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NPTEL ONLINE
CERTIFICATION COURSE

Life Cycle of an Angiosperm

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Introduction

Growth and Development are essential processes in the life cycle of any higher organisms including plants

Plant Developmental Biology: Study of how various tissues and organs are developed, starting from a single cell zygote, in a complex multicellular plants. How different organs are developed during various phases of life cycle?

This course will provide an overview of mechanisms underlying the primary meristem establishment and maintenance, cell specification & differentiation during organ development in the flowering plants.



Life Cycle of Land Plants

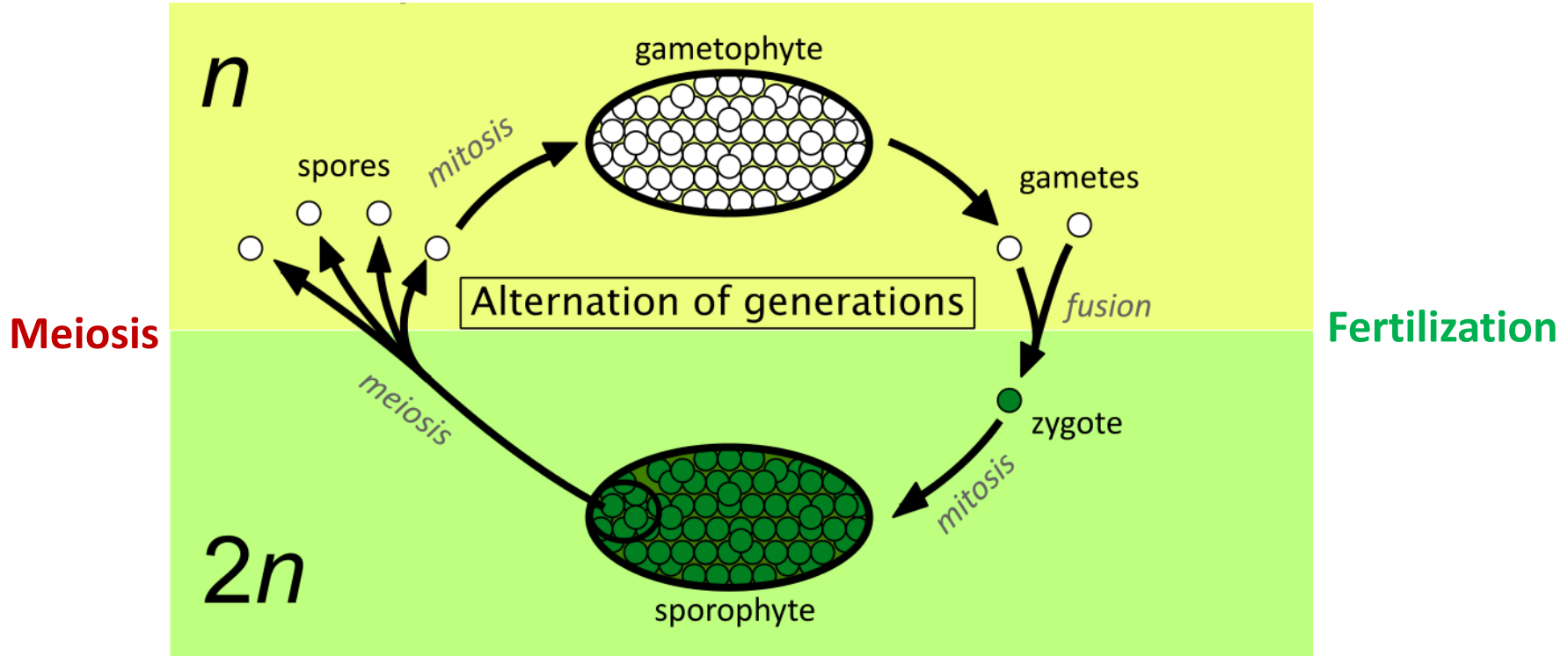
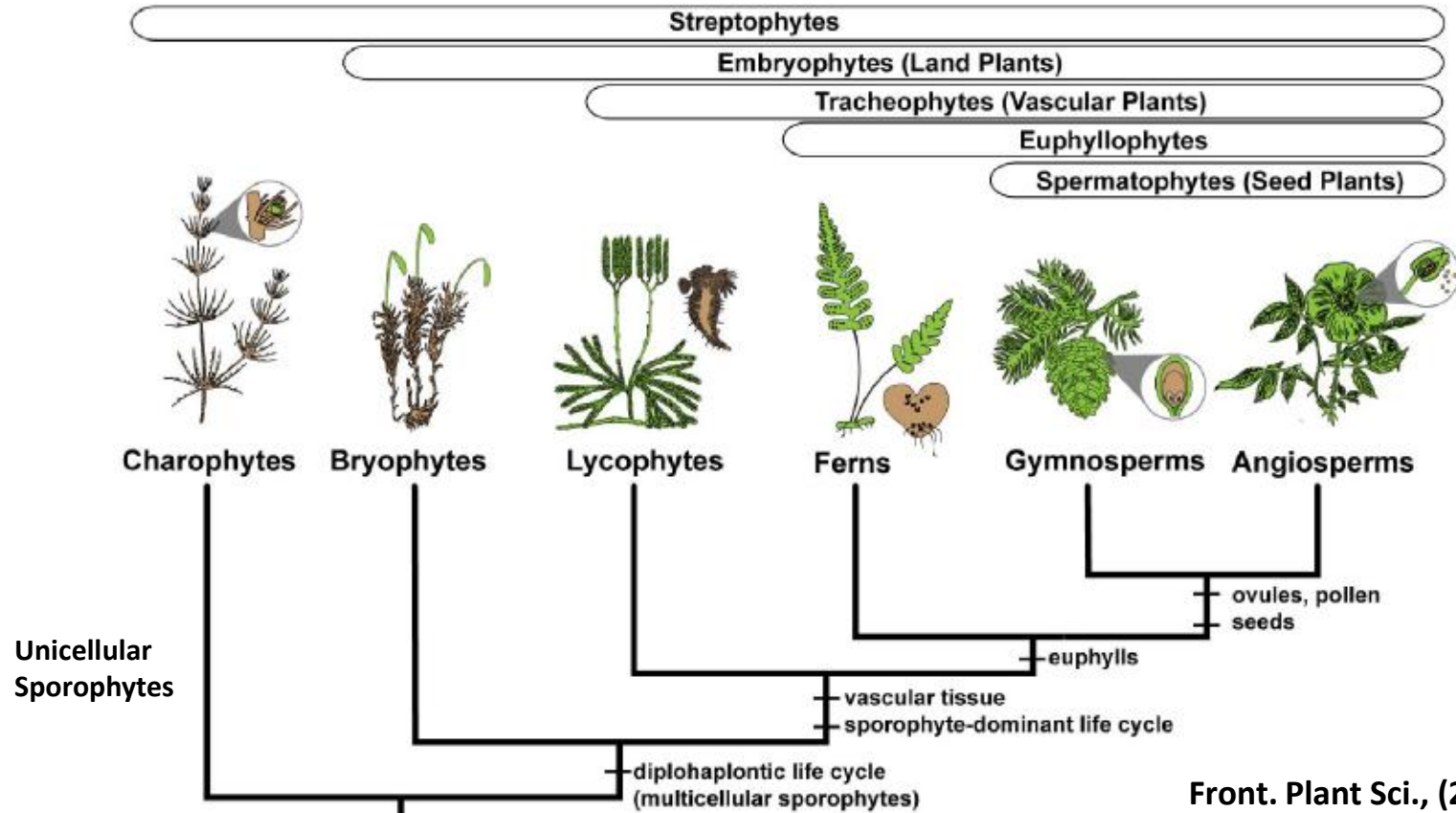


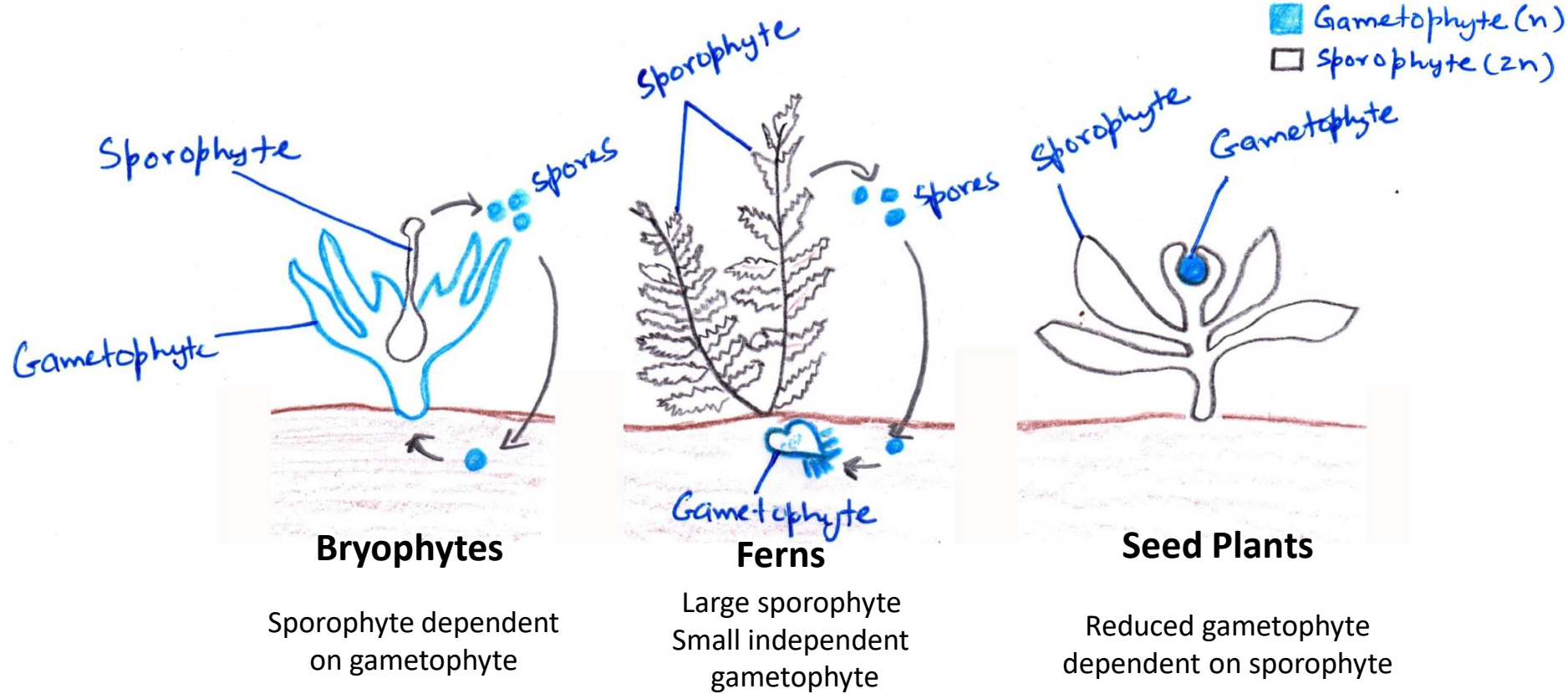
Image Source: Wikipedia

Evolution of Land Plants

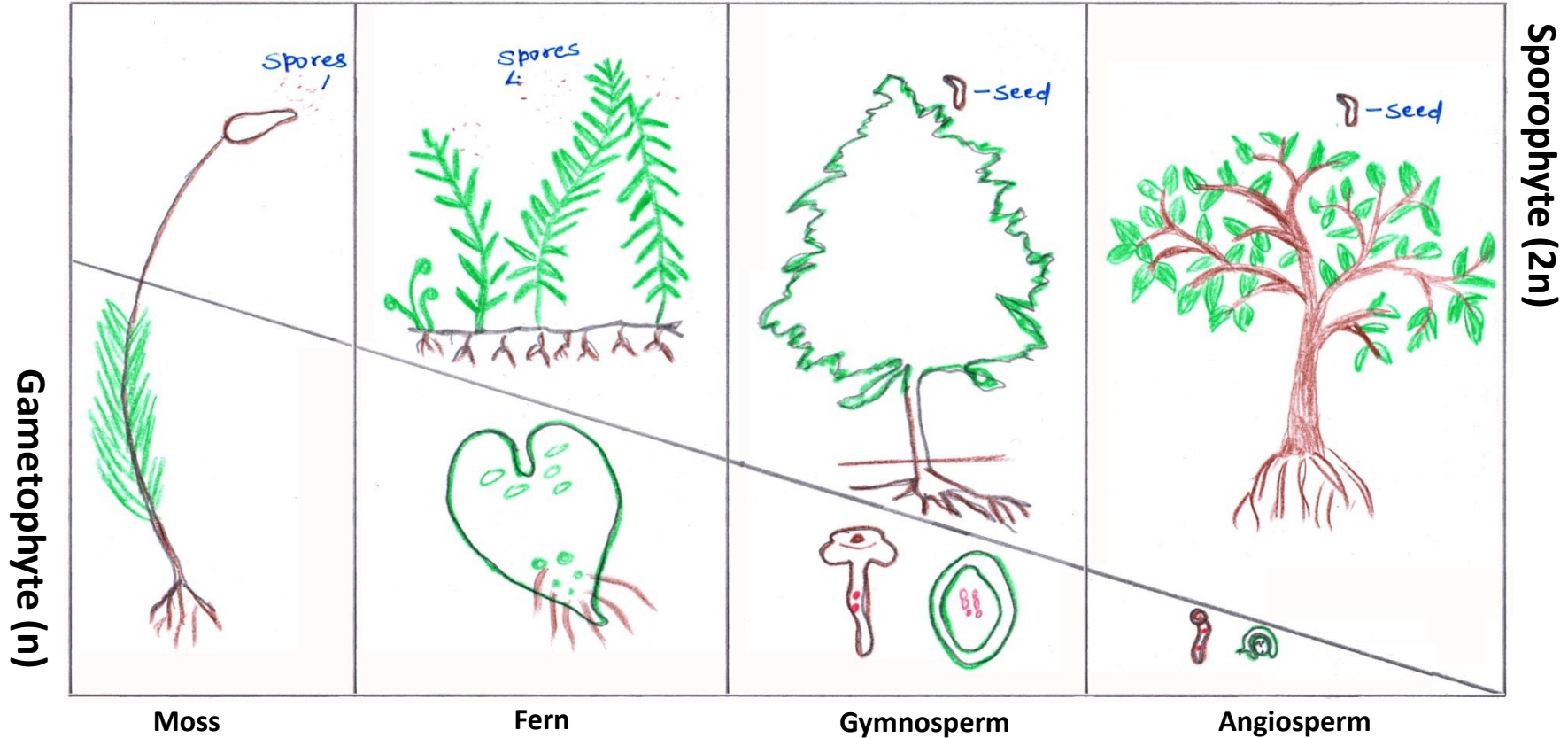


Front. Plant Sci., (2018), 9: 1450

Alternation of Generation in Land Plants



Sporophyte vs Gametophyte



Angiosperm Life Cycle

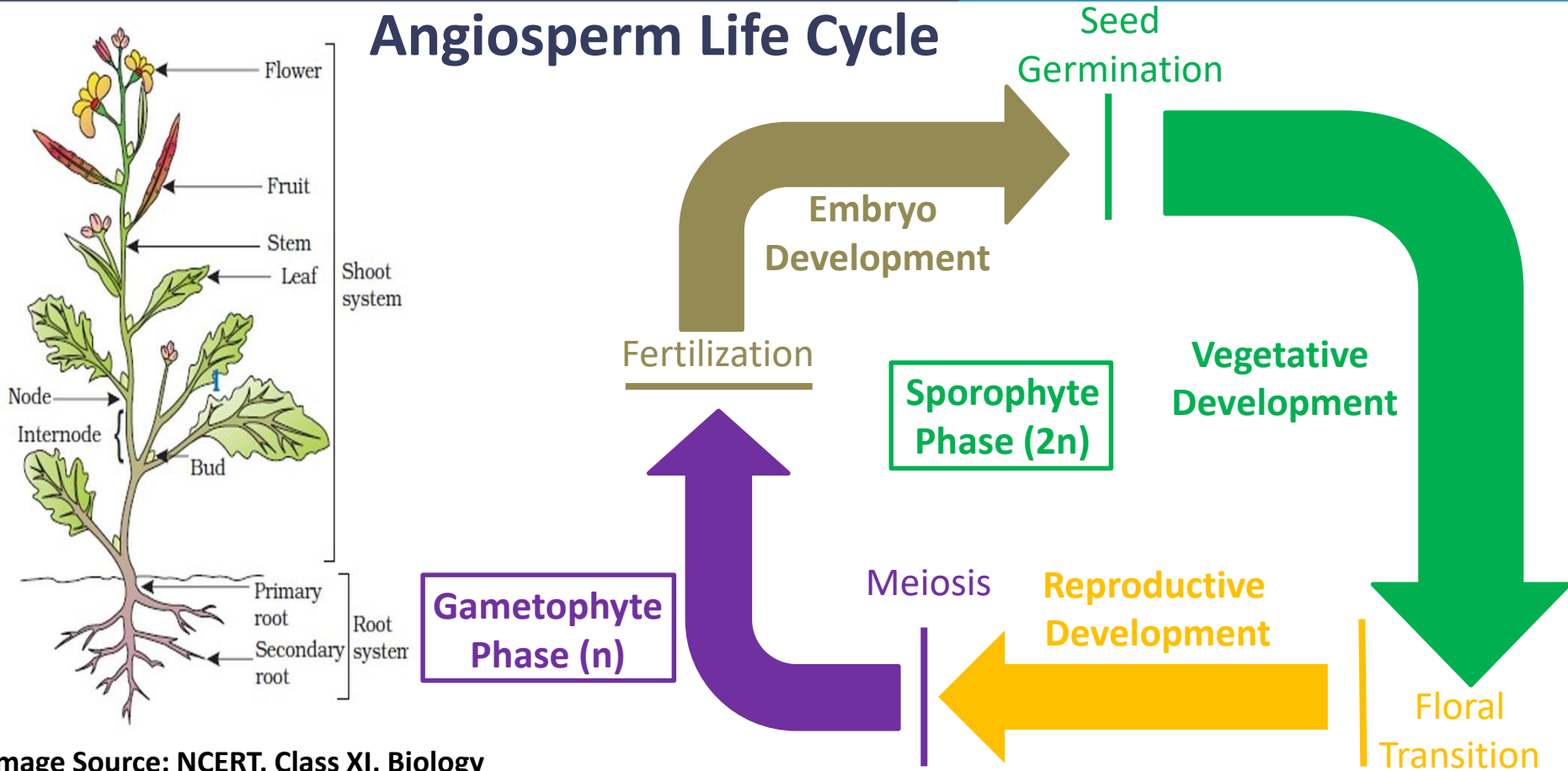


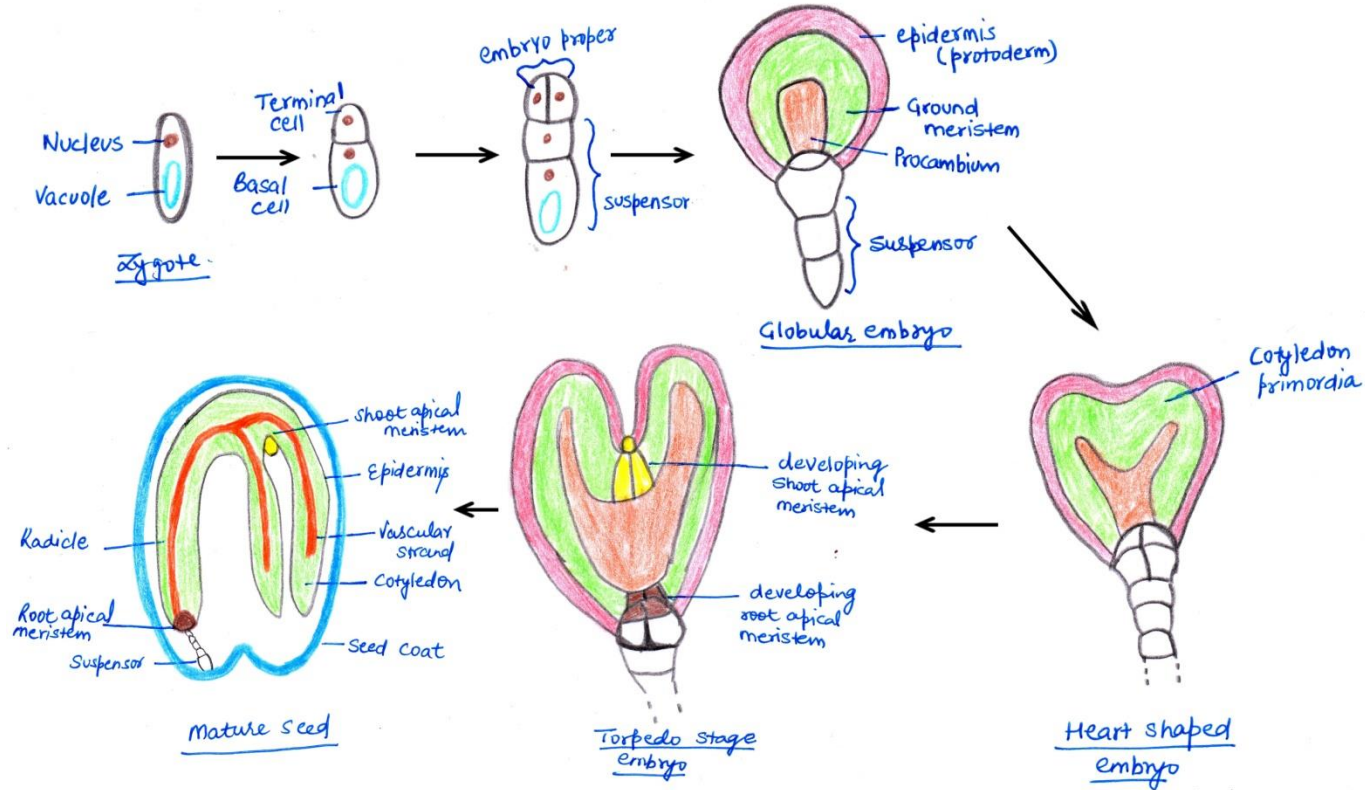
Image Source: NCERT, Class XI, Biology

Embryogenesis and Seed Development

- During embryogenesis, **basic body pattern** is established before seed dormancy.
- Embryogenesis includes-
 - Establishing **apical-basal axis** polarity
 - Radial tissue patterning; spatial arrangement of **epidermis** (protoderm), **ground tissues** (ground meristem) and **vascular tissues** (procambium)
 - Positioning **shoot and root apical meristems** along the apical-basal axis
 - Formation of **cotyledons**



Embryogenesis and Seed Development

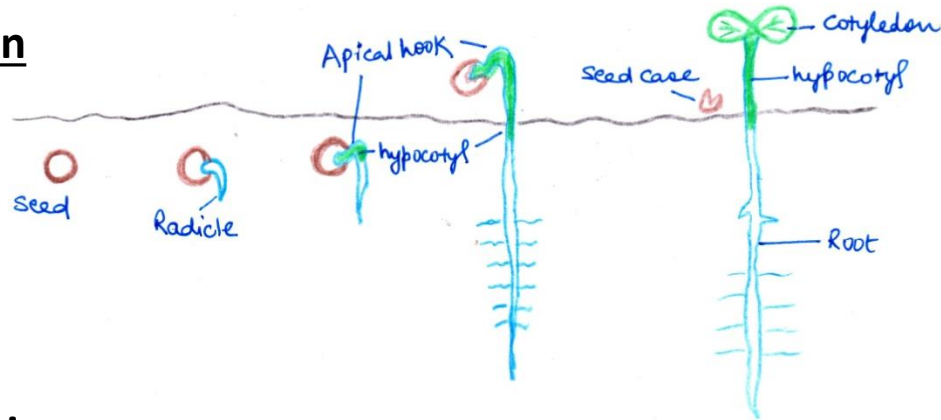


Seed Germination

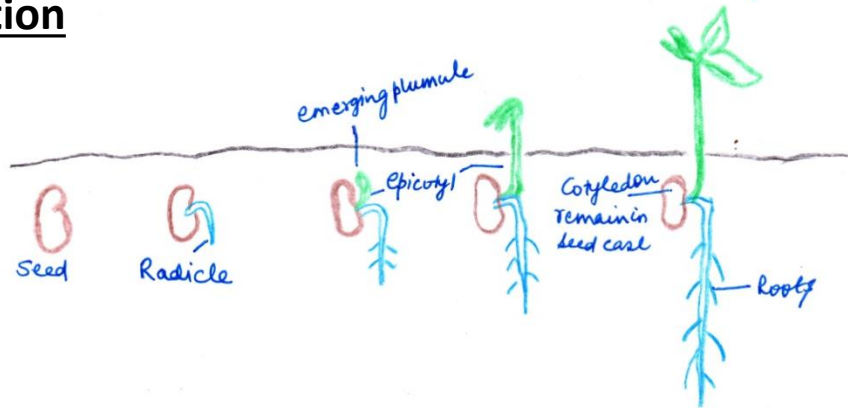
- The embryos break their dormancy during seed germination which requires proper external cues such as temperature, moisture and light.
- Germination results in formation of radicle moving underground and plumule that carries shoot above ground.
- Depending on the region of the elongation, pattern of germination can be of two categories-
 - (a) **Epigeal Germination**: In this case, elongation occurs in a region between cotyledon and radical (i.e. hypocotyls) and cotyledons comes above the ground.
 - (b) **Hypogeal Germination**: When elongation occurs in the epicotyls i.e. between the cotyledons and the SAM, the cotyledons remains below the ground.

Seed Germination

Epigeal Germination



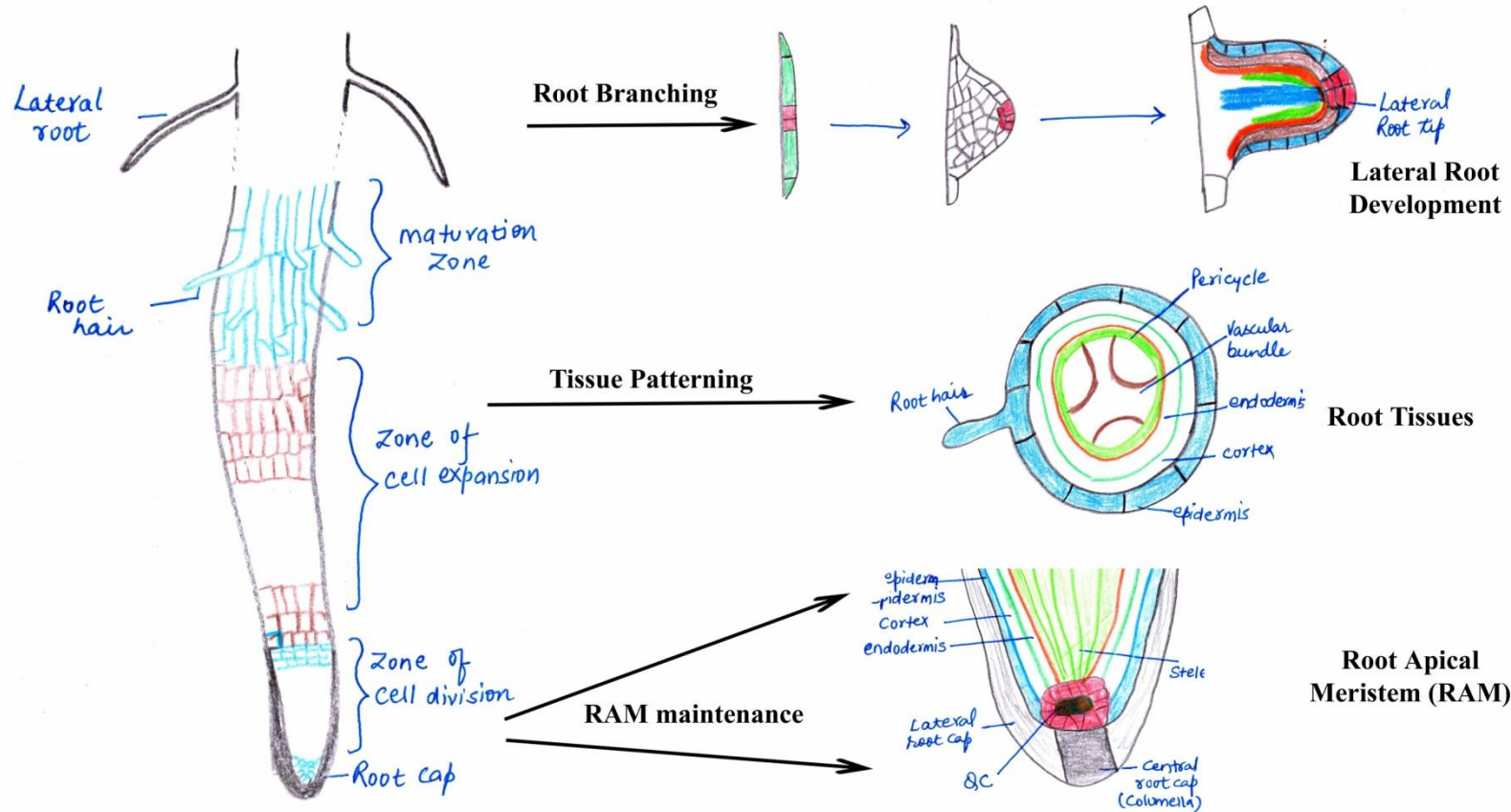
Hypogeal Germination



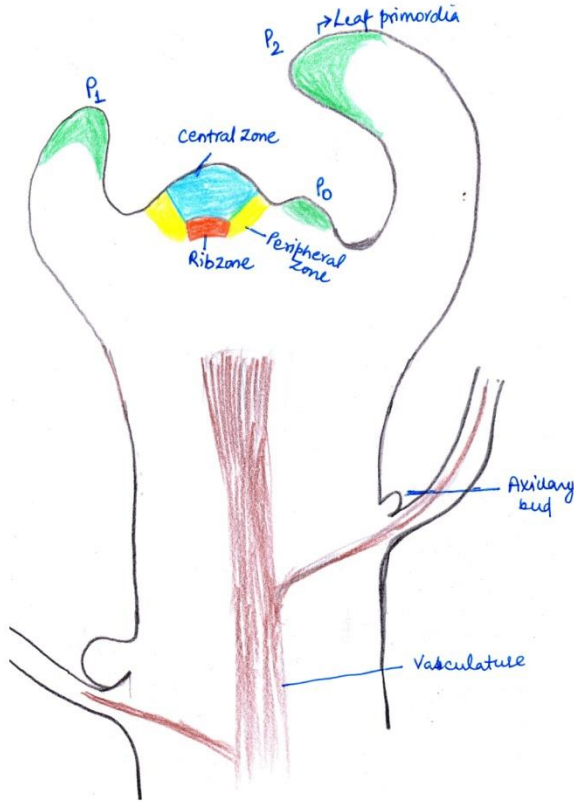
Vegetative Development

- With seed germination, plants undergo **post-embryonic** vegetative development.
- During primary vegetative phase, following developments occur-
 - **Primary growth**; apical meristems (Root and shoot apical meristems maintenance)
 - Formation of vegetative organs (**Organogenesis**)
 - Lateral branching; root and shoot branching (**Organ patterning**)
 - Vascular tissue development (**Tissue patterning**)

Root Development



Shoot Development



**Shoot Apical Meristem
Maintenance**



Organogenesis

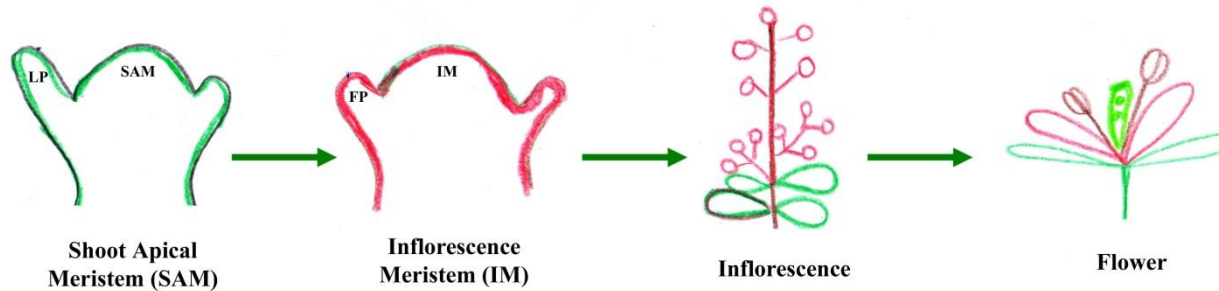
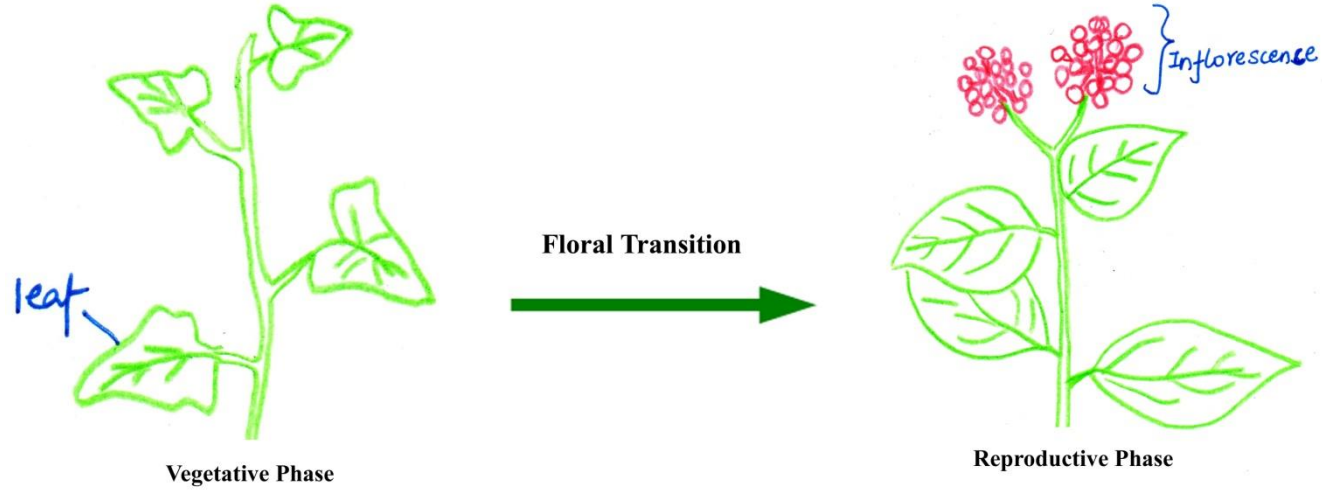


Tissue/organ patterning



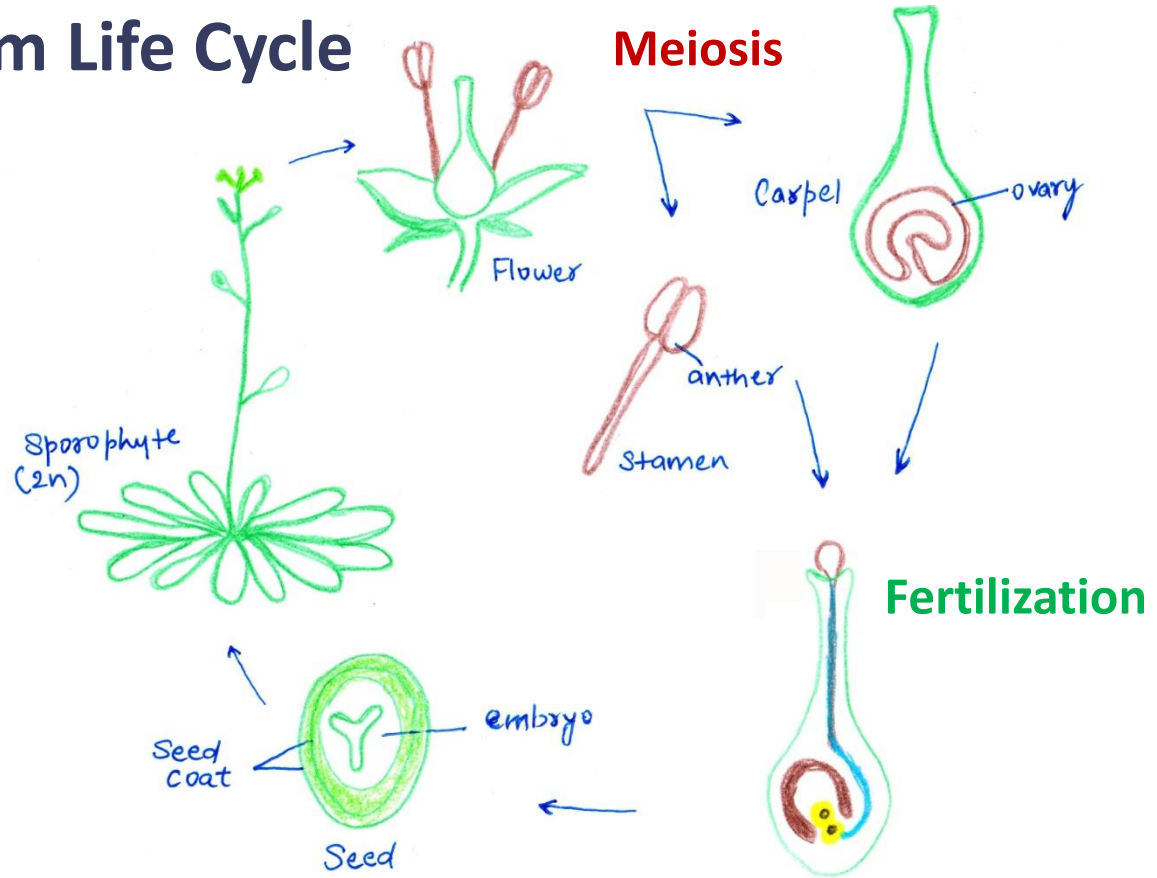
Shoot branching

Reproductive Development

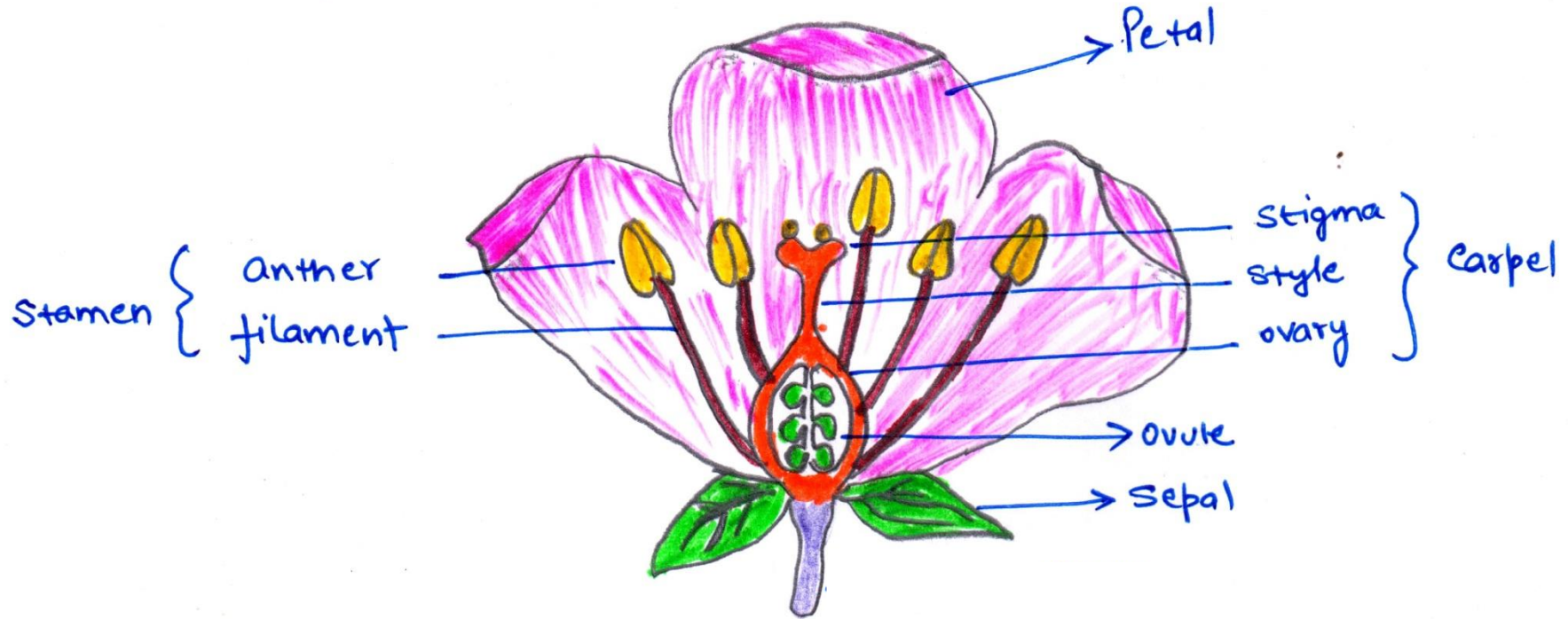


Angiosperm Life Cycle

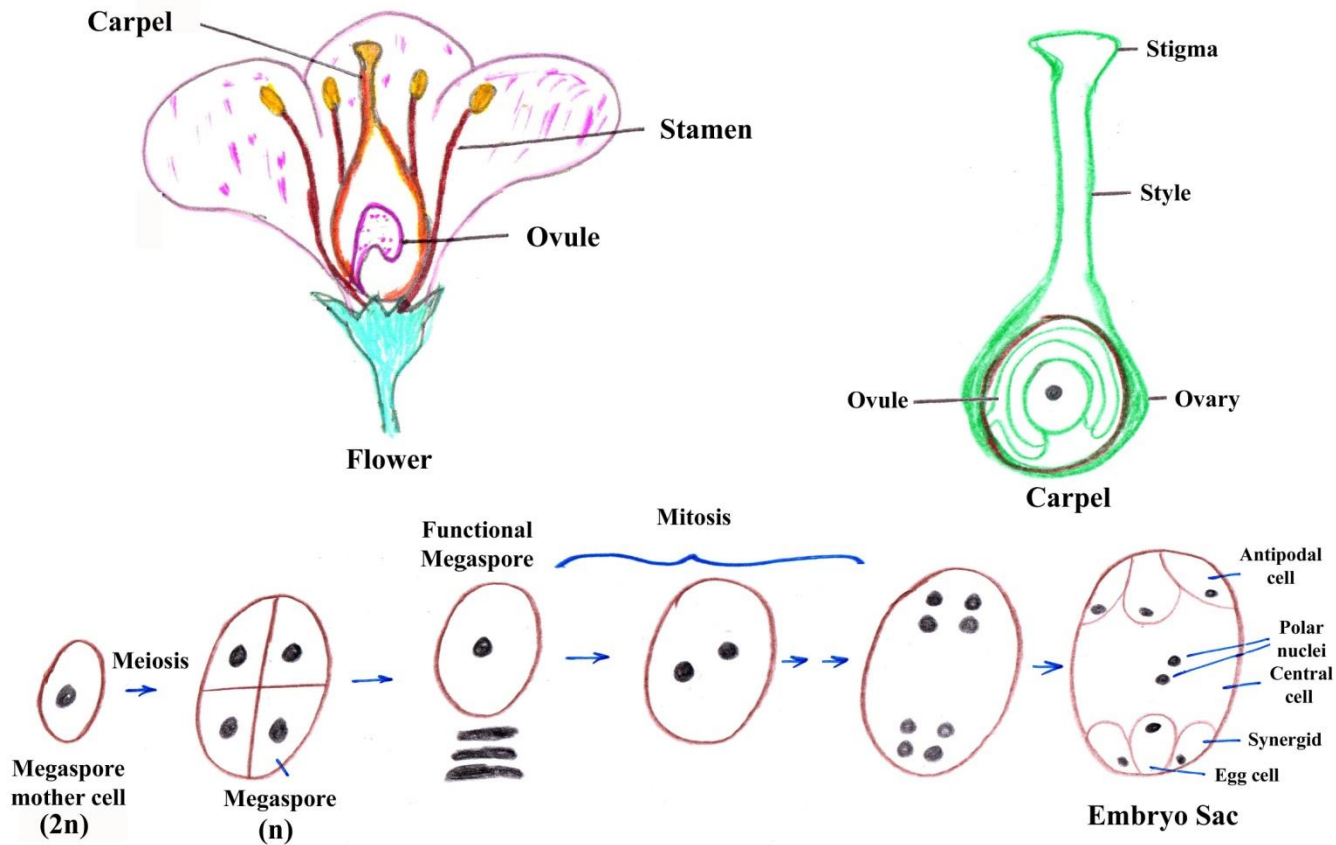
- **Gametophyte**
(haploid phase)
 - Megaspore
(female gametophyte)
 - Microspore
(male gametophyte)



Reproductive Organs: Flower

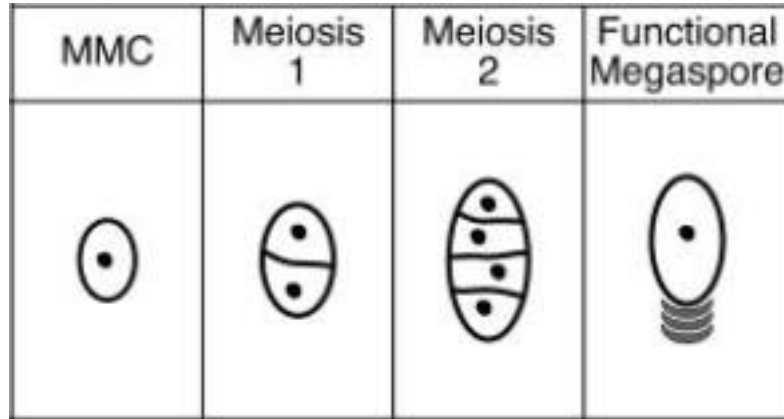


Female Gametophyte Development



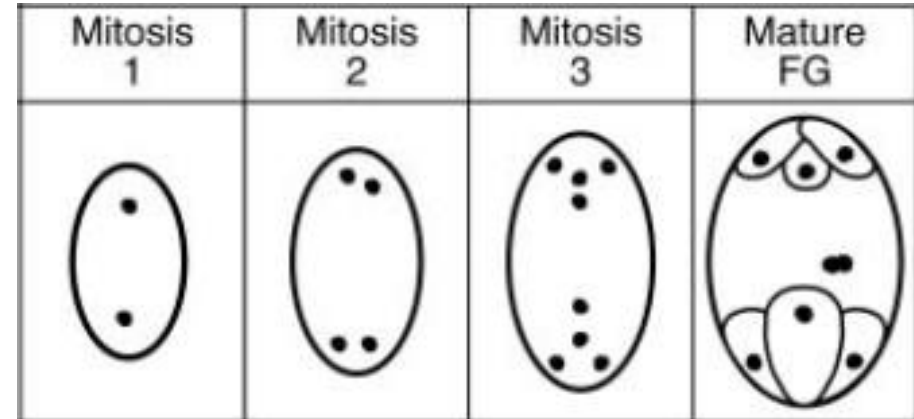
Embryo Sac Development

Megasporogenesis



Megasporocyte ($2n$) $\xrightarrow{\text{Meiosis}}$ Megaspores (n)

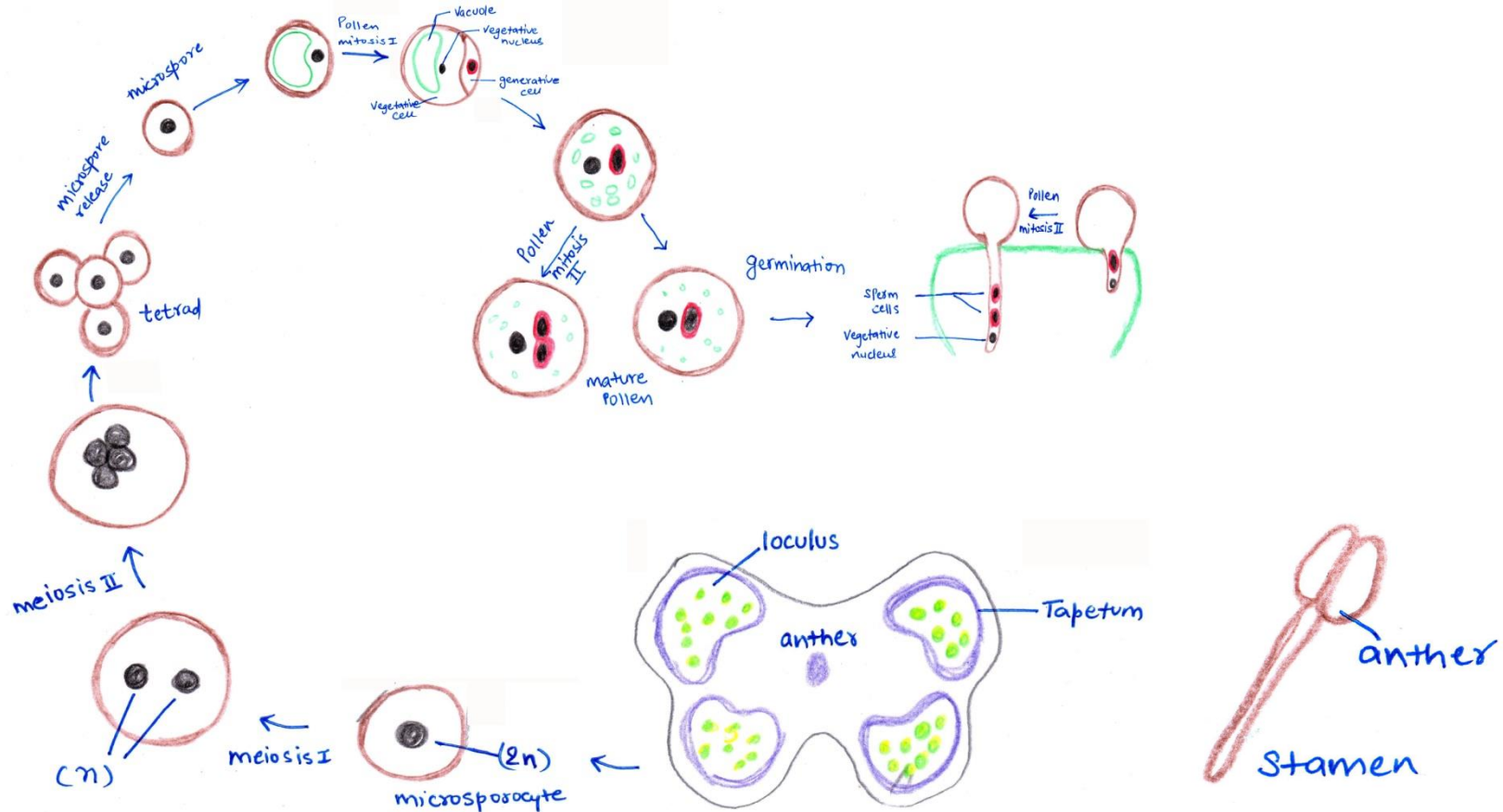
Megagametogenesis



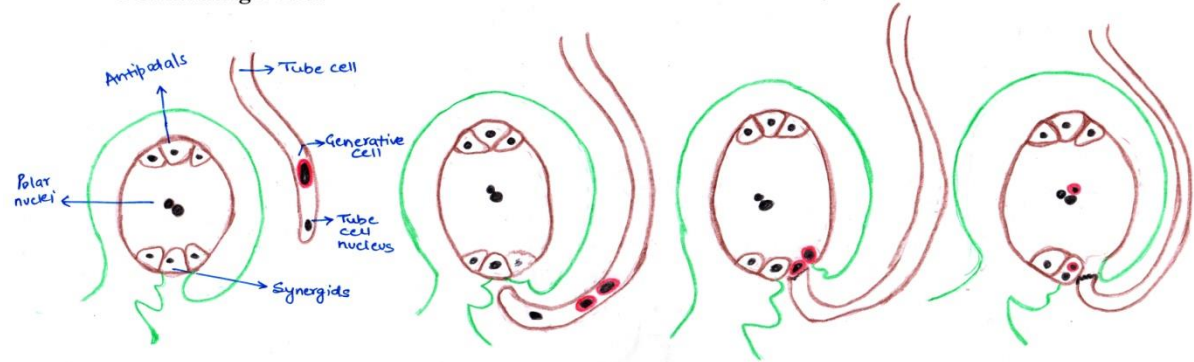
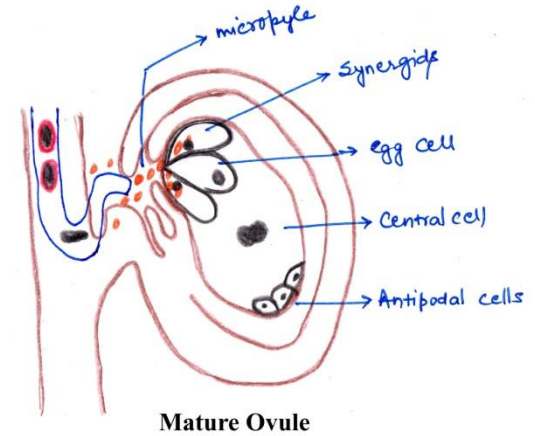
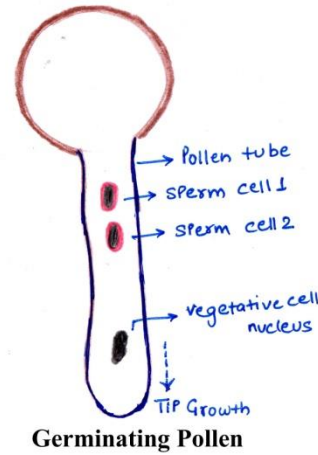
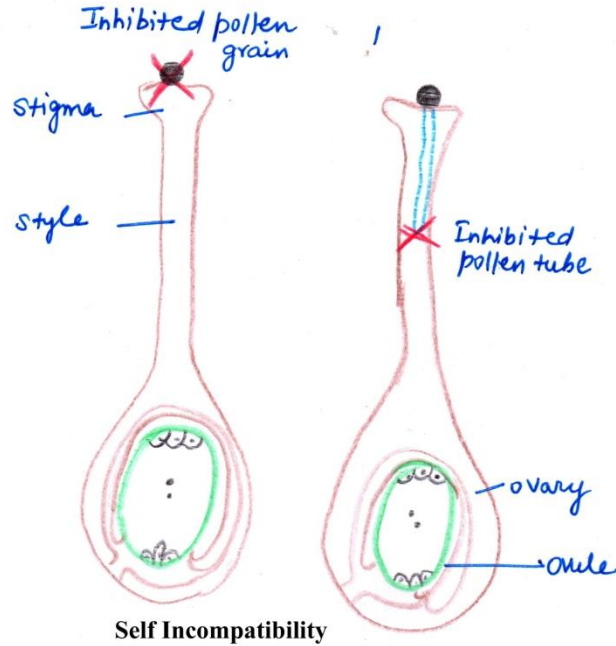
Megaspore (n) $\xrightarrow[\text{Rearrangement}]{\text{Mitosis}}$ Female Gametophyte (n)

Plant Cell, (2004), 16: 133-141.

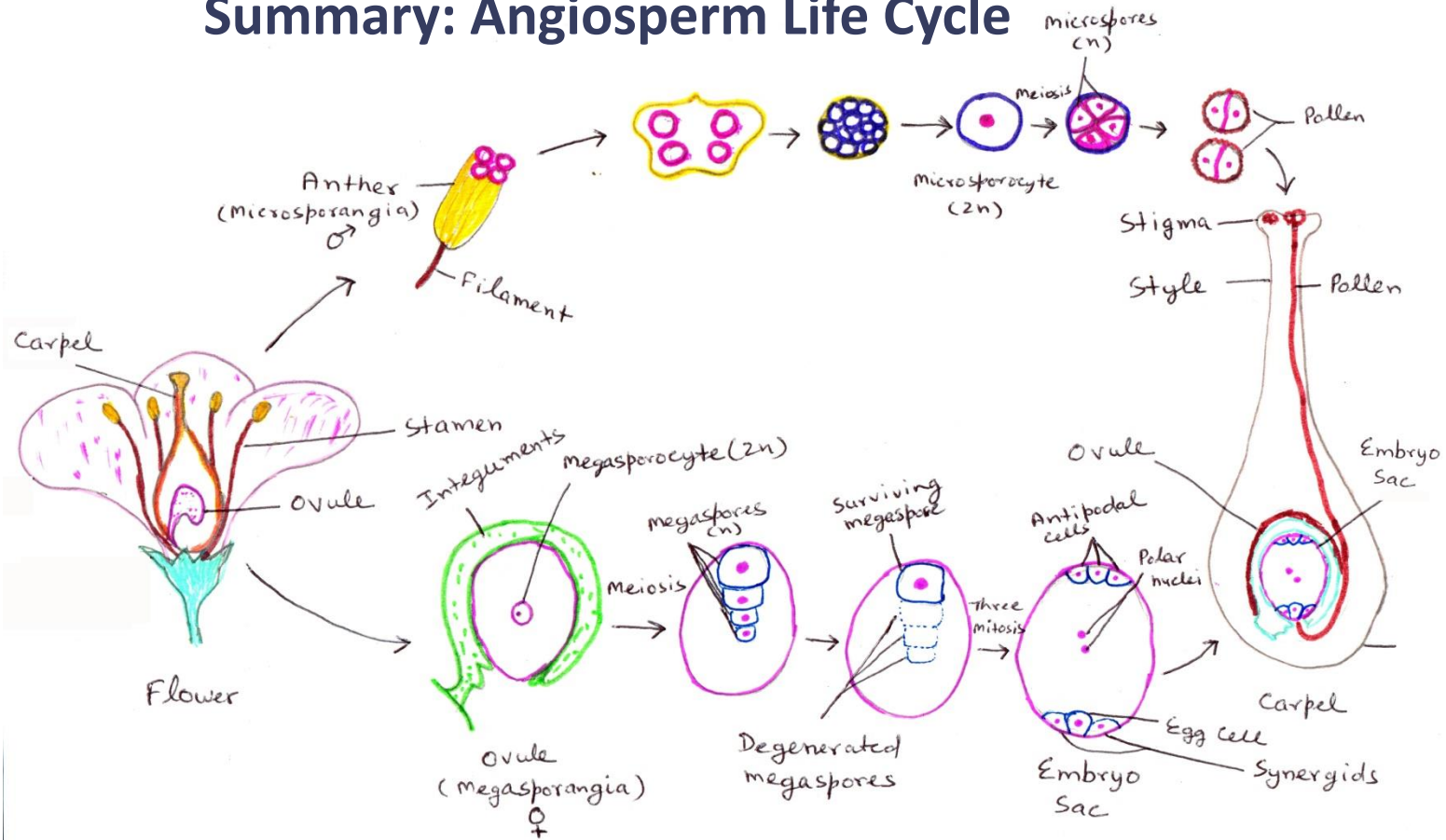
Male Gametophyte Development



Pollination and Double Fertilization



Summary: Angiosperm Life Cycle



Summary: Angiosperm Life Cycle

- Angiosperm plant alternates their life cycle between diploid sporophyte and haploid gametophyte
- Sporophyte is an extensive phase whereas gametophyte is more restricted
- Male gametophyte develops in anther of the stamen and contains haploid sperms
- Female gametophyte is produced within ovule of the carpel and contains a haploid egg cell and two haploid polar nuclei, three antipodal and two synergid cells
- Double fertilization is a characteristic feature of an angiosperm which occurs when pollen tube discharges two sperm nuclei into the female gametophyte
- One sperm fertilizes the egg cell to develop a diploid zygote and other combines with two polar nuclei to produce a triploid endosperm

