Imperfect Flowers: A Design for Genetic Diversity

Overview: Genetic diversity is an important characteristic for all species including plants to prepare them to survive environmental changes and challenges. Plants have evolved specific attributes that promote cross-pollination, a term that describes when the pollen from a flower on one plant fertilizes a flower on a different plant, to support genetic diversity. In this lesson, students will explore plants that have imperfect flowers and learn how this characteristic can help ensure their survival.

Grade Level/Range: 3rd-8th Grade

Objective: Students will learn:

- Plants with imperfect flowers have two types of flowers; some contain male structures producing pollen and others contain female structures producing eggs and seeds.
- Cross-pollination supports genetic diversity and genetic diversity supports the survival of a species.

Time: 4 to 8 weeks

Materials:

- Plants with imperfect flowers such as squash, cucumbers, pumpkins or begonias to study
- Observation Journals

Background Information:
Although flower structure can vary greatly, all share some basic parts. The female organ is the pistil. The platform at the top of the pistil — often sticky so it can trap pollen — is the stigma, held up by the tube-like style. The style leads down to the ovary, inside of which are the ovules, containing female egg cells. The male parts are the stamens. The anther on top of the stamen, held up by the stem-like filament, produces pollen, which contains male sperm cells.

Pollination is the transfer of pollen from male to female flower parts. When a grain of pollen lands on the stigma, a tiny pollen tube grows from it and probes down the style into the ovary. Sperm cells then travel through this tube from the pollen grain to an ovule, and there join with an egg cell in the process called fertilization. The fertilized ovule will become a seed, and the ovary a fruit. Without pollination and fertilization, fruit and seed production cannot occur in most plants.

In most plants, flowers contain both female and male parts. These flowers are classified as “perfect” flowers. However, some plants have evolved to produce flowers with only male or female parts; these flowers are classified as “imperfect.” Despite the name, which might seem to imply a deficiency, imperfect flowers are actually designed to provide a biological advantage by promoting genetic diversity.

Genetic diversity is a vital component in the overall health and survival of a species. If all plants in a species were identical, they could be vulnerable when faced with challenging environmental conditions or disease problems. For example, a disease or environmental change that killed one plant might wipe out the whole population. If populations of plants contain some variability, hopefully some plants would be strong enough to survive a challenge even if others perish. In wild plants, genetic diversity is

maintained when plants cross-pollinate; that is, when the pollen from a flower on one plant fertilizes a flower on a different plant.

Imperfect flowers reduce the likelihood of self-fertilization and therefore promote genetic diversity. With separate parts, it obviously makes self-fertilization of an individual flower impossible, and it also increases the likelihood that pollinators will transfer pollen to surrounding plants. Many plants with imperfect flowers further promote transfer between different plants by producing male and female flowers at different times. Male flowers usually appear on the plants before female flowers.

The squash family provides a good example of plants with imperfect flowers. Members of the squash family include cucumbers, gourds and melons. New gardeners are often discouraged when their cucumber or pumpkin plant keeps dropping flowers without producing any fruit. This is because those first flowers are usually male flowers and are not capable of producing any fruit. The female flowers will begin to appear a few days to a couple of weeks later and then you will begin to see fruit set.

Plants in the squash family need pollinators. Since the reproductive parts are on separate flowers and plants can produce male and female flowers at different times, pollinating insects like bees are needed to move pollen from the male stamens of one plant to the female pistils of another.

Advanced Preparation: Plant squash family plants like squash, cucumbers or pumpkins in your garden 4 to 6 weeks before you want to conduct your observations. For indoor spaces without grow lights, or if you have limited time availability, you can obtain blooming begonias to study imperfect flowers, although they may not provide the same natural pollination observation opportunities and seed pods produced are smaller. A sample size of 6 to 8 plants (or more) would be preferable.

Laying the Groundwork

Introduce the common flower components and study examples of perfect flowers like lilies or tulips. Additional resources on flower structure can be found in the Pollinator Activity Kit. Once students learn how to identify the stamens and pistils on these traditional flower examples, explain that there are many variations on how these structures look and are arranged on flowers. Take a walk through your school garden or a local natural area to look at different types of flowers and practice identifying the pistil and stamens. Use the Background Information above to introduce the concept of imperfect flowers.

Exploration:

1. When the squash family or begonia plants you started in the Advanced Preparation begin to bloom, have students draw models of both the male and female flowers in an Observation Journal.

Male and female begonia flowers.

2. Visit your garden daily and track the number of each type of flower on each plant each day. During your observations, also look for and note the presence and activity of pollinators in your garden. Also make sure to record when you begin to see fruit developing. If you are growing either plant indoors, remember you will need to be the pollinator for your plants. Try using a paintbrush to transfer pollen from the male flowers of one plant to the female of another.

3. After a few weeks, plot your data and look for patterns in the appearance of male and female flowers on your plants.

4. Explain the process of cross-pollination and then use the data you have collected about the appearance of male and female flowers on your

plants to discuss with your class the chances that their plants exchanged pollen in the process of fruit production.

Making Connections:

As a class or individually, read about the history of the potato plant and what happened when we relied on food crops that did not have much genetic diversity. Discuss the importance of cross-pollination and explain why it leads to new plants with genetic diversity.

Branching Out:

- Learn about other plant adaptations that support genetic diversity with the article Flower Adaptations to Lure Pollinators.

- Further investigate other ways plants attract pollinators to their flowers through Petal Attraction.

Link to Standards:

3-LS4 Biological Evolution: Unity and Diversity
3-LS4-2. Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing.

4-LS1 From Molecules to Organisms: Structures and Processes
4-LS1-1. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.

MS-LS3 Heredity: Inheritance and Variation of Traits
MS-LS3-2. Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.