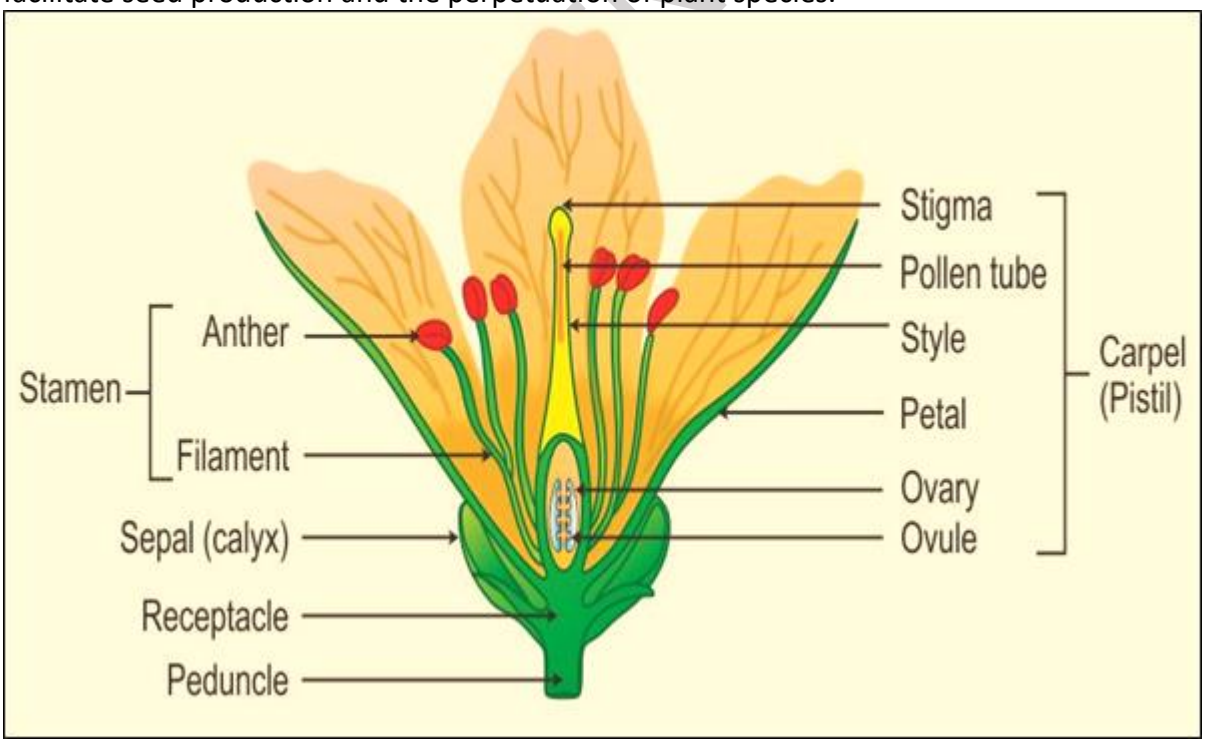
Class 12 Biology Notes

Chapter 1 – Sexual Reproduction in flowering Plants

Reproduction in flowering plants is a captivating process that is crucial for the survival of the species. In contrast to animals, plants have both sexual and asexual modes of reproduction. Sexual reproduction involves the fusion of male and female gametes to form seeds, while asexual reproduction occurs through various vegetative structures. The complex processes of pollination, fertilization, and seed development play a key role in the diversity and adaptability of flowering plants, making them essential for ecosystems. This section delves into the structural and functional characteristics of flowers, the importance of pollination, and the subsequent stages that lead to seed and fruit formation. Understanding these processes offers valuable insights into the evolutionary strategies of plants and their vital contribution to sustaining life on our planet.

Flower – A Fascinating Organ of Angiosperms

A flower is the reproductive organ of flowering plants, scientifically referred to as angiosperms. This specialized structure is essential for sexual reproduction, with its different components collaborating to facilitate seed production and the perpetuation of plant species.



Parts of a flower:

- **Sepals:** Protect the flower in the bud stage.
- **Petals:** Attract pollinators with their colors and fragrances.

- **Stamens:** Male reproductive organs consisting of anther and filament.
- **Carpels/Pistils:** Female reproductive organs consisting of stigma, style, and ovary.

Types of reproduction in flowering plants:

Flowering plants display two primary methods of reproduction: sexual and asexual. These processes are essential for the continuation and spread of plant species in diverse habitats.

Sexual Reproduction:

- Pollination involves the transfer of pollen grains from the male anther to the female stigma within the same flower (self-pollination) or between different flowers (cross-pollination).
- Fertilization occurs when the male gamete (sperm nucleus in pollen) fuses with the female gamete (egg cell in ovule) to form a zygote.

Asexual Reproduction:

- Vegetative Propagation involves asexual reproduction through structures like stems, roots, and leaves. Examples include runners, rhizomes, tubers, and bulbs.
- Apomixis is the production of seeds without fertilization, where the ovule develops into a seed without pollination or zygote formation.
- Fragmentation refers to the breaking of plant parts (e.g., stem fragments or leaves) that can develop into new individuals.

Special Modes of Reproduction:

- Polyembryony is the formation of multiple embryos within a single seed.
- Sexual Reproduction in Plants with Unisexual Flowers:
    - Dioecious Plants have male and female reproductive organs on separate individuals.
    - Monoecious Plants have male and female reproductive organs on the same individual.

Human-Induced Reproduction:

- Plant Breeding involves controlled pollination to develop plants with desired traits.
- Hybridization is the cross-breeding of different varieties or species to create hybrids with specific characteristics.

Pre-fertilization: Structure and Events

1. **Gametogenesis:**

Male Gametogenesis: Takes place in the anther of the stamen. Diploid cells undergo meiosis to produce haploid microspores, which develop into pollen grains containing generative and tube cells.

Female Gametogenesis: Occurs in the ovule within the ovary of the carpel/pistil. Diploid cells undergo meiosis to produce haploid megaspores. One megaspore develops into the female gamete (egg cell).

2. **Pollination:**

Transfer of Pollen: The movement of pollen from the anther to the stigma.

Self-pollination: Pollen from the same flower reaches the stigma.

Cross-pollination: Pollen from one flower is transferred to the stigma of another flower, often facilitated by wind, insects, birds, or animals.

3. **Germination of Pollen Grain:**

Activation: Upon landing on the stigma, the pollen grain absorbs moisture and begins to grow.

Formation of Pollen Tube: A pollen tube grows down the style, facilitated by the tube cell. This tube allows the sperm nuclei to travel towards the ovule.

4. **Recognition and Guidance of Pollen Tube:**

Chemical Signals: The stigma and style release chemical signals that direct the pollen tube towards the ovule.

Compatibility: Identifying compatible pollen is crucial for successful fertilization.

5. **Entry into Ovule:**

Pollen Tube Growth: The pollen tube enters the ovule through a small opening known as the micropyle.

Guidance by Synergid Cells: Synergid cells within the ovule attract and guide the pollen tube.

6. **Fertilization Site Preparation:**

Degradation of Synergid Cells: One of the synergid cells breaks down, creating a pathway for the pollen tube.

Positioning of the Tube: The pollen tube situates itself near the egg cell.

These pre-fertilization events establish an optimal environment for the eventual fusion of male and female gametes during fertilization. The precise coordination of these processes guarantees the success of sexual reproduction in flowering plants.

Double fertilization

Double fertilization is a unique reproductive process found only in angiosperms, or flowering plants. It involves the fusion of two sperm nuclei from a pollen grain with two different nuclei within the ovule. This fusion results in the formation of both a zygote and endosperm. Double fertilization plays a crucial role in seed development and occurs during the fertilization stage of sexual reproduction. The process can be summarized as follows:

First Fertilization Event:

One of the sperm nuclei from the pollen tube fuses with the egg cell (female gamete) within the ovule. This fusion gives rise to a diploid zygote.

Second Fertilization Event:

Another sperm nucleus from the same pollen tube fuses with two polar nuclei in the central cell of the female gametophyte within the ovule. This fusion leads to the formation of a triploid cell called the primary endosperm nucleus.

Formation of Zygote and Endosperm:

The zygote develops into the embryo, which contains the future plant with its primary root, shoot, and cotyledons. The primary endosperm nucleus undergoes multiple divisions to form the endosperm tissue, a nutrient-rich material that surrounds and nourishes the developing embryo.

Seed and Fruit Development:

The fertilized ovule, now a seed, undergoes further development. The ovary surrounding the fertilized ovule develops into a fruit, providing protection to the seed(s) and aiding in their dispersal.

Post-fertilization: Structure and Events

Post-fertilization events in plants encompass the formation of seeds and fruits after successful fertilization. These events are crucial for the production of viable seeds and the dispersal and germination of the next generation. Here is an overview of the key post-fertilization events:

Seed Development:

Following fertilization, the fertilized ovule transforms into a seed. The zygote within the ovule differentiates into an embryo, which consists of the future plant with its primary root, shoot, and cotyledons. The surrounding tissues of the ovule develop into the seed coat, providing protection to the embryo.

Fruit Formation:

The ovary, which housed the fertilized ovule, undergoes changes and develops into a fruit. The fruit serves as a protective structure for the seeds and aids in their dispersal.

Maturation of Seeds:

Seeds undergo maturation, accumulating essential nutrients and storage materials for the developing embryo. If present, the endosperm acts as a nutrient source for the growing embryo.

Dispersal of Seeds:

Fruits and seeds possess adaptations that facilitate their dispersal to new locations, reducing competition among offspring. Dispersal mechanisms include wind, animals, water, and explosive mechanisms in certain plants.

Seed Dormancy:

Some seeds enter a state of dormancy, a period of inactivity. Dormancy can be broken by specific environmental cues, ensuring germination occurs under favourable conditions.

Germination:

Germination is the resumption of metabolic activities in the seed, leading to the growth of a new plant. Favourable conditions such as moisture, warmth, and oxygen trigger germination. The radicle (embryonic root) emerges first, followed by the shoot (embryonic stem).

Establishment of a New Plant:

The germinating seed develops into a seedling and eventually matures into a new plant. If present, the cotyledons provide initial nutrients for the seedling until it can independently perform photosynthesis.

Life Cycle Continuation:

The new plant progresses through the vegetative and reproductive phases, completing the life cycle. The reproductive phase includes the production of flowers, pollination, and subsequent fertilization, ensuring the continuation of the plant's life cycle.

Apomixis and Polyembryony

Apomixis is a type of plant reproduction that occurs without the need for meiosis, fertilization, or the development of true seeds. In this process, embryos are formed from somatic cells of the ovule, leading to offspring that are genetically identical to the parent plant.

Polyembryony is a remarkable occurrence in which numerous embryos originate from either a solitary fertilized egg cell or multiple fertilized egg cells enclosed within a solitary seed. Consequently, this leads to the existence of multiple plantlets within a single seed, each possessing the potential to flourish into a fully grown plant.