

Pollination Explanation!



Learning Objectives

Students will:

- Understand the basics of plant reproduction and why this generates a need for pollinators
- Understand the overall process of pollination and why this process is important to nature
- Understand key aspects of pollination (abiotic/biotic) (self-pollination/cross pollination)



•Method

Students will engage in a range of debating motions covering pollinators and plant reproduction. The debate sessions will provide opportunities for students to share their perspective on the process of pollination.

Materials

- Large piece of newsprint or Bristol board
- Crayons, pens and pencils
- Supporting research material, such as graphs, illustrations, lists, or artifacts (e.g., bird's nests)

Background

Before any discussions surrounding **pollination**, it is important that student's understand plants need to reproduce in order to survive. The process of pollination would not exist if plants did not reproduce. This would be a great time to discuss plant reproduction with students and emphasize the importance of this process that must occur. This discussion could begin with the following question.

Why do plants reproduce?

Plants need to reproduce to ensure survival of their species in future generations. During reproduction plants can pass on their genetic information to their offspring. It is important to understand that reproduction in plants can occur in different ways. The two major forms of reproduction in plants are asexual reproduction and sexual reproduction.

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1. Vegetative Reproduction – Vegetative reproduction is method for plants to reproduce without the need to invest energy into the development reproductive organs and **gametes**. During vegetative reproduction, the offspring are identical clones to the parent plant. The major advantage of vegetative reproduction is that the process can happen quickly and does not rely on processes including pollination. The major disadvantage with vegetative reproduction is the lack of genetic diversity within a population. There are two main types of vegetative reproduction that can occur.

1.a. The first method is called **apomixis**. During apomixis, a plant is able to produce a seed without fertilization occurring. During apomixis there is no **pollen** that fertilizes the egg cell, to produce a **seed**. This method of reproduction is very uncommon in nature. An example of a native plant species that can undergo apomixis is the dandelion!

1.b. The second type of vegetative reproduction that occurs is the production of clones. During vegetative reproduction, plant parts including stems and roots can form new offspring which are identical clones of the parent plant. Some examples of plants that reproduce via vegetative propagation are ginger, potatoes, and strawberries.

2. Seed reproduction - Is a method of reproduction where the male gamete (sperm cell contained within the pollen) fertilizes the female gamete (egg contained within the **ovary**) to produce new seeds. During seed reproduction, there is a transfer of pollen grains from the male reproductive structure (**anther**) to the female reproductive structure (**stigma**). Once the pollen has landed on the stigma, the pollen grain will absorb water and produce a **pollen tube** that will transport the gamete cells (sperm) down the female reproductive structure into the ovary. When the pollen tube finds the ovule (egg) inside the ovary, the male gamete cell will fertilize the ovule to produce an embryo, which is the new plant contained within a seed.



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The ability for plants to successfully reproduce was necessary as plants transitioned from an aquatic environment to the land. Once plants established on land, the rise of reproduction and pollinators allowed plants to flourish and colonize the land. To transition the discussion to pollination it is important to talk about the early land plants and a few major changes that occurred prior to the need for pollination.

The Rise of Pollination

The first plants that inhabited the earth, did not produce seeds during reproduction. The earliest forms of plant life (ferns, mosses, liverworts) produced male and female spores which could be dispersed into the environment by different vectors including water and wind. The male spores had a tail (**flagella**) structure, that provided the ability to swim. The male and female spores could interact and undergo fertilization to form a new plant. This process was not advantageous because there was a huge dependence on water for successful reproduction. Since the terrestrial environment can be dry, plants needed a better mechanism to ensure successful reproduction.

To improve the success of plant reproduction in early land plants, two important events occurred.

- 1) Plants evolved to produce pollen. The pollen is similar to the male spore, with the major difference being a pollen can survive without water. The pollen grain is protected from environment and could persist for long periods of time without water. One major advantage of pollen, was the ability for pollen to travel large distances to fertilize the female gamete. This was a key requirement for the beginning of pollination.
- 2) The second major event to improve the success of reproduction was the production of seeds. According to fossil records, the first plants to form seeds were ferns. The seed bearing ferns date close to 390 million years old. Following reproduction, a mature seed would form on a plant.

This seed could be dispersed into the environment where a new plant would eventually grow. The major advantage that a seed possessed was the ability to remain dormant in a dry environment. When the conditions were favorable for growth (water, sunlight, temperature) the seed could germinate and grow into a new plant. With these two major changes occurring in plants, the need for pollination was now at the forefront. To introduce the topic of pollination, you can ask the students to identify some problems that plants may have during reproduction.

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What are some challenges that plants may face during reproduction?

There are several valid answers to this question.

- There is the risk of predators eating the plant material and flowers
- Plants need large amounts of nutrients, water and sunlight to develop structures associated with reproduction. The development of flowers require a substantial amount of energy!
- Plants are sedentary organisms, which means they are unable to move. This is a major obstacle when considering plant reproduction. If plants are not close to each other, it may be difficult to transfer pollen between plants to ensure fertilization can occur. This is a major reason why we have pollinators!

Pollination

Pollination is the process of transferring **pollen** from the male reproductive structure (**anther**) to the female reproductive structure (**stigma**) on a flower. Once the pollen has landed on the female structure (**stigma**), the pollen grain will absorb water and produce a **pollen tube** that will transport the sperm cells down the female reproductive structure into the ovary. When the pollen tube finds the **ovule** (egg) inside the ovary, the sperm cell will fertilize the ovule to produce an **embryo**, which is the new plant.



The process of pollination will specifically focus on the transfer of pollen from the male to female reproductive parts. There are two major types of pollination that can occur.

1) **Abiotic Pollination** – This pollination process is facilitated by non-living vectors which include wind, water and gravity. Abiotic pollination was believed to be the first type of pollination that occurred in nature. The first instance of abiotic pollination (wind) documented in the fossil record was fern-like plants dating back to the Carboniferous period nearly 298-359 million years ago.

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It is predicted that approximately 20% of the present-day species utilize abiotic pollination, with the majority utilizing wind pollination (98%).

- Wind pollinated plants - Wheat, rice, corn, barley, oats
- Water/rain pollinated plants - Lotus, water lily

2) **Biotic Pollination** – This pollination process is facilitated by living organisms (pollinators), which can include various mammals, insects, birds, and human. Biotic pollination, like abiotic pollination is a process that originated millions of years ago. Scientists recently discovered a fossilized flower beetle with traces of pollen in a piece of amber. Scientists determined the age of this particular fossil to be 99 million years old, indicating the importance of pollinators in prehistoric times when dinosaurs roamed the earth.

Biotic pollination is an interesting process due to the important relationship that forms between the plant and the pollinator. The plant supplies the pollinator with a source of nutrition and the pollinator provides transportation for pollen to promote seed reproduction. Pollinators play an important role to promote cross-pollination between plants. Cross pollination is important to promote genetic diversity amongst plants.

It is also interesting to note that some plants (self-pollinators) are not dependent on pollinators. These plants are able to self-pollinate themselves. Many plants in nature have flowers which contain both male and female reproductive structures. Many of these plants are able to transfer pollen from the male reproductive structure to the female reproductive structure without the need for a pollinator to physically transfer the pollen. A few examples of self-pollinators include tomatoes, canola, and wheat.

Questions to Discuss

1 Why do plants have flowers?

- Flowers are important for producing seeds, which humans and animals can use for several different reasons including food

2. What are your favorite flowers and why?

- Flowers are important structures to produce seeds and fruits. Animals and humans rely on flowers and plant reproduction for sustainable food sources
- Smell and color are great answers (pollinators are attracted to these features).

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3. What are pollinators? Can you give an example of a pollinator?

- Pollinators are organisms that help move pollen between plants to help promote reproduction of plants

4. Why are pollinators attracted to flowers?

- Smell, color, design and shape of flowers, nectar

5. Do all plants need pollinators?

- This should make for an interesting discussion. The answer is no. While many plants rely on pollinators, many plants can spread pollen using non-living vectors including wind and water.

6. What important foods depend on the activity of pollinators?

- There are many foods that depend on pollinators. Approximately 75% of the world's food production depends on pollinator.
- In our garden, foods like pumpkins, squash, and cucumbers rely on pollinators
- Our chocolate and vanilla desserts also rely on pollinators too!

Activity

Debate topics

- Divide the students into groups. A few students will debate for or against the motion while other students would be judges
- Biotic pollination is the best form of pollination

References

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Taylor, T.N. and M.A. Millay. 1979. Pollination biology and reproduction in early seed plants. Review of Paleobotany and Palynology, 27, 329-355.