Grade 5, Unit 2: Pollen For You
Lesson Plan

Unit Driving Questions:

1. How is genetic information passed from one generation to the next?
2. How can a change in the environment affect the development of the traits in a population of organisms?

Unit Standard(s):

- 5.L3U1.9 Obtain, evaluate, and communicate information about patterns between the offspring of plants, and the offspring of animals (including humans); construct an explanation of how genetic information is passed from one generation to the next.
- 5.L3U1.10 Construct an explanation based on evidence that the changes in an environment can affect the development of the traits in a population of organisms.

Engage: (15 minutes)

Materials: Teacher Slide Deck, WonderWall, post-its, Driving Questions remain posted
Things to Consider: Students will be continuing to make plant observations.

Phenomena: Students watch Desert Museum video on what the ancient relatives of corn, beans, and squash looked like compared to the modern day varieties.

Lesson: Have students watch the Desert Museum video comparing the corn, chilies, squash, and beans of today to their ancient, wild relatives. Have them post their *I Wonders* on a Wonder Wall. Lead a discussion of their wonderings/thinking and help them organize their wonderings into groups.

Probe: (10 minutes)

Have students read the Probe in their groups or lead this as a whole class using Slide Deck slide 4. Have them discuss with each other which student they agree with and why, then write their name on

a post-it note and place it by the name of the person they agree with on the Probe. Lead a discussion to hear their thoughts.

Things to Consider: You will need the names of the students on the Probe up so students can put post-it notes by the name they agree with. Students still need time each day with plants.

Explore 1: (30 minutes)

Materials: Students' flowering Fast Plants (Day 14 to 16) • forceps • 2 cm wide clear adhesive tape • pointy toothpicks • hand lens or microscope • Unit 2, Pollen for You, Student Handout #1 • magnifying glasses • Teacher Slide Deck • forceps • skewer • ruler • tweezers

If you are not using Wisconsin Fast plants, you will need to bring in flowers that are easy to dissect and with clearly seen reproductive parts. Florists are sometimes able to provide "dead" flowers that are past their prime if you explain that you will be doing flower dissections. Lilies and Alstroemerias clearly show flower stucture, especially lilies, with their size. The Brassica flowers are small and challenge students to deal with their tiny, fragile parts.

Things to Consider: Whichever flowers you choose, the Wisconsin Fast Plant website video links are very helpful. Lead the dissection on one flower, showing it under a Document Camera to model how, then have students do the same with a partner. To cut into the flower, pointed toothpicks work well, or a plastic knife should suffice. You may want to cut one flower ovary with a sharp knife to show the ovules, the immature eggs, in finer detail. If not using the Brassica flowers, have them skip this part of the handout.

Lesson: Have students observe their seedlings and compare them with another group's seedlings that were exposed to different amounts of light. They will measure final growth with a ruler in metric and draw a conclusion about how more or less light affects the growth of the plant. They will record their conclusion on their Unit 2 Student Handout #1. Lead the class in a discussion of their findings of how an environmental factor impacted the plant.

Then direct their attention to the flower and ask them to consider its purpose. Show the flower dissection video on Slide Deck slide 7, then dissect one of their flowers or a flower you brought into class. (Even if you use the Brassica flowers, you may want a larger lily for the group demonstration.) Students examine, draw and label their flower and its parts on Unit 2 Student Handout #1. Do a quick practice of identifying flower parts with the Slide Deck Slides 10-11. Male parts (stamens) include the anther and filament. Female parts (pistil) include the stigma, style, and ovary. Revisit the initial questions about flowers posted in the Slide Deck before students watched the video and dissected a flower. Lead a class discussion that asks students why pollinators would visit flowers. What's in it for them?

Explain: (20 minutes)

Materials: Teacher Slide Deck, Unit 2 Student Handout #1

Things to Consider: Students still need time to pollinate plants. Wisconsin Fast Plants recommends Bee Sticks be made before the Explore section of the lesson - teacher may choose to make Bee Sticks, or have students make them, before the next session of Explore or during this session. If you do not have Bee Sticks, use Q-tips.

Lesson: Show the Science Sauce Pollination video on Slide15 and ask students to share their wonderings and what they noticed. Introduce the vocabulary words pollination and cross-pollination. Pollination, the transfer of pollen from an anther to a stigma, leads to seed production. Cross-pollination is the transfer of pollen from the anther of a plant to the stigma of the flower of another plant. Self-pollination is the transfer of pollen from the anther of a flower to the stigma of the same flower of another flower of the same plant. Wisconsin Fast Plants™ DO NOT self-pollinate, so they need to be cross-pollinated by pollinators or by hand. When pollen lands on the stigma, a pollen tube grows through the style to reach the egg and allows for fertilization and the development of fruit and seeds. Show the Science Sauce Flower Fertilization video on Slide 16. Explain that pollination is the delivery of pollen to enable fertilization to happen, and without it, most flowering plants couldn't reproduce. Without it, there would also be no fruits or seeds for animals to eat.

Using Slide Deck Slides 17-21, explain the importance of identifying species even if it is difficult due to trait variation. (Remember the butterflies that looked different depending on the time of year?) Knowing species is important for for us to accurately communicate about different life forms. Introduce the term biodiversity and that the varieties of living things provide all kinds of services that we depend on (think of the oxygen that we breathe that plants provide, or the soil aeration that ants provide so that plant roots can take in rain water more easily). And biodiversity is the source of so many products that we depend on, from food, to textiles, to shelter, to medicines. We need biodiversity! Remind the students how having a variety of traits allows species to survive under a variety of environmental conditions and keep providing all of these services. Healthy ecosystems depend on all of the collective "jobs" of their varied organisms, and the more diversity there is, the more productive and resilient those ecosystems are. If we understand the importance of biodiversity, we will value it and work to conserve life in all its varied forms. Explain that the great variation in traits can make it difficult to identify species just by appearance, so scientists must rely on something else than physical traits; they rely on DNA.

With slides 22-31, introduce students to the Tucson Bee Collaborative and how they are using DNA barcoding to identify the many native bees of the Sonoran Desert Region. Most recent estimates indicate that there are more than 1000 native bee species in the Sonoran Desert Region. We are a bee hotspot! We don't even know which species are all here! This is where the work on the Tucson Bee Collaborative comes in.

Students then take a closer look at the anatomy of bees and how their body helps them collect pollen. *(You may want students to make Bee Sticks at this time, or choose to make them yourself, for their use in the Explore section below.)*

Explore 2: (30 minutes)

Materials: Teacher Slide Deck, student plants, Unit 2 Student Handout #1, toothpicks, forceps, tweezers, scissors, glue, dried bees from Wisconsin Fast Plant kits, skewers

Things to consider: In this part of the unit, students will be selecting for specific traits to propagate by pollinating plants whose traits they want to transmit to the next generation of plants. They will simulate pollination by transferring pollen from flower to flower with Bee Sticks made with dried honeybees. When students are selecting for traits and cutting back the plants that do not have the traits they want in their future generation of plants, have students use scissors. If they try pulling the plants out, they often pull up plants they did not intend to pull up. Students use toothpicks, tweezers and forceps to help with the cutting and selecting of traits.

The Fast Plants will begin to flower about 15 days after sowing. When flowers on more than two Fast Plants are open, your students should begin to pollinate their flowers and continue pollinating every day or two among all open flowers for up to 7 days.

Lesson: Have your students consider that if insects can pollinate flowers, could humans pollinate flowers as well? Ask how we could select for traits we want in the next generation of plants. Students then decide which traits they want to see in their next generation of plants. Have them look at their group's plants and those of other groups, then choose 2 parent plants whose traits they want to transmit through cross-pollination. Students record the traits they are selecting for on their Unit 2 Student Handout #1.

Using the images in Slides 35-38, discuss how humans could transfer pollen with various things like pollen transferring kits sold online, QTips, brushes, pipecleaners, etc. Tell the class that they will be using Bee Sticks to act as bees to transfer pollen from one plant to another. Students follow the Wisconsin Fast Plant instructions in the Slide Deck Slide 37 to assemble the Bee Sticks (unless you or they have already done so earlier). Then they pollinate their two parent plants they have selected, collecting pollen with their Bee Stick from the flowers of one plant and moving it to the stigmas of the other plant’s flowers. Students need to be sure to deposit a good amount of pollen on the stigma of each flower. Fast Plants are self-incompatible: that is, each stigma prevents germination of its own pollen and cannot self pollinate. This is why the students need to perform cross-pollination.

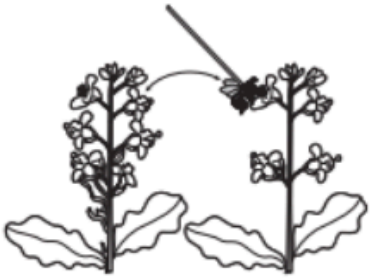
Making beesticks: Day 12

Add a drop of glue to fix the bee to the toothpick.
Push toothpick into the top of the thorax (middle section) of the bee.

Let beesticks dry overnight.

Procedure: Setting the Floral Clock

1. At a time between **Day 14** and **Day 16** when five or more flowers are open on each plant in the film can, cross-pollinate all open flowers on each plant with a beestick by gently rolling the bee thorax back and forth over the anthers of flowers of several plants until yellow pollen can be observed on the hairs.



Moving to other plants and repeating the rolling motion over the anthers and the stigma of each pistil, students should make sure to deposit pollen collected on the beestick on to the stigma of each flower. Students from one group may wish to "fly" their bees to flowers of other groups. Buzz!

Explore 2, Option B: IF PLANTS DIE (30 minutes)

Materials: Teacher Slide Deck **Option B** for Unit 2, Unit 2 Option B Chilicraft Student Handout, coin (students work in pairs with a partner), Chiltepin Menu (There are options for a full sheet or two half sheet copies. Copy enough for each pair to share, or just show the chiltepin menu on the slide deck.)

Lesson: If the plants die, or a vacation will occur while trying to grow the next generation of plants, use this option. Begin by having students consider that if insects can pollinate flowers, could humans pollinate flowers? Ask them to consider how we could select for traits we want in the next generation of plants. Explain that if time allowed or if the plants had lived, they would have selected 2 parent plants based on the traits they wanted to see expressed in the next generation. Since the plants are not available, students will play a game/simulation to select for traits they want to see in a future generation of plants. However, they will not be using Fast Plants, but they will explore selection of traits of the chiltepin plant.

Use the Option B Slide Deck slides 11-16 to teach students that the wild chiltepin is known as the "Mother of all Chilies." The chiltepin has been used by humans for over 7,000 years. It is incredibly hearty and well adapted it is to the environment of the North American Southwest - it even uses a nurse plant as protection for survival in the extremes of the desert. Chitepines are used in food and for medicine. Describe the Scoville Scale and how chiltepines are quite hot compared to many other peppers. Explain that the students will work in pairs to create their own a chiltepin Dream Pepper with selected characteristics of heat, color, size, and shape. Pass out student handouts (and one chiltepin menu per pair if using a paper copy), then guide them through the Chilicraft directions as outlined on the handout and slides 17-29 of the Option B Slide Deck. Have students record data on their worksheet and draw what the third generation of chiltepin plants looks like, drawing a star by the third generation offspring that most looks like their Dream Pepper. They then discuss and record what they learned from the impact of their trait selection on the generation of chiltepines. Guide the students to the realization that humans can select for traits and can manually pollinate plants; they have been doing it for thousands of years. However, due to trait variation, trait selection does not show immediate results. Selecting for desired traits takes time.

Elaborate (25 minutes)

Materials: Teacher Slide Deck (the Elaborate and Evaluate Slides are in both slide decks,) Unit 2 Pollen for You Student Handout #1

Lesson: Ask students to share what they know about pollinators and other forces that move pollen. Why do animals want to pollinate flowers anyways? What's in it for them? You may need to remind students to think of pollen, not seeds. Students may think of seeds that get onto their clothing or that they have seen on their dog's fur. The discussion is specifically on pollen. Student groups put their heads together and discuss which animals pollinate plants and why. They also discuss if pollen can be moved any other way besides animals. Ask students what they already know about Sonoran Desert pollinators and how many different kinds they can name. Using the slides, reveal many kinds of desert pollinators. Ask the students what the pollinators get from flowers. Many different organisms pollinate plants, including bees, butterflies, beetles, bats, birds, moths, wasps, flies, and more. As they have seen, even humans can be pollinators, but it is a lot of work! Pollinators spread pollen when they make contact with flowers. We know this helps out the plants, but what is in it for the pollinators? Generally, flowers provide them with rewards such as nectar, pollen, perfumes, and oils. Lead a class discussion on the pollinators of the Sonoran Desert. Students may note that wind can also spread pollen from plant to plant. Grasses are wind pollinated. Many of our grain crops (corn, wheat, barley, rice, rye, and oats) are wind-pollinated, as are some trees. Pollen of Fast Plants is relatively heavy and sticky and is normally not carried in the air. For brassicas, bees are marvelously coevolved pollen-transferring devices.

Evaluate: (25 minutes)

Materials: Teacher Slide Deck, Unit 2 Student Handout, Unit 2 Possible Rubrics, Unit 2 Evaluation Student Handout

Lesson: Have students re-watch the Phenomena video they saw at the beginning of this unit, then discuss how the crops of today look so different than their wild ancestors. Students should discuss that humans probably selected for traits over the years to yield the crops they wanted. Have students revisit the Probe from the beginning of the unit on page 3 of their Student Handout #1. You may want to keep the slide (44 or 35 depending on your selected Slide Deck) posted to show the varieties of colors of seeds since most students will have a black and white copy of the Student Handout. Remind students of the vocabulary and the Driving Questions as they write their response. Students then take the Unit 2 Evaluation (pages 1-2 of the Evaluation - pages 3-4 contain teacher information and evaluation rubrics.) Go over directions and make suggestions for strong responses (using content specific vocabulary, citing examples they learned about in the lesson.)