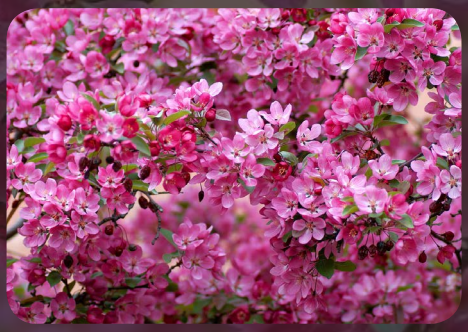

The Beauty of Bees

Grade: 4

Subject Areas:
Life Science, Language Arts

Skills: classifying, describing, drawing, identifying, observing, manufacturing

Duration: 1-2 hours

Connections:
social studies, evolution, botany, ecology, economics

Vocabulary
natural selection
symbiosis
mutualism
pollinators
pollen
stamen
stigma
nectar
honey bees
native bees

Objective:
Students will understand the mutualistic relationship between flowers and their pollinators, especially the role of bees.

Materials
- An assortment of fairly large flowers
- tweezers and scalpels
- magnification (loupes or stand alone magnifiers)
- samples of fruit, nuts, and vegetables
- large picture of a flower/ flower model
- an assortment of wood
- drill and drill bits.
- safety goggles
- paper straws, small hollow sticks like bamboo
- clay
- a warm location protected from rain and predators
- a post hole digger or hooks

Standards

Strands: Excellence in Environmental Education Guidelines
Strand 2.2 — The Living Environment: A) Organisms, populations, and communities: Learners understand basic similarities and differences among a wide variety of living organisms. They understand the concept of habitat. **B) Heredity and evolution:** Learners understand that plants and animals have different characteristics and that many of the characteristics are inherited. **C) Systems and connections:** Learners understand basic ways in which organisms are related to their environments and to other organisms. **D) Flow of matter and energy:** Learners know that living things need some source of energy to live and grow.
Strand 2.4 — Environment and Society: A) Human/environment interactions: Learners understand that people depend on, change, and are affected by the environment.
Strand 3— Decision-Making and Citizenship Skills: B) Evaluating the need for citizen action: Learners are able to think critically about whether they believe action is needed in particular situations and whether they believe they should be involved.

California State Educational Standards:
Life Sciences (LS) 2a: Students know producers and consumers are related in food chains and food webs and may compete with each other for resources in an ecosystem.
LS 3b: Students know that in any particular environment, some kinds of plants and animals survive well, some survive less well, and some cannot survive at all. **3c:** Students know many plants depend on animals for pollination and seed dispersal, and animals depend on plants for food and shelter.
Investigation and Experimentation 6f: Students will follow a set of written instructions for a scientific investigation.

Background

Partners in Nature

In order for organisms to survive, they need to adapt to their environment. Through natural selection, traits (or genes) that give an organism an advantage for survival are passed down to the next generation. This is sometimes referred to as "descent with modification", a phrase used by Charles Darwin. Variation in traits is possible through mutations, which are changes in the DNA of an organism. These changes mostly happen through mistakes made during cell replication. **Natural selection** is the driving force behind evolution.

Sometimes the most beneficial survival mechanism is a partnership. Many partnerships exist between various organisms. We call these relationships symbiosis. **Symbiosis** is sometimes referred to as coevolution. Each species involved in coevolution exerts selective pressure on the other. **Mutualism** is a form of coevolution whereby both partners benefit from the relationship.

There are few more remarkable forms of mutualism than exist between flowers and their pollinators. The act of pollination is ubiquitous (occurs everywhere). However, sometimes the relationship between plant and **pollinator** is so specialized that only one species can pollinate a particular plant as is the case with some orchids. Other times many different species of flower are pollinated by the same animal. In all cases, the plant benefits by getting pollinated and the pollinator benefits by getting a meal.

Flowering plants evolved over 100 million years ago from non-flowering plants. Non-flowering plants include ferns and mosses. All plants have male and female parts whichunite during fertilization producing an embryo. The embryo holds the combined DNA of the two parents and will become the next generation. In flowering plants, pollination needs to occur before fertilization happens.

The female part of a flowering plant is tucked away in an ovary that lies in the lower portion of a flower. Inside each ovary is one or more eggs. These eggs are met by sperm that is produced by the pollen once the pollen arrives at the correct place. **Pollen** is produced by the male part of the flower and is held in the **stamens**. It needs to travel to a feature above the flower's ovary, called the stigma. The **stigma** is attached to a column called a style. There is a wide array of how the anthers and stigmas are arranged on any particular flower.

Attract and React

Basically flowers have one function, sex. Those trying to attract pollinators, have many ways of advertising themselves. Some flowers are very showy. The petals and sepals can

Local Connection

Several farmers in the local area raise bees. These bees, although non-native, are honey bees—they make honey! Apparently, one out of three bites of food an average American eats is made possible because of honey bees. Just to support the almond crops grown in California alone, over half of all honey bees available in the U.S. are needed. This adds up to 1.5 million colonies — that is a lot of bees.

Honey bees are successful at pollination because they come in vast numbers. One colony can support more than 50,000 individuals. A hive depends on a queen bee. She creates a caste system where all workers bees are sterile females. She lays countless eggs in the spring which hatch into larvae and then grow into adults. Like many other bees, they have to feed their young a combination of pollen and nectar. Unlike other bees, however, honey bees live throughout the winter. To keep themselves alive, they make honey. Honey is made out of pollen and is what bees eat to get them through the cold winter months.

An interesting discovery about honey bees is the waggle dance. It turns out that honey bees can communicate where feeding grounds are, and the quality of the feeding ground they just visited. They do this by moving their bodies a certain way once they are back in their hive. Unfortunately, another discovery has revealed that honey bees are in trouble. They have been hit hard by a mysterious disease called Colony Collapse Disorder. For unknown reasons, whole colonies die quite suddenly causing fear and concern amongst agriculturalists and bee keepers alike.

come in spectacular colors and designs. Others have fragrance or attractive aromas. Still others have a tasty treat called nectar. Often it is the nectarthat the pollinators are after. Nectar is basically sugar water and is an important food source. Not all flowers depend on a pollinator, however. Some flowers depend on wind to get the job done.

The animals that pollinate flowers comprise many groups including birds, bats, and insects. The structure of flowers often determine the pollinator they are trying to attract. For instance, flowers that depend on bats, like the agavecactus, open up at night and have large light colored flowers. Those that attract hummingbirds are usually red and tubular with very little smell. Some flowers can be miniscule and attract tiny insects like flies and gnats. Still others are lavishly displayed and even provide landing pads and runways to help flies, bees, and other insects find their way.

Bees Needs

Insects by far do most of the pollinating, especially one group called the Hymenoptera. Hymenoptera include bees and wasps. There is one bee that does more pollinating than any other bee in the world; the honey bee. This is the kind of bee most people know about, but they are not native to America, they come from Europe. **Honey bees** are very important, however. They not only make honey, but are responsible for fertilizing more plants compared to any other insect. Fruit trees, nut trees, an assortment of vegetables and many berries depend on bees for pollination. (For more information on honey bees, refer to the Local Connection.)

The bees of the King Range National Conservation Area (NCA), are mostly **native bees**. There are two main groups of bees; solitary bees and social bees. Honey bees and bumble bees are social bees although honey bees have much bigger social groups. They are not typical, however. By far, out of the thousands of species of bees worldwide, most are solitary. In California there are about 1,600 species of bees.

Several species of native bees are found in the King Range NCA. They come in many colors and sizes including green, purple and black. Often their names reflect their nesting preferences. There are the miner bees, carpenter bees, mud bees, and masonry bees. Bumble bees are the largest kind of bee found here; sometimes over an inch in length. About 70% of native bees live underground and the other 30% live in wooden tunnels, usually taking advantage of preexisting holes dug by beetles. Native bees do not make honey.

For many years now, scientists have been discovering a shortage of bees across the nation. Pesticides and a non-native parasitic mite from Asia are the most probable sources for their decrease in numbers. This has many people concerned, especially farmers, bee keepers, and honey lovers. The close relationship bees have with flowers makes them crucial members of most ecosystems, not to mention agriculture. One thing people can do to help maintain bee populations, is create habitat for them.

Habitat for bees depends on two things: a place for a nest and flowers to feed on. Nest sites can vary from bare ground to tree snags. Bumble bees nest in places like brush piles and rodent burrows. Flowers can be native or non-native. Apparently, most bees aren't too choosy as long as their home is close to their foraging ground.

One thing all bees share in common is their need for pollen which means, they need flowers. Many flowers in turn need pollinators, and few animals do this better than bees. The more people understand this close and utterly amazing relationship between flowers and their pollinators, the better off the bees will be.

Activity 1: Flower Power

Preparation

Gather enough flowers for every student to have one. Flowers can be kept in a refrigerator overnight as long as they are kept moist.

Materials

- **An assortment of fairly large flowers with easy to see male and female parts**
- **tweezers and scalpels**
- **magnification (loupes or stand alone magnifiers)**
- **samples of fruit, nuts, and vegetables that require animal pollination, especially from bees.**
- **large picture of a flower or a flower model**

Procedure

1. Hold up an assortment of fresh fruits, nuts and vegetables. Refer to a picture of a flower when appropriate. Use these items as an introduction into pollination and the importance of bees. Find out what the students already know about pollination. You may want to break the class up into groups after the initial discussion, and have some proceed to Activity 2.

- *Who knows what this kind of ____ is?*
- *Does anybody like to eat ____?*
- *What is your favorite type of fruit? (or nut, or vegetable)*
- *What do fruits and nuts begin their lives as? (flowers)*
- *Does anybody know what needs to happen in order for a fruit or nut to form? (Hold up a picture of a flower and point to various parts)*
- *What is pollen?*
- *What part of the plant produces pollen?*
- *What kind of animals are famous for pollinating flowers?*
- *If you were a bee, where do you have to carry your pollen to in order to fertilize a flower?*
- *Do you think the bees know they have to pollinate flowers?*
- *Have you ever heard of the birds and the bees?*
- *Why are they visiting flowers?*
- *Do you think pollination is important?*

2. Explain to the students that a partnership like the ones between pollinators and flowers is called symbiosis. Further explain that both of the partners in this case benefit. This type of symbiosis is called mutualism. In order to understand pollination better, they are going to look closely at flowers. See student instructions. (If you want the students to cut open the ovary of a flower, set up some safety rules around cutting with a sharp tool.)

3. Hold up a large picture of a flower and point out the main parts. It is not necessary for them to learn all of the parts to a flower. Pass out one flower to each student along with a magnifying glass to allow them to see the flower structures up close. A worthwhile option here is to have the students practice drawing what they see. Be sure to have them look closely at both the stamens and the stigma. These are the two parts critical in pollination. Clean up accordingly.

Activity 2: Making Homes for Native Bees

Preparation

To make bee condos, cut the wooden posts into blocks 8-12 inches long. Practice on a few pieces to show as demonstration pieces later and to familiarize yourself with necessary precautions. The holes need to be drilled 3-5 inches deep, and at least 3/4 inches apart (see attached photos). Bees prefer dark colored wood, so you may want to char the front of the "bee condo" with a torch. For easier bee houses, kids can make a bundle of hollow sticks or straws with one end sealed. You may want to make a few of these to show them examples. More information is available at: **http://blog.greenearthbamboo.com**

Materials

- **an assortment of wood. 4x6 or 6x6 soft wood, like pine or fir posts, work best. You can try other weathered pieces of wood.**
- **drill and drill bits. Bits need to range from 1/4 to 3/8 inches**
- **safety goggles**
- **paper straws, small hollow sticks like bamboo**
- **clay to seal one end of the hollow sticks and straws**
- **a warm location protected from rain and predators, preferably near a flower garden**
- **a post hold digger or hooks for mounting purposes**

Procedure

1. In small groups with an adult present, begin drilling holes in a post. Make sure students are wearing safety goggles. As mentioned above, the holes need to be drilled 3-5 in. deep, and at least 3/4 in. apart. For the alternative design, have students plug the ends of hollow sticks and paper straws with clay. Using twine, they need to tie a bundle of 7-10 sticks together using a firm knot. They can also place them in a container. These need to sit or hang so that the holes lay horizontal to the ground.

2. Have the students add a decorative label to their bundle if they are not going to take it home. All houses should be put in a warm location with southern exposure. A small slanted eave can be made over the "bee condos". Bees are more likely to find these hand-made homes if they are put near flowers. They can be a well addition to a school garden.

Extensions

- Using nets, go outside and catch pollinators. Bring them back to the classroom in jars to observe them using magnification.
- Invite a beekeeper to school and have them show the students a bee hive.
- Use bees to introduce important agricultural crops and the importance they have to our economy. Have the students pick a food crop to research on their own.
- Use plants to begin a discussion on ecological food chains and food webs.
- Taste different honeys produced locally.
- Incorporate a unit on healthy by making food with honey instead of sugar.
- Learn more about native bees through the Native Bee Teacher Guide available through UC Cooperative Extension. website: http://groups.ucanr.org/MGCSP/files/76694.pdf

References

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Coevolution and Pollinator, http://biology.clc.uc.edu/courses/bio303/coevolution.htm, 2010

Home made sweet homes, http://www.fs.fed.us/wildflowers/kids/activities/beebox.shtml,2010

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Recommended Reading

- Buchmann, Stephen, Honey Bees, Letters from the Hive: A History of Bees and Honey, Random House Children's Books, 2010
- Mayan Stingless Bee Keeping: Going, Going, Gone? Science Daily, June 16, 2005
- Heinrich, Bernd, Bumblebee Economics, Harvard University Press, 2004

Observing Flowers

Goals: Students will gain an appreciation of flowers and their role in pollination by identifying some of the major parts.

Objectives: Students will be able to identify the parts of a flower especially those important in pollination.
Materials: flower part table, fresh flowers.

Procedure:
1. Using the handout showing flower parts, compare your flower to the handout using a magnifying glass. Try and find all of the parts listed on your handout.
2. Find the stamens and touch one with your pencil. Did you see individual pollen grains?
3. How many stamens are there on your flower?
4. After looking at a stamen up close, draw one as realistically as you can.
5. Find the entire female part of the flower and remove it.
6. Look closely at the top of it. What is this structure called?
7. Draw the female part of the flower as realistically as you can.
8. Carefully cut open the swollen ovary straight down the middle.
9. Using your pencil open up the ovary and look inside. What do you see?
10. Estimate how many eggs are in the ovary of your flower.
11. Write a short statement explaining where pollen is located and where it needs to go in order for pollination to occur.