LIFE CYCLES IN PLANTS

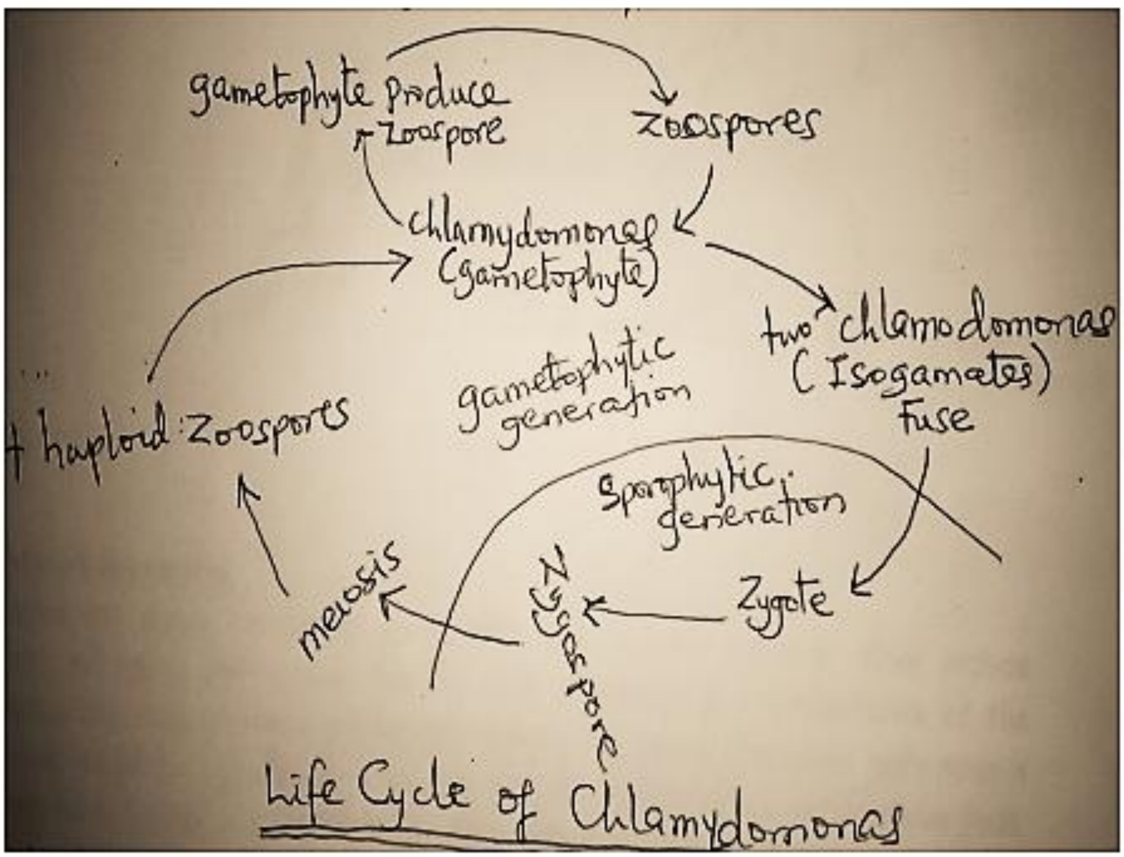
Plants have two distinct stages in their lifecycle: the **gametophyte stage** and the **sporophyte stage**. The haploid **gametophyte** produces the male and female gametes by mitosis in distinct multicellular structures. Fusion of the male and females gametes forms the diploid zygote, which develops into the **sporophyte**. After reaching maturity, the diploid sporophyte produces spores by meiosis, which in turn divides by mitosis to produce the haploid gametophyte. Therefore life cycles of all sexually reproducing plants follow a pattern of alternation between a haploid, sexual generation called gametophyte with a diploid, asexual generation called sporophyte. This phenomenon of alternation between gametophyte (n) and sporophyte (2n) in the life cycle of a plant is called alternation of generations. In the life cycle, change of ploidy level from diploid (2n) to haploid (n) is brought about by meiosis while fertilization change the ploidy level from haploid (n) to diploid (2n) .

In the life cycle, any one of these two generations is found to be more conspicuous and more visible is referred to as the **dominant generation**. In **algae and bryophytes** the vegetative plant body is the **gametophyte** which is dominant and visible. But in **Pteridophytes, gymnosperms and angiosperms** the visible plant body is the **sporophyte** which is dominant while the gametophyte generation is less conspicuous. Alternation of generations is of two types- isomorphic and heteromorphy. In **isomorphic type** both the alternating generations are morphologically similar, while in **heteromophic type** of alternation of generations both the generations of life cycle are morphologically dissimilar.

Representative Life Cycle

Life Cycle of Chlorophytes

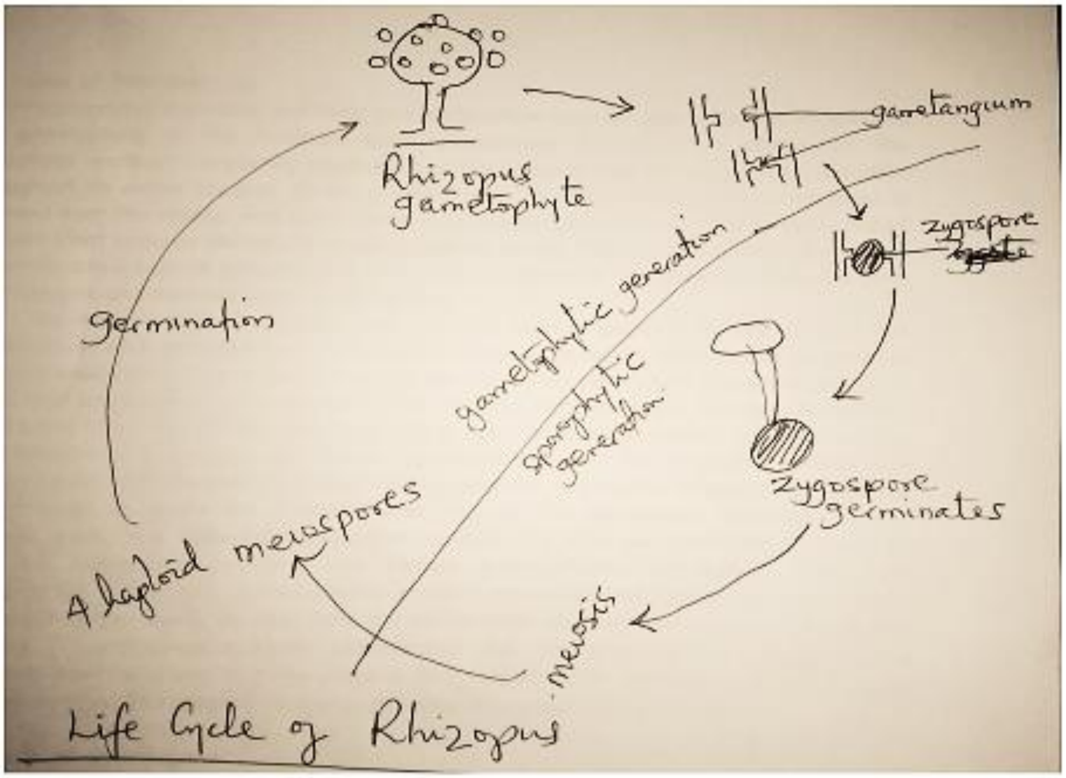
Unicellullar algae may divide asexually by cell division. Here the nucleus and the chloroplast divide follow by the cytoplasm. Fragmentation of filaments also takes place. Asexual reproduction may also occur by formation of **zoospores (motile ciliated spores)**. Sexual reproduction in Chlorophytes occurs in different ways. For example in Chlamydomonas, at the time of sexual reproduction pairs of cells (**isogametes**) would be attracted to each other at their flagella and they **act as gametes**. The cell walls degenerate, the protoplasts come in contact and fuse to form a zygote. The zygote takes on a new thick rough cell wall, which remain dormant for some time until when conditions become favourable. The diploid zygote undergoes meiosis and produce four haploid zoospores. The thick round wall of the zygote dissolves releasing the motile zoospores. They swim away and each develops to fully-grown Chlamydomonas. **Asexual reproduction** in Chlamydomonas is by **mitosis**. Before this process starts, the flagella degenerates and drop off, the nucleus divides along with the entire cell contents. At the end, two daughter cells are produced with in the same cellulose cell wall. The daughter cells produce flagella, the wall breaks off and the cells released. Sometimes under adverse conditions the flagella may not develop, in such cases, the Chlamydomonas cells remain together as a colony. Later when the condition improves, each cell of the colony develops the flagella and swim away.



Life cycle of Fungi

The division of **Zygomycota** also called **conjugation fungi** are representative of the black bread mold. **Rhizopus** is a typical member of the **Zygomycota**. The Zygomycetes undergo asexual and sexual reproductions. Asexually when the spore lands on a suitable place, it germinates to produce a mycelium with many haploid nuclei. The mycelium develops to produce hyphae called sporangiophore (hyphae that bears sporangium). Mature sporangia rupture to release the black spherical spores, which germinate on suitable medium to produce a new organism.

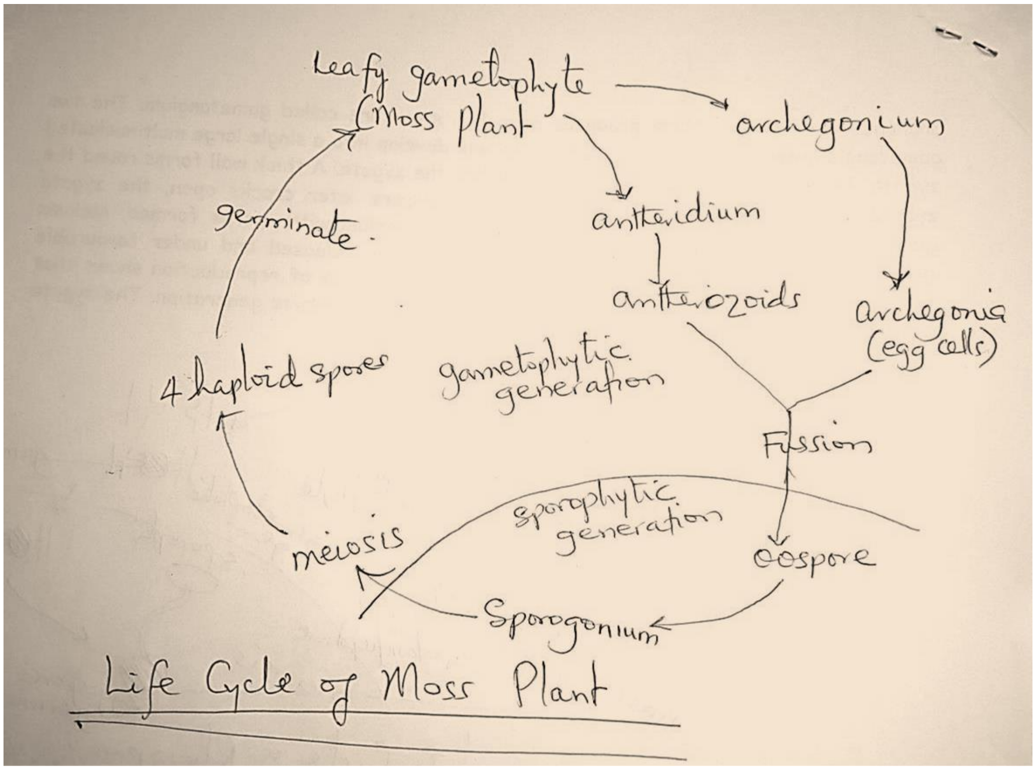
Sexual reproduction is by **conjugation** of two different mating hyphae. Here the two compatible but different mating strains grow close to each other, develop lateral branches and each of them produces a swollen structure called gametangium. The two gametangia grow towards each other, merge and develop into a single large **multinucleated zygote**. The nuclei of the two strains fuse inside the zygote. A thick wall forms round the zygote to develop into the **zygospore**. The zygospore later cracks open, the zygote germinates and a **sporangiophore carrying the sporangium with spores formed**. Meiosis occurs to produce **meiospores.** These spores are then released and under favourable conditions germinate to give new haploid Rhizopus. This type of reproduction shows that the **predominant (dorminant)** generation in the Rhizopus is the **gametophyte generation**. The **zygote** invariably represent the **sporophyte generation**.



Life cycle of Bryophytes

Bryophytes are simple terrestrial plants that lack vascular systems. They include liverworts, hornworts and mosses. The life cycle of mosses (a representative of the bryophytes) comprises of sexual and asexual reproductive stages. The green leafy moss is the haploid independent gametophyte. At maturity, the gametophyte plant produces buds, which reproduce asexually to produce a new leafy gametophyte plant.

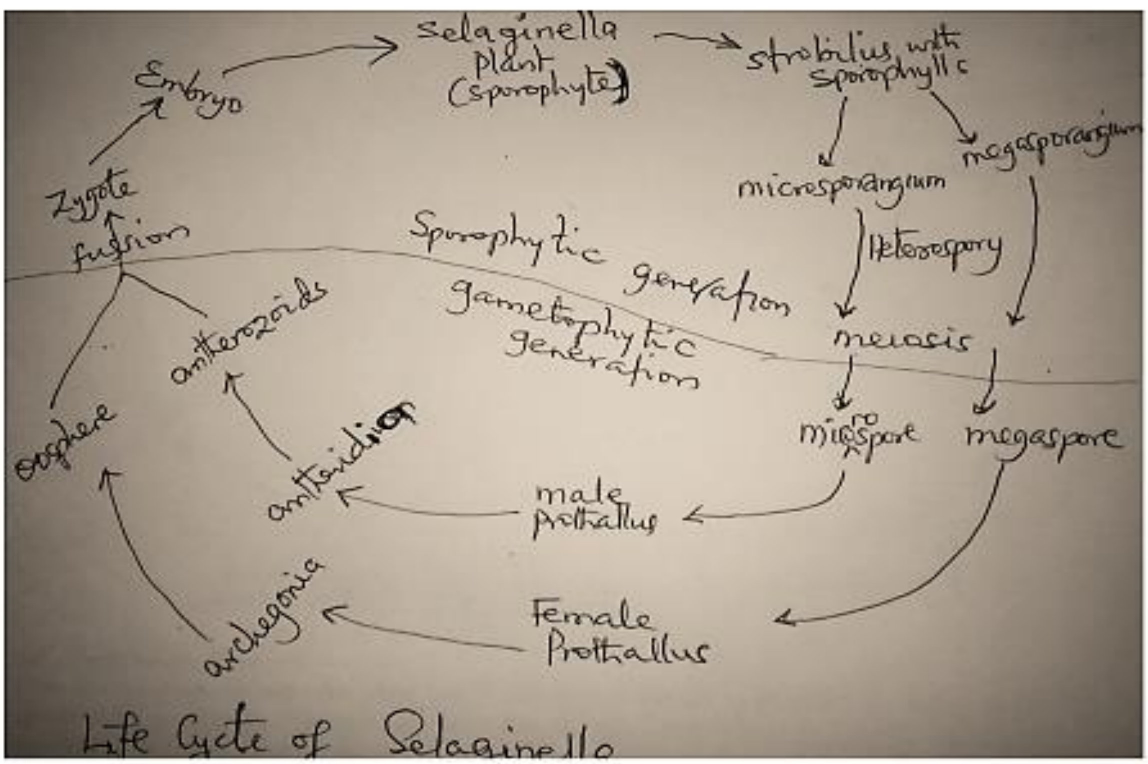
Sexually, most moss plants are **monoecious**. The tip of some branches of moss becomes fertile and produces antheridia and archegonia. Raindrops may cause flagellated **antherozoids** (sperm) to splash out thus helping them to reach the **archegonia**. The antherozoid fuses with the egg cells to form a **zygote termed oospore**. The oospore (zygote) develops to form the embryo. The embryo later develops into sporogonium, which is the sporophyte stage of the plant. The sporogonium contains spore mother cells that undergo meiotic cell division to form four haploid spores. These spores are released to germinate into a new gametophyte plant. Note that in bryophytes the sporophyte is almost completely dependent on the gametophyte for support and nutrition throughout its entire lifespan.



Life cycle of Pteridophytes

The Pteridophytes are ferns and their related seedless vascular plants. As earlier pointed out, the gametophyte of bryophytes is the dominant more conspicuous and long-lived generation; the sporophyte is almost completely dependent on the gametophyte for support and nutrition throughout its entire lifespan. In the pteridophytes, the sporophyte is dominant over the smaller and nutritionally independent gametophyte. The sporophytes of seedless plant (Pteridophytes) undergo meiosis to produce haploid spores. Each of the spores germinates and grows into a haploid gametophyte that produces gametes. The gametes fuse, becomes diploid zygote and develops into the sporophyte.

The mature *Selaginella* plant bears strobili bearing sporophylls. The axils of the sporophylls of each strobilus bear two distinct types of sporangia. Some sporangia produce numerous **small** spores (i.e. microspores) and are called microsporangia. The other produces usually four **large** spores (i.e. megaspore) and is called megasporangia. Because *Selaginella* produce two types spores they are described as heterosporous as oppose the homosporous condition seen in *Lycopodium spp.* The microspore-mother-cells and megaspore-mother-cell undergo meiotic cell division to produce microspores and megaspores respectively. The two distinct types of spore are released when ripe by the dehiscence (splitting) of the sporangia walls. The released microspores develop into male gametophytes (prothallus) while the megaspores develop into female gametophytes (prothallus). The male gametophytes and female gametophytes produce antheridia and achegonia respectively. Biflagellate antherozoids develop from the antheridium while the achegonium develop into oosphere. Fertilization between antherozoid and oosphere produces zygote which surrounds itself with wall to form oospore. The oospore after resting for a short period develops embryo. The oospore (2n) later develops into a new *Sellaginella* plant.

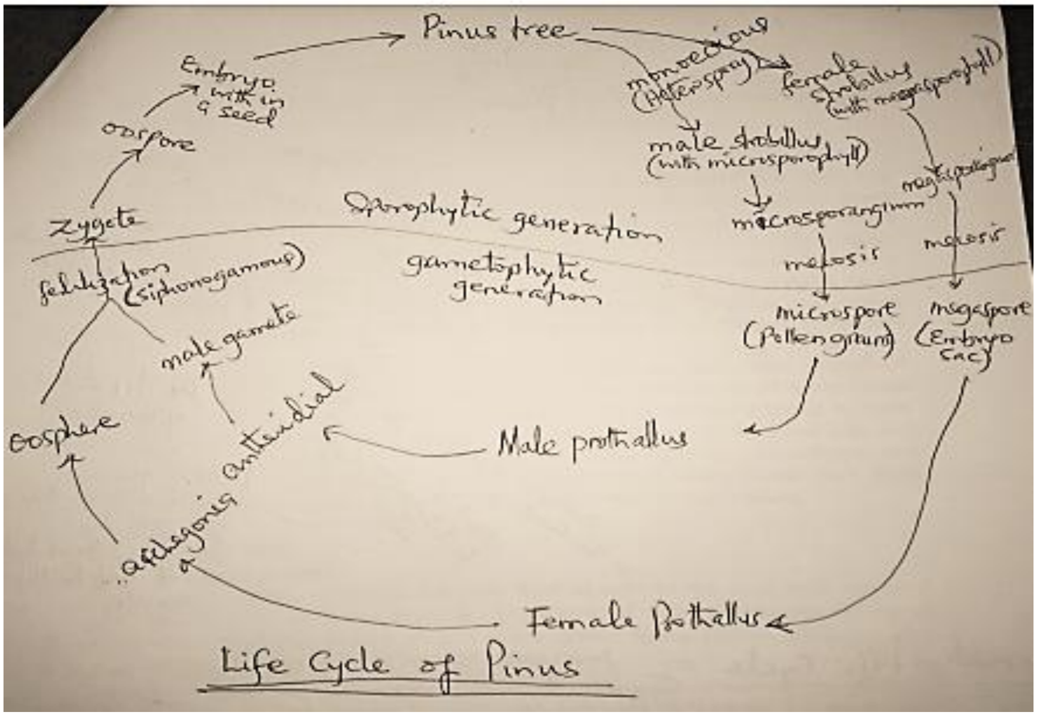


Life Cycle of Gymnosperm

Gymnosperms are cone-bearing trees or woody plants but do not produce flower. Although as seed plants they bear seeds on scale-like leaves which are arranged spirally to form a cone. The seeds are termed 'naked seeds' because they are exposed on the surface of the cone scales.

The life cycle of conifers (e.g. *Pinus sylvestris*) revealed that the plant is monoecious (unisexual strobili) and heterosporous. Its reproductive spores are borne on sporophylls aggregated into clearly-defined cones or strobili. The male cones appear in clusters while at maturity, microspores (or pollen grains) are shed in large numbers. At this stage there are microspores (pollen grain) in microsporangia (pollen sac) on the microsporophylls. When the female reproductive structures are fully formed, they are megaspores (embryo sac) in megasporangia (ovule) on the megasporophylls. The microsporangium contains numerous microspore-mother-cells, each of which undergoes meiotic division to develop a tetrad of microspores or pollen grains. The megaospore-mother-cells also undergo meiotic division to produce four megaspores in which only one of the four is functional, however the remaining three degenerate.

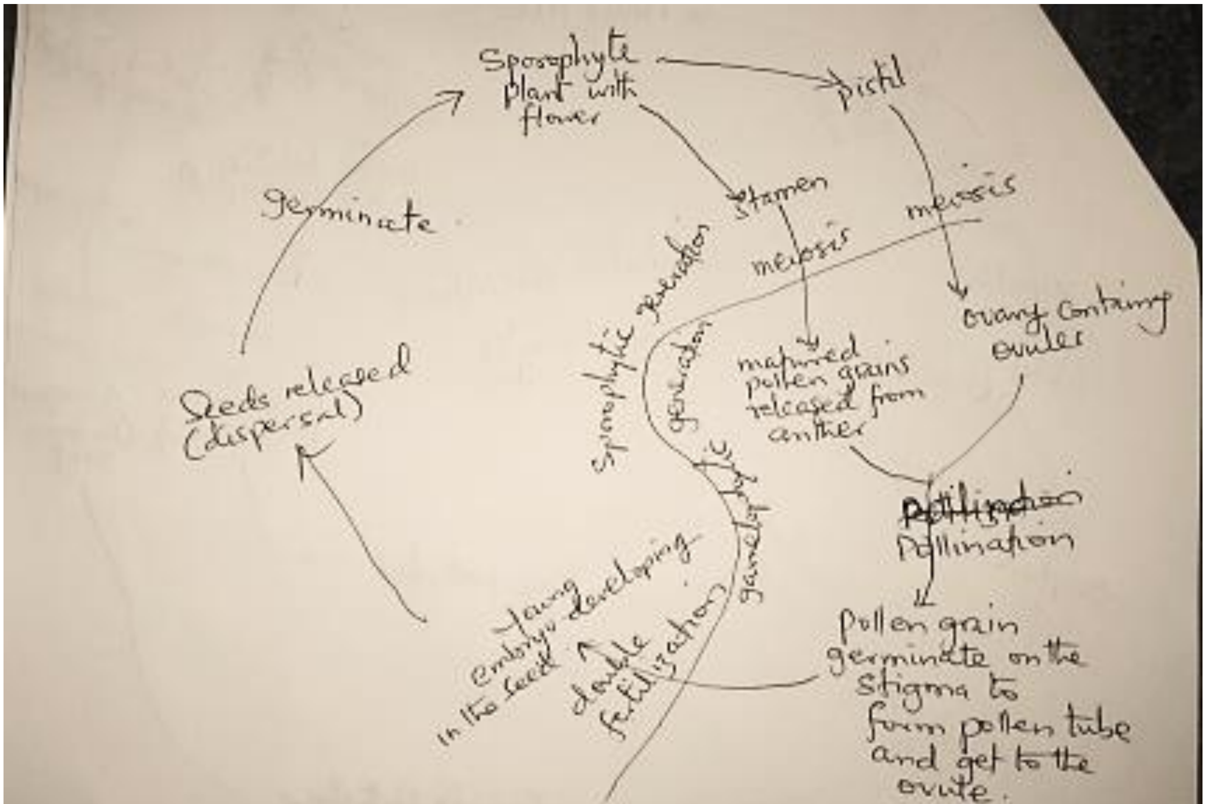
The microspore or pollen grain develops into an extremely reduced male prothallus (male gametophyte). This male gametophyte produces antheridial cells from which male gametes are produced. The female gametophyte on the other hand produces archegonia from which the oosphere is produced. The male gamete and oosphere fuse (fertilization using wind pollination) to produce zygote that later develop into oospore. The oospore develops into the seed containing embryo. The embryo of the seed germinates into a new *Pinus* plant.



Life Cycle of Angiosperms

The life cycle starts with the plant itself, which is a diploid sporophyte and the most conspicuous generation. The production of flower with their sporophylls (leaf bearing sporangia) marks the maturation of the sporophyte. The flowers consist of the diploid megasporophyll (carpels) and microsporophyll (stamens), which house the megasporangium (ovules) and microsporangium (pollen sac in anther) respectively. Meiosis of megaspore- and microspore-mother-cells produces megaspores (embryo sac) and microspore (pollen grains).

Pollination is the transfer of pollen grains from the microsporangia (pollen sacs) of the stamen to the stigma of the megasporophyll (carpel). Once the pollen grain lands on the stigma, it germinates to form pollen tube (siphonogamous fertilization), which goes through the stigma and the style to reach the ovule. Double fertilization (a phenomenon peculiar to only angiosperms) takes place. Here two male nuclei are produced, one of which fertilizes egg nucleus to give the zygote which transform to the embryo of the seed. The other male nucleus fertilizes the two polar nuclei to produce the endosperm (which is triploid, 3n). The seed germinate to produce a new sporophytic plant.



Generalized Life Cycle of Angiosperm