIFICATION OF THE PTERIDOPHYTES

Phylum Pteridophyta

Class Lycopodiopsida

Order Lycopodiales, the club mosses and ground pines, approximately 400 species

Order Selaginellales, the spike mosses, approximately 450 species

Order Isoetales, the quillworts, approximately 130 species

Class Equisetopsida, the horsetails or scouring rushes, 15 species

Class Psilotopsida, the whisk ferns, approximately 12 species

Class Polypodiopsida (Ferns), the true ferns, approximately 10,000 species

Matherial:

Division Tracheophyta – vascular plants, tracheophytes

Class Polypodiopsida – leptosporangiate ferns

Order Polypodiales Family Dryopteridaceae – wood ferns, woodferns

Genus Dryopteris Adans. – shieldfern, woodfern

Objects:

Herbarium and permanent preparation of *Dryopteris filix-mass*

Objective:

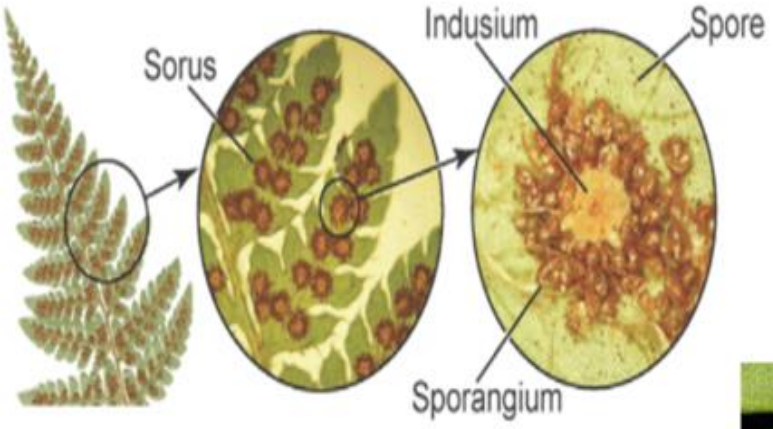
To investigate the structural features of *Dryopteris filix - mass*

Tasks of work:

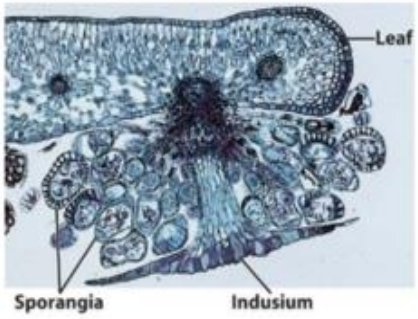
Draws the appearance of the shoots of *Dryopteris filix – mass*

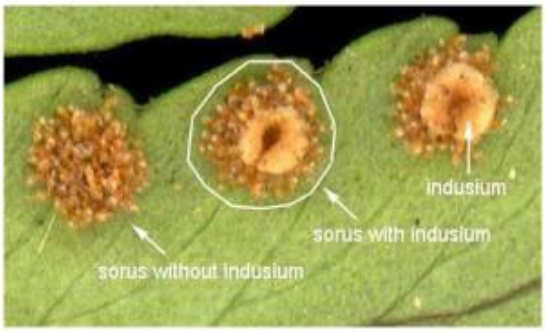
Draw the structure of the sorus, prothallus and Gametophyte

Draw the life cycle of Dryopteris filix – mass



A flap of tissue that protects the sorus in some ferns. When spores are mature and ready for release, the indusia usually shrivel or bend backwards to expose the sporangia.



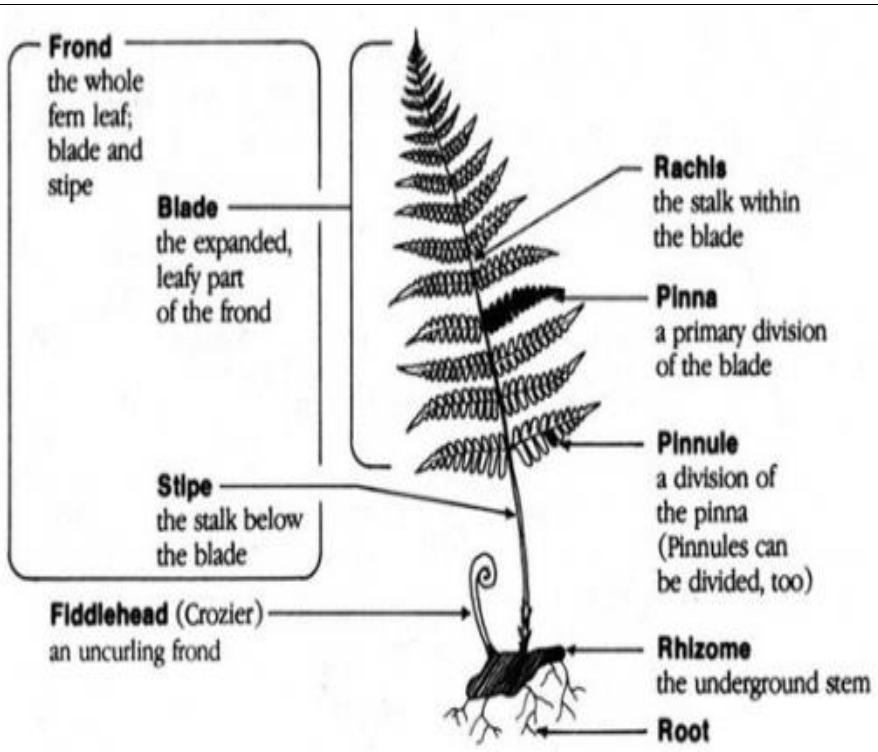


The genus *Dryopteris*

included 250 species that are distributed in tropical, subtropical and north temperate regions of the world. They usually grow in moist, cool and shady places. *Dryopteris* is herbaceous, perennial and rhizomatous.

The sporophytic plant body is differentiated into **roots, rhizomatous stem and leaves.**

The **primary root** is **ephemeral**, and **is replaced** by a large number of **adventitious roots** growing from the leaf bases. The roots are small and branched.



Dryopteris sp.

Dryopteris is a homosporous fern.
The **sori** are borne in two rows on two sides of the median vein of a pinnule in-between the margin and the midrib.
Each **sorus** is covered by a kidney-shaped **indusium**. A number of stalked sporangia arise from the central placental tissue. Sori are of mixed type i.e., sporangia arise without any order of development.

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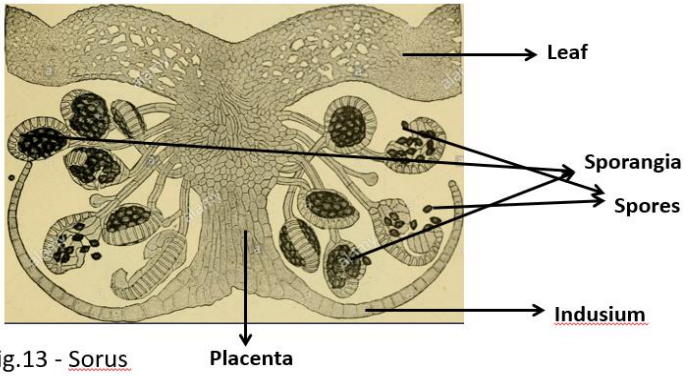


Fig.13 - Sorus

A haploid spore is the first cell of sexual or gametophyte generation. Under suitable moist condition, each spore germinates into a ***gametophyte called prothallus*** *(Fig.15). It is a flat, green, non-vascular heart shaped structure with about 5- 13 mm in diameter. The dorsal surface is smooth while ventral surface contains unicellular rhizoids and sex-organs. Prothallus has a narrow posterior end and a distinct apical notch at anterior end.*

Gametophyte:

A haploid spore is the first cell of sexual or gametophyte generation. Under suitable moist condition, each spore germinates into a **gametophyte called prothallus** (Fig.15). It is a flat, green, non-vascular heart shaped structure with about 5- 13 mm in diameter. The dorsal surface is smooth while ventral surface contains unicellular rhizoids and sex-organs. Prothallus has a narrow posterior end and a distinct apical notch at anterior end.

The rhizoids arise from the ventral side of the posterior end which helps in anchorage, absorption of water and nutrients from soil. Prothallus is short lived and dies in drought conditions.

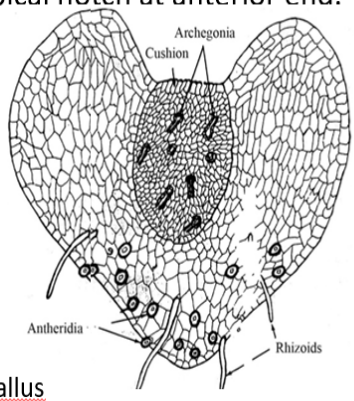
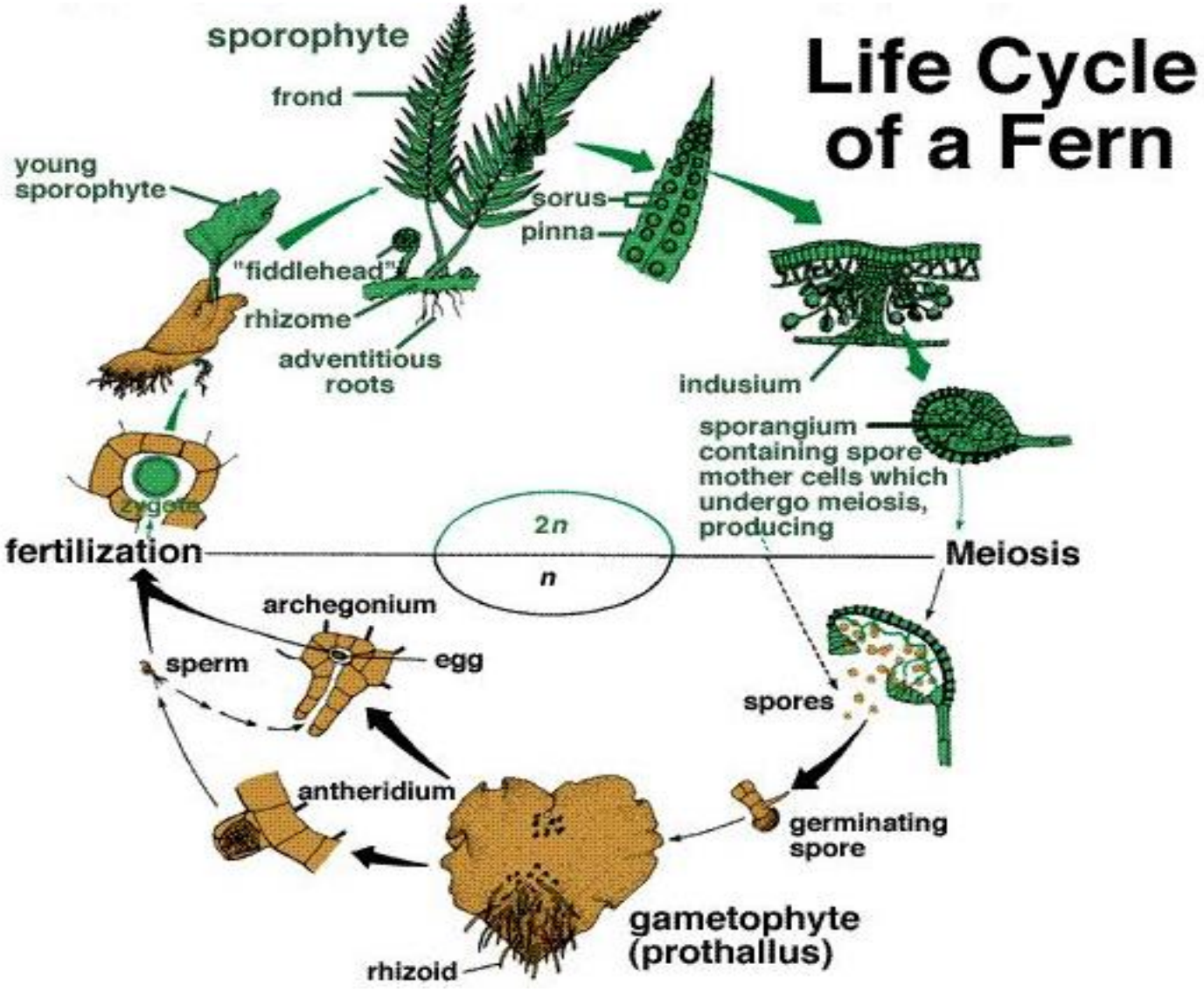


Fig.15 - Prothallus



Today, there over one thousand species of gymnosperms belonging to **four main divisions:**
1. Coniferophyta,
2. Cycadophyta,
3. Ginkgophyta,
4. Gnetophyta.

Some of the most recognizable examples of these woody shrubs and trees include pines, spruces, firs, and ginkgoes. Gymnosperms are abundant in **temperate forest** and **boreal forest** biomes with species that can tolerate moist or dry conditions.

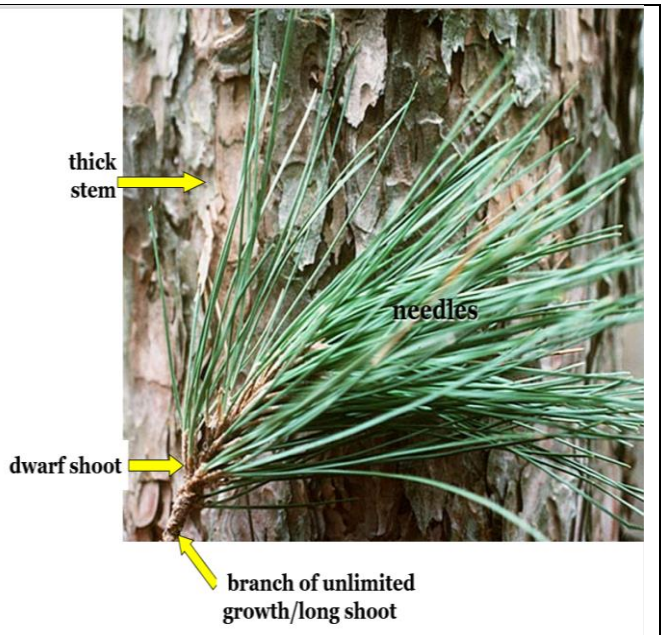
Coniferophyta / Pinophyta

- **The conifers are assigned to the**
  - **Division: Pinophyta / Coniferophyta**
  - **Class: Pinopsida / Coniferopsida**
  - **Order: Pinales / Coniferales**
- Termed conifers because most members bear their seeds in cones
  - Cones protect ovule and seed and facilitate pollination and dispersal
- They are the largest and most ecologically & economically important of the gymnosperms

Family: Coniferaceae/Pinaceae

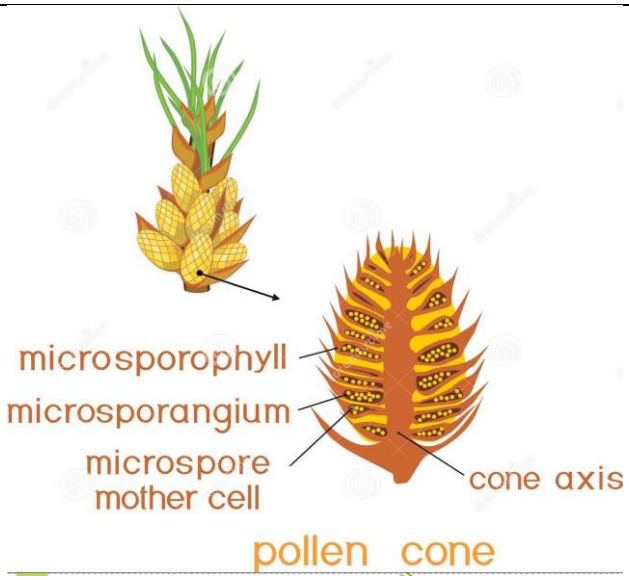
Strong trees

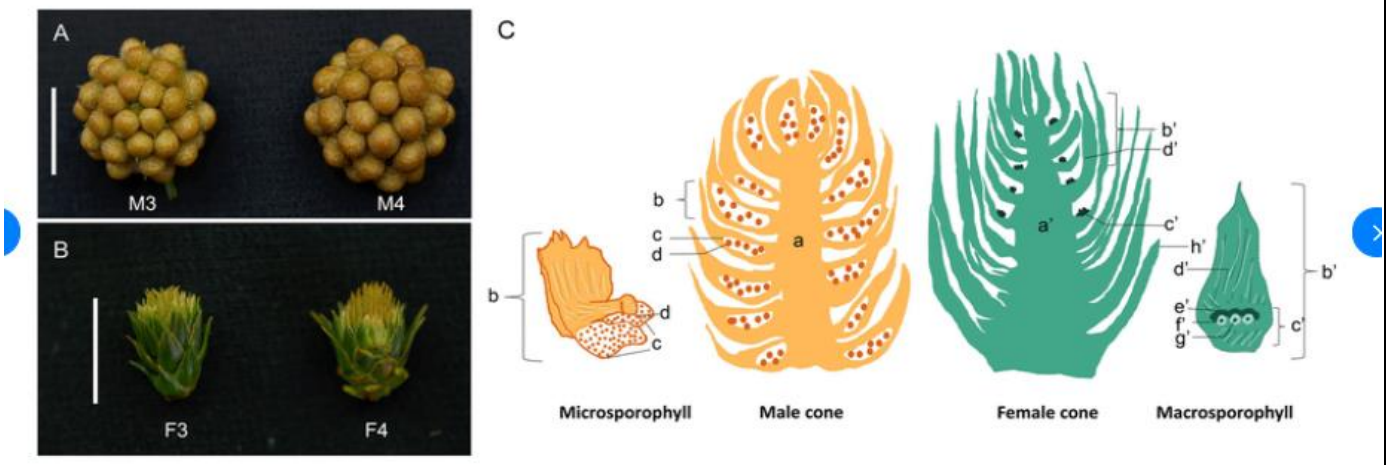
- Emit strong odour from bark &/or leaves
  - Resin canals throughout stem & leaves
- Branches whorled or opposite
  - Consist of long and short shoots
- Simple leaves
  - Linear / Needle-shaped
  - Clustered in fascicles of 2-5 needles
  - Sessile or short petioled on long shoots
  - Tightly clustered on short shoots
  - Persistent (evergreen)
- Usually have straight trunks with horizontal branches varying more or less regularly in length from bottom to top, so that the trees are conical in outline
- Members are **monecious**



• Reproduce through **micro- & megasporangiate** (staminate and ovulate) cones • Wood is very hard	
Pinaceae - Reproduction In pine as in other vascular plants, the sporophyte (the spore-producing generation), or pine tree is the dominant generation. The sporophyte bears two types of reproductive structures referred to as "male" and "female" cones. Each cone is considered to be a modified branch with a number of modified leaves, called scales or sporophylls. Each sporophyll bears a structure called a sporangium in which the spores are produced. Unlike the ferns, in gymnosperms the spores as well as the gametes come in two sizes: separate microspores (produced in microsporangia, and which develop into male gametophytes) and megaspores (produced in megasporangia, and which develop into female gametophytes) — (micro = small; mega = large, great).	
The "male" (staminate) cones typically are found in clusters at the tips of lower, side (lateral) branches, and usually take several years to develop. In these cones, the modified leaves are called microsporophylls (phyll = leaf). Each microsporophyll bears two microsporangia within which the microspores are produced.	

Within the microsporangia, the microspore mother cells undergo meiosis to form four haploid microspores, the start of the male gametophyte generation (the pollen — note, pollen is not the same thing as sperm, rather it is a gametophyte). Still inside the microsporangium, each microspore divides and "grows" to form a four-celled (four nuclei, anyway) male gametophyte, also known as pollen which *contains* two sperm nuclei. A grain of pine pollen also has two large air sacs to make it buoyant in the wind.





C. lanceolata female and male cones with their vertical section. a Male cone with a high number of male strobili. b Female cone with scale leaves and slightly opened bract-scales. Tree No.3–15-31, shown as F3, M3; Tree No.4–9-31, shown as F4, M4. Scale bar: A, B = 1 cm. c Male cone with axes (a), microsporophyll (b). Microsporophyll bears pollen sac (c), and pollen (d). Female cone with axes (a'), scale (h'), and macrosporophyll. Macrosporophyll with bract-scale (d'), ovuliferous scale (c'). ovuliferous scale with lobe (e'), integument (f'), nucellus (g') [8]

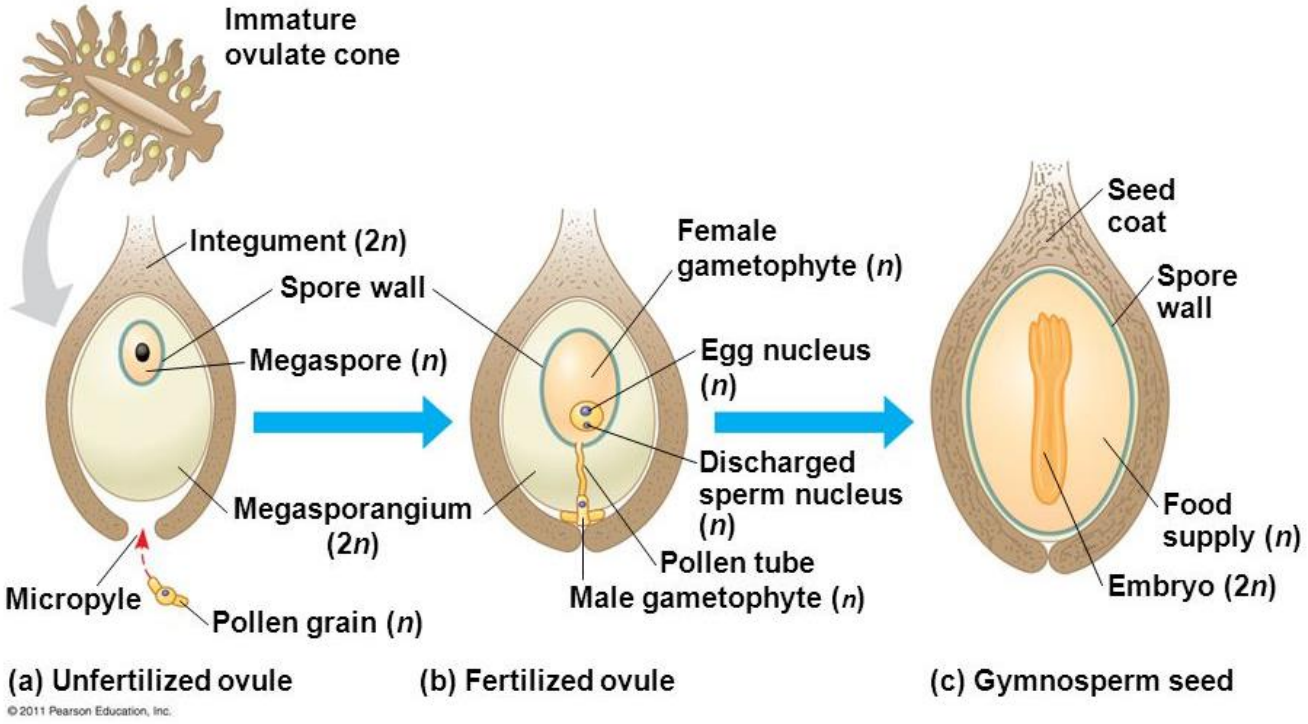
Pinaceae – Reproduction

- Megasporangiate/ovulate cones
  - Larger than the male cones
  - Borne on stem (intercalary)
  - Spirally arranged, flattened bract/ovuliferous-scale complex
    - Woody (ovuliferous) scale (megasporophyll) envelops the 2 ovules on adaxial surface.
    - Papery bract / carpellary scale
    - Micropyles of ovules directed toward the axis of the cone
    - Few archegonia/ovule

- Derived from modified branch bearing lateral branches (with seeds) borne in the axils of leaves

Fertilization

- As mentioned above, **pollination** is the transfer of pollen to the female cone, and is not the same as fertilization. After a pollen grain enters the micropyle and contacts the nucellus of the female plant, as mentioned, a tube from the pollen grain begins to grow through the nucellus. The nucleus of the tube cell remains near the tip of this tube, apparently directing its growth. Within the pollen, the generative cell divides to form a stalk cell and a body cell. The nucleus of the body cell divides once more to form two **sperm nuclei**. When the pollen tube penetrates the egg, the sperm nuclei travel down the pollen tube, then enter the egg. One of them unites with the egg nucleus (**fertilization**) and the other disintegrates. Even though several archegonia are formed, only one egg is fertilized and only one **zygote** develops per ovule. The other sperm nucleus and all other eggs and archegonia in that female gametophyte disintegrate so one **zygote** per ovule is left.

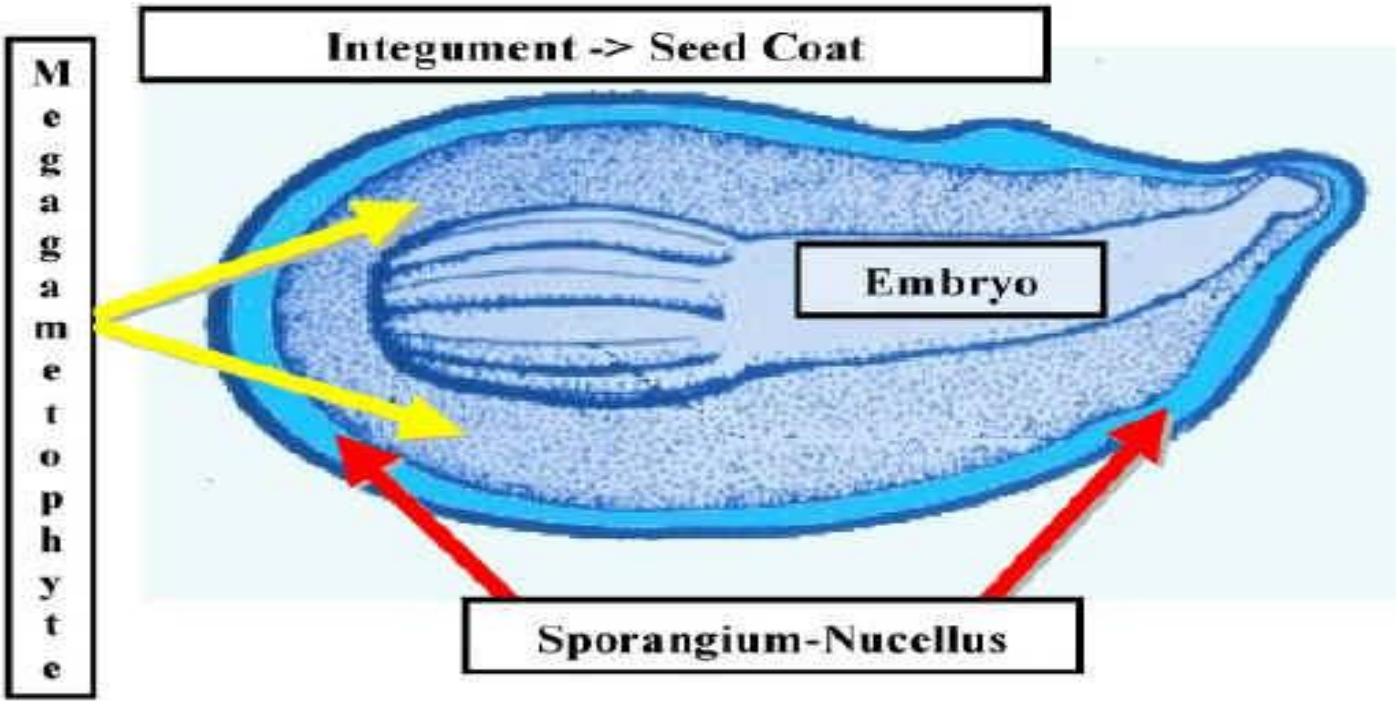


New Sporophyte and Seed

As the cells of the new zygote divide, an **embryo sporophyte** (2n) is formed in the midst of the female gametophyte (1n). The female gametophyte (1n) stores up "food", especially oils and proteins, for the embryo to use until it sprouts and begins to do photosynthesis. The nucellus (2n) becomes a thin, papery layer and the integument (2n) becomes a hard seed coat. A portion of the scale (2n) separates from the scale to form a "wing" for the seed.

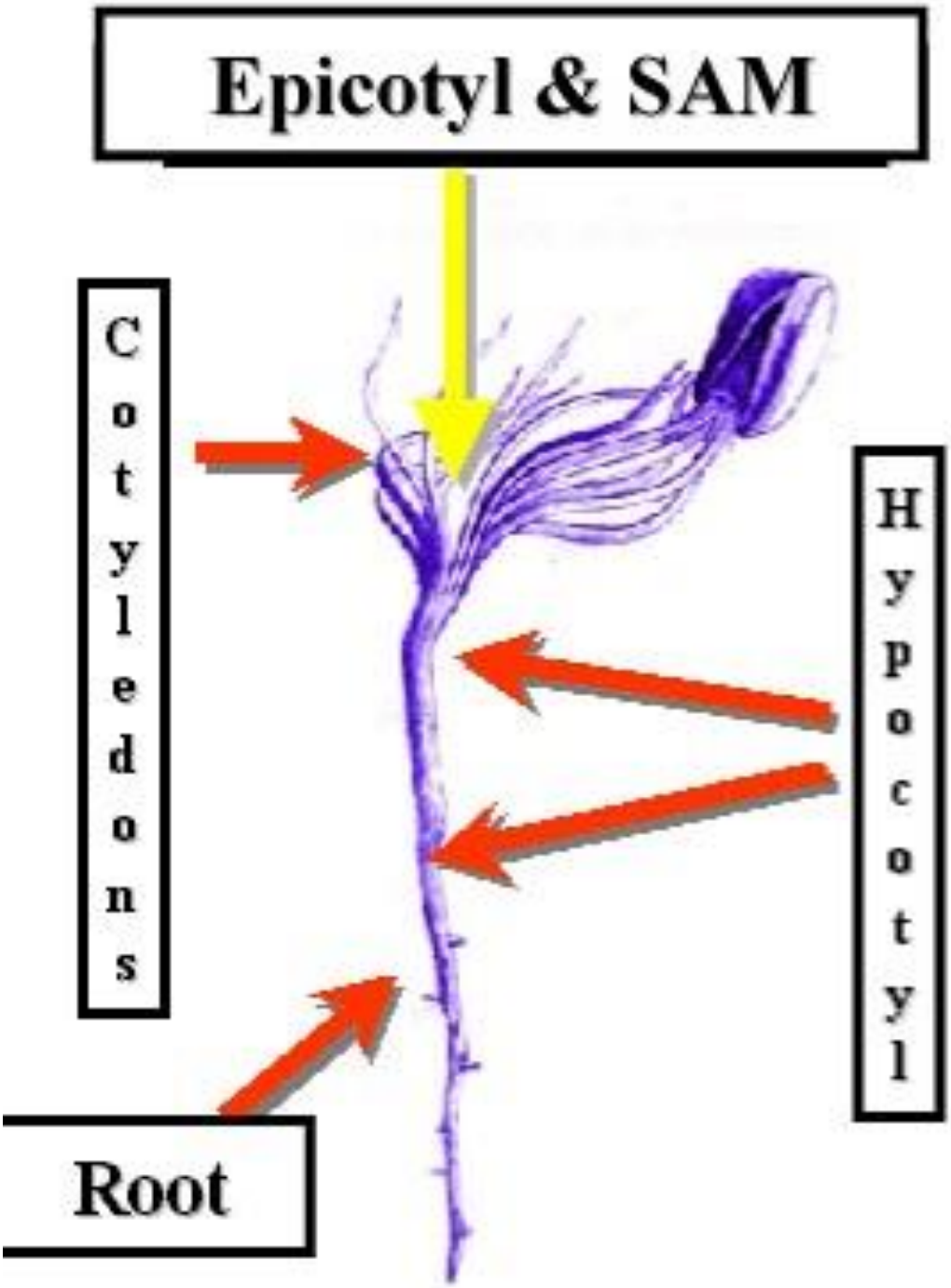
The embryo within the female gametophyte has definite parts, visible in a cross section of the seed. The central axis of the embryo is called the **hypocotyl** because it is located below the cotyledons. The bottom end (near the micropyle) is called the **radicle** (**radix** = root) and will become the root. At the opposite (top) end is a cluster of finger-like "leaves" called **cotyledons**. In the center of them is a mound of tissue called the **epicotyl** which, technically is above them, and will become the new stem (trunk) and leaves (needles).

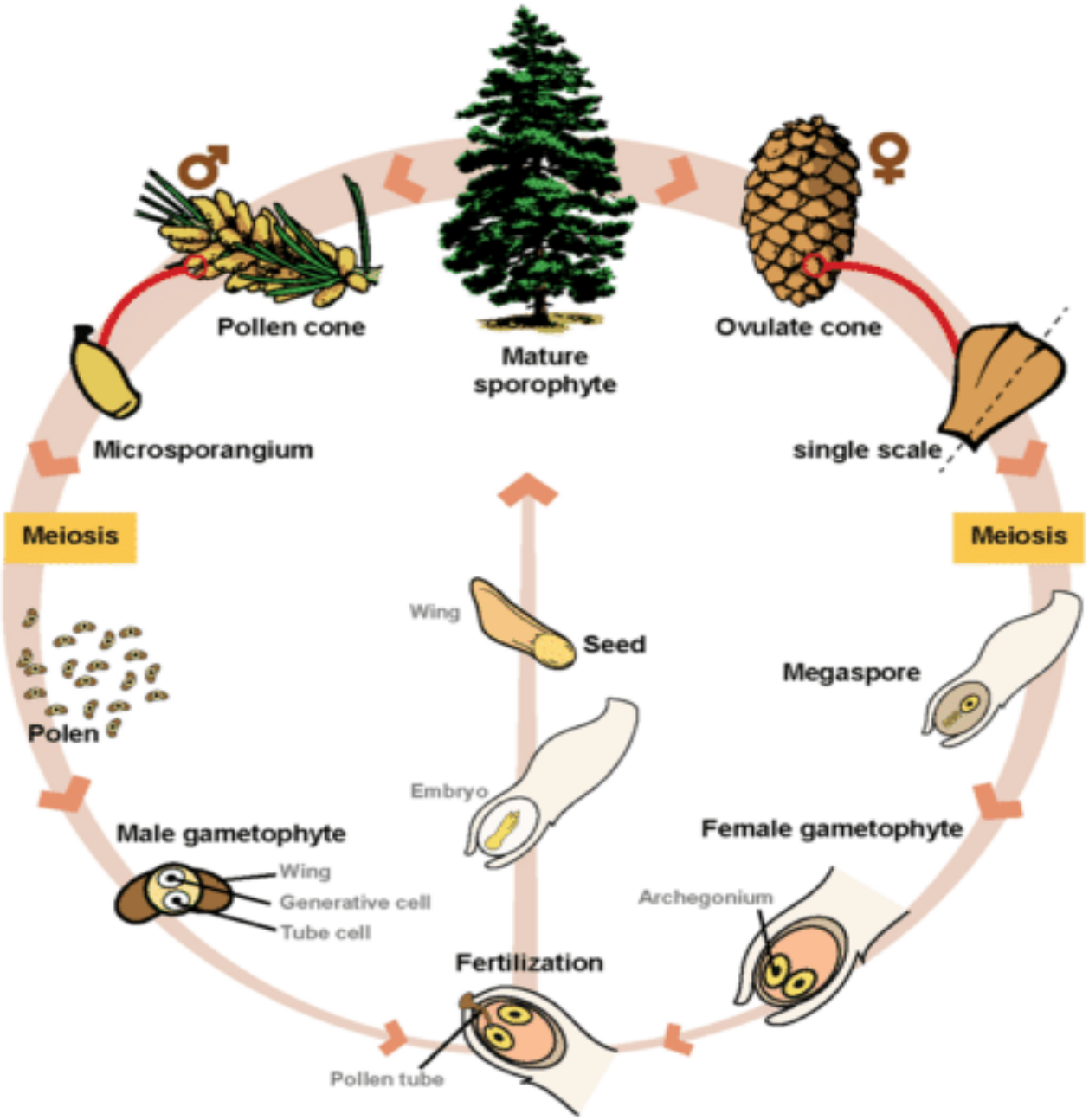
Mature seed structure



Pinaceae - Germination

- Germiation is epigeal
- The first sign of germination is the fracturing of the seed coat and the emergence of the Radicle
- The hypocotyl elongates and lifts the remainder of the seed above the substrate.
- The cotyledons enlarge and absorb nutrients from female gametophyte (now endosperm), further growth of the cotyledons results in their separation from the megagametophyte.
- The cotyledons complete their development and act as photosynthetic leaves.
- The embryonic shoot (Epicotyl) emerges and produces the first leafy stem.
- This overtakes the cotyledons as the source of photosynthate.
-


Epicotyl & SAM
Cotyledons
Hypocotyl
Root


♂
Pollen cone
Mature sporophyte
Ovulate cone
♀
Microsporangium
single scale
Meiosis
Meiosis
Wing
Seed
Polen
Megaspore
Embryo
Male gametophyte
Wing
Generative cell
Tube cell
Female gametophyte
Archegonium
Fertilization
Pollen tube