Fertilization, the union of the microspore and megaspore nuclei, produces the diploid zygote, which is the first cell of the next sporophyte generation. The zygote grows by mitosis to produce the diploid embryo, which remains inside the ovule. Now that there is an embryo, the ovule becomes a seed. It develops a seed coat which protects the embryo until there are suitable conditions for germination. Some gymnosperm seeds may develop within a few months, but most species take two to four years to mature. During this seed development, the female cones become brown and take on a woody texture. As they dry, the scales separate and the seeds fall out. Eventually the empty female cones fall to the ground. If conditions are suitable, the seeds germinate. After germination, the tiny plant is called a seedling. Gymnosperms usually have to grow for many years before they produce male and female cones. Although the gymnosperm gametophyte generation is extremely tiny, both in size and duration, it still creates variety in the next generation of plants to ensure survival under many different circumstances.

Life Cycle of Angiosperms

Angiosperms produce seeds that are enclosed and protected inside a fruit, which is formed by various flower parts. Many can reproduce asexually by a broad variety of mechanisms, but they all reproduce by alternation of generations. The sexual phase of alternation of generations allows genetic material to be recombined as a result of fertilization. Even the young produced by the same two parents can be very different from each other.

The entire angiosperm plant, including the roots, stem, leaves, and flowers, belongs to the diploid sporophyte generation. In the appropriate season, the flower bud opens and the petals unfurl. The reproductive parts are revealed and, in a few days, they mature (**Figure 10**). The filament of the stamen elongates and the anther enlarges. Each anther consists of several chambers in which diploid microspore mother cells are located. Each of these undergoes meiosis to form four haploid microspores, or male gametophytes. Each will develop into a mature pollen grain. When the pollen grains reach maturity, the anther chambers split, and as they curl inside out, the pollen grains appear to be coating the outside of the anthers. The pollen of some species is quite sticky, while in others it is like dry powder. The pollen of some plants has tiny wings, while in others the surface has distinctive ridges and grooves. During this stamen development, the style of the pistil also elongates and the stigma enlarges slightly and secretes a sticky, sometimes scented, substance that covers its surface. At the bottom of the pistil, the ovary also enlarges. Inside are one or more ovules. Within each ovule, the diploid megaspore mother cell undergoes meiosis and forms four haploid megaspores, but only one survives as the female gametophyte.

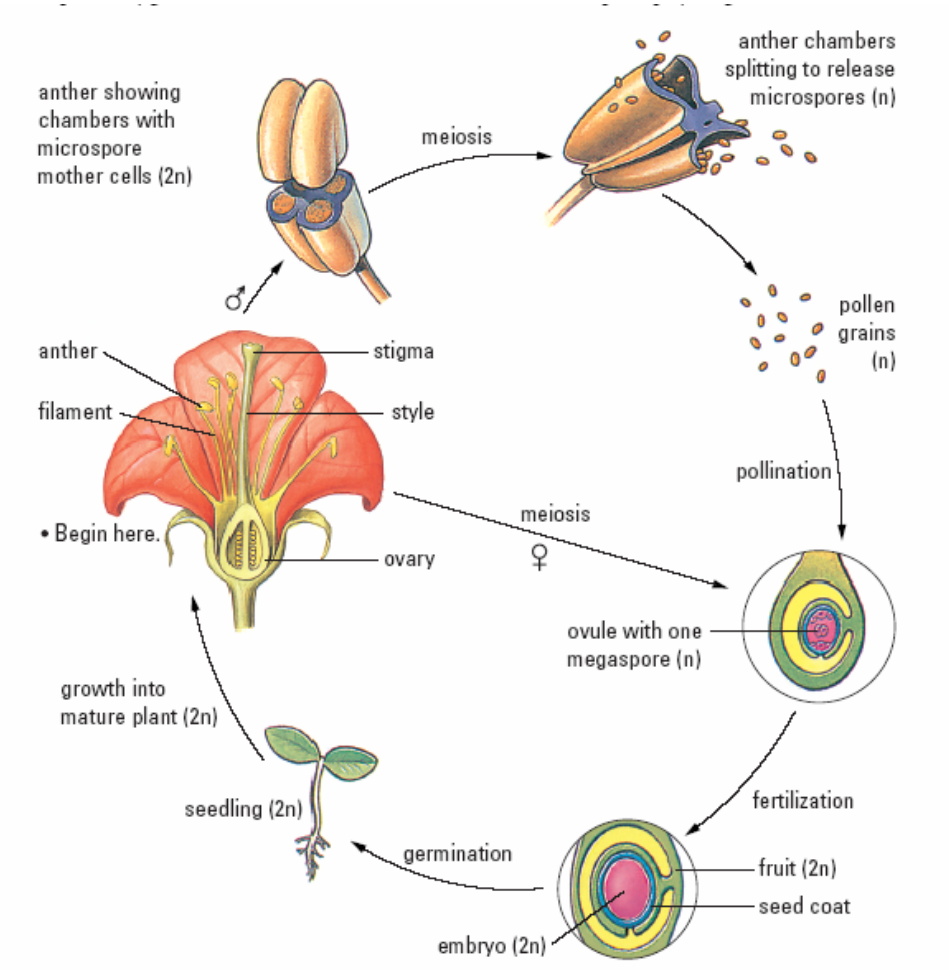

Figure 10
Alternation of generations of a typical flowering plant. Starting with the mature diploid sporophyte flower at the left of the diagram, follow the cycle clockwise and note the labels carefully. Remember that even though the gametophyte generation is small, it is very important for maintaining diversity within the species.

Pollination is usually carried out by wind or insects, but for some angiosperms, pollination is aided by birds or bats. The transfer of pollen from the anther to the stigma on the same flower or another flower on the same plant is called self-pollination. When pollen is transferred to a flower on a different plant, it is called cross-pollination. The pollen grains tend to adhere to the sticky stigmas. Part of the pollen makes its way down through the style tissue and the sperm eventually reaches the egg in the ovule.

Fertilization, the fusion of microspore and megaspore nuclei, produces the diploid zygote, which is the first cell of the next sporophyte generation. The zygote grows by mitosis to form an embryo, which remains inside the ovule. Now that there is an embryo, the ovule is called a seed and has its own protective seed coat. Besides the embryo, the seed also contains some special tissue that will provide nourishment to the developing embryo during seed germination and to the seedling until photosynthetic leaves become functional. While these changes are taking place inside the ovule, the ovary and perhaps some surrounding tissue are developing into a fruit. The fruit may be fleshy or quite hard and dry. The fruit provides protection for the seeds and often helps

secure dispersal of the seeds. During seed and fruit development, the other flower parts often become dry and blow away or may stay attached to the fruit as withered bits of tissue.

After some time elapses, the mature fruit falls or is carried away by animals. Under suitable conditions, the fruit decomposes, the seed coat splits, and germination occurs. The embryo grows very quickly and is now called a seedling. In some angiosperms, the seedling will grow big enough to produce its own flowers and seeds within a few months. In other angiosperms, the plant has to grow many years before it produces its own flowers.

There are many angiosperms that also reproduce asexually. The methods vary widely. Humans have also intervened in plant reproduction by devising methods of reproducing angiosperms by asexual or vegetative means that the plants could not actually do themselves. Humans also intervene in the pollination process, either by manually transferring the pollen from one flower to another or by preventing pollen from reaching the stigmas of the flowers