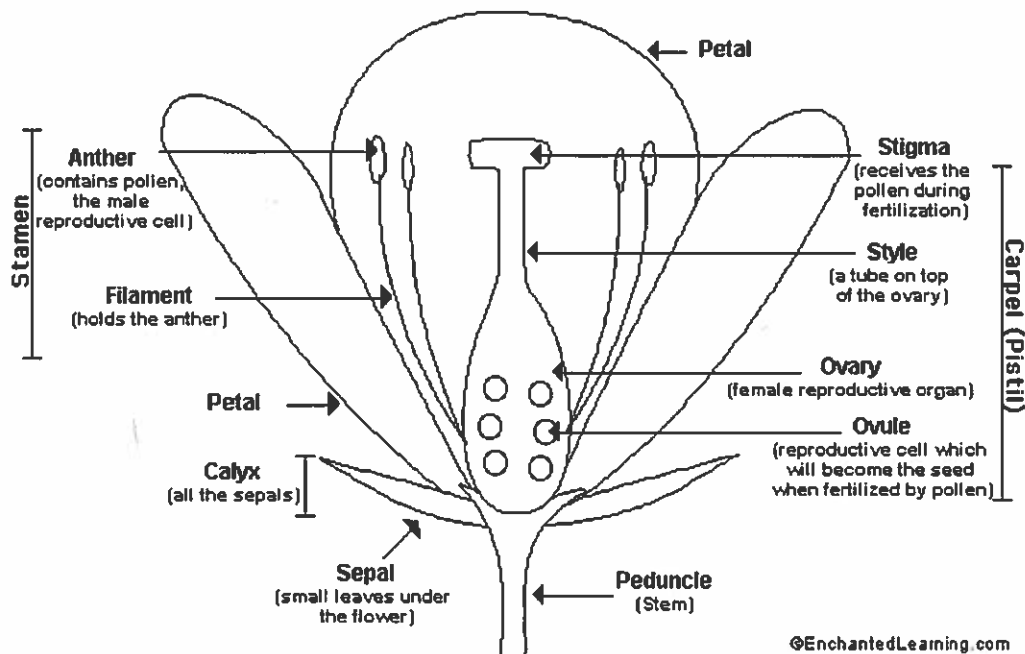


Flower Anatomy



The Flower:

The flower is the reproductive unit of some plants (angiosperms). Parts of the flower include petals, sepals, one or more carpels (the female reproductive organs), and stamens (the male reproductive organs).

The Female Reproductive Organs:

The pistil is the collective term for the carpel(s). Each carpel includes an ovary (where the ovules are produced; ovules are the female reproductive cells, the eggs), a style (a tube on top of the ovary), and a stigma (which receives the pollen during fertilization).

The Male Reproductive Organs:

Stamens are the male reproductive parts of flowers. A stamen consists of an anther (which produces pollen) and a filament. The pollen consists of the male reproductive cells; they fertilize ovules.

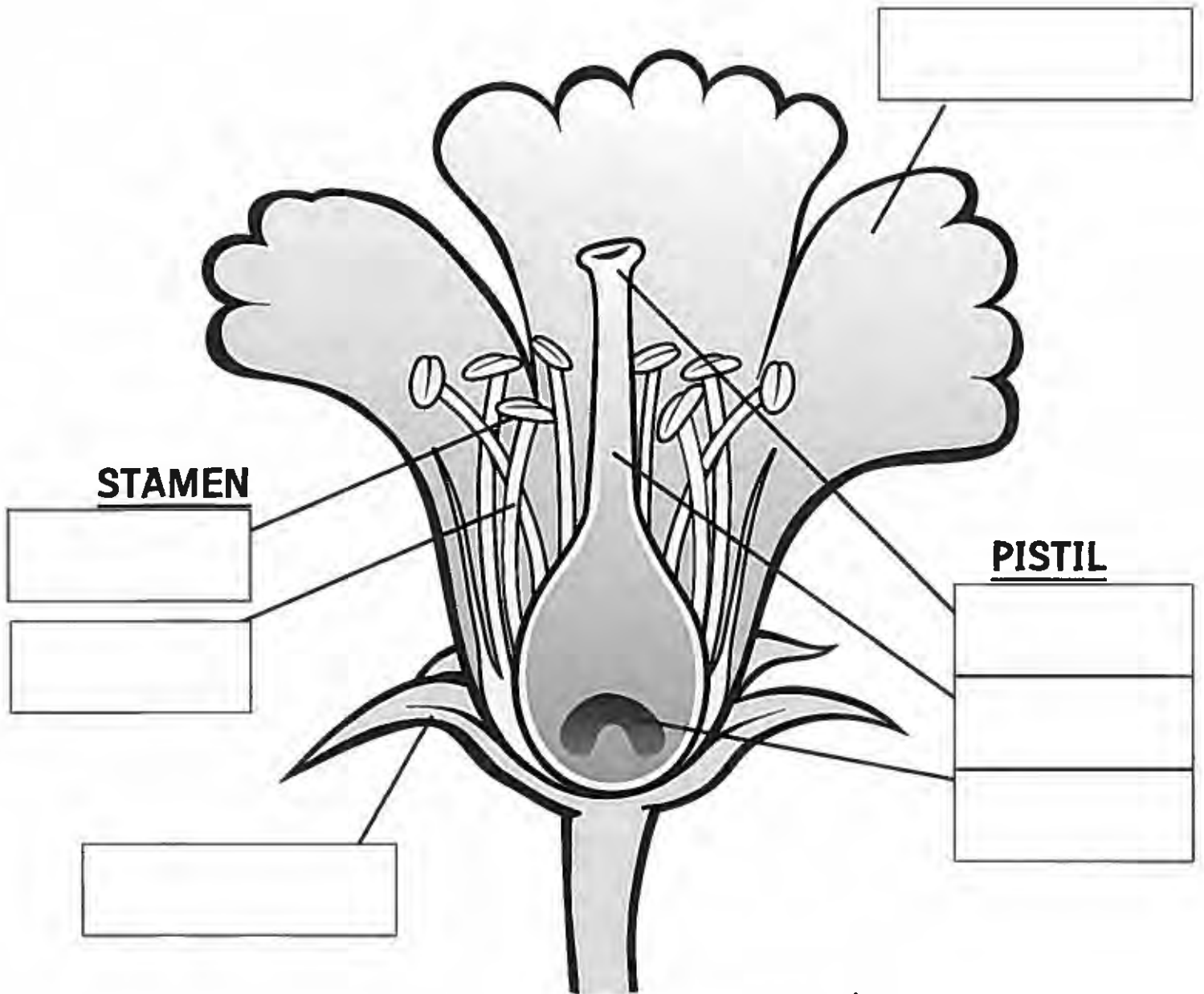
Fertilization:

Pollen must fertilize an ovule to produce a viable seed. This process is called pollination, and is often aided by animals like bees, which fly from flower to flower collecting sweet nectar. As they visit flowers, they spread pollen around, depositing it on some stigmas. After a male's pollen grains have landed on the stigma during fertilization, pollen tubes develop within the style, burrowing down to the ovary, where the sperm fertilizes an ovum (an egg cell), in the ovule. After fertilization, the ovule develops into a seed in the ovary.

Types of Flowers:

Some flowers (called perfect flowers) have both male and female reproductive organs; some flowers (called imperfect flowers) have only male reproductive organs or only female reproductive organs. Some plants have both male and female flowers, while others have males on one plant and females on another. Complete flowers have stamens, a pistil, petals, and sepals. Incomplete flowers lack one of these parts.

Parts of a Flower



Flower Part Words

Anther

Filament

Ovary

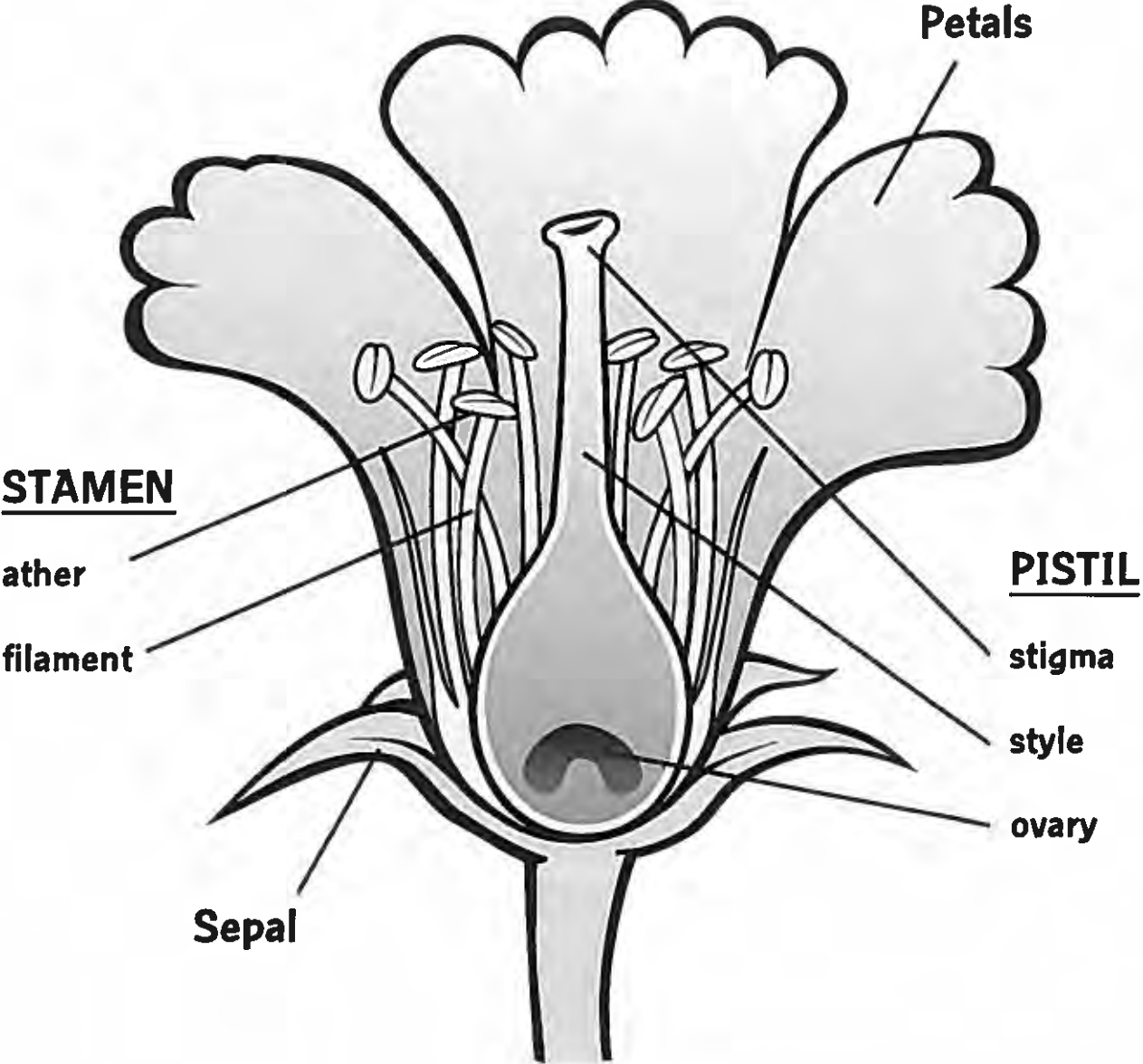
Petals

Sepals

Stigma

Style

Parts of a Flower- answer key



Pollination Parade



Objective:

Students will explore the relationship between flowers and their pollinators.

Grade Level: 4-6

Groupings: Pairs or small groups

Materials: Several different flowers; *Flower Description Cards* and *Pollinator Profile Cards* (see pages 235 - 36); collection of miscellaneous materials for constructing flowers such as paper plates, drinking straws, toilet paper tubes, crepe paper, assorted scents and flavored extracts, toothpicks, play dough, pipe cleaners, cotton balls, scraps of felt, wire floral stems, and string.

Time Allotment: 30 minutes

Extension:

a. Have the students conduct a pollination survey. Have them observe a flower over time, noting the different types and behavior of pollinators that visit it.

Directions:

*This activity works best if the students are familiar with the material presented in **Flower Power** (page 227).*

1. Bring in several flowers of different shapes and colors. Ask the students to vote for their favorite flower. When the votes are in, explain that not everyone voted for the same flower as different people have different preferences. Different insects and other plant visitors have flower preferences, too.
2. Explain to the class that the purpose of a flower in the life of a plant is to reproduce the plant. In order to do that, pollen from one flower must be carried to other flowers and vice versa. The pollen fertilizes the pistil of the plant, producing fertile seeds. These seeds can then grow into new plants. Introduce the class to the idea that different flowers are pollinated in different ways. Explain that flowers have evolved specialized parts, shapes, colors, scents, and other characteristics expressly to attract **pollinators** — animals, birds, and insects that spread pollen from flower to flower. The class will construct their own flowers that are adapted in different ways to attract pollinators. Later they will play the role of the various pollinators.
3. Divide the students into pairs or groups. Give each group a *Flower Description Card*. Using the materials provided, have the students make a three-dimensional flower that meets the requirements detailed on their card. Stress that the flower should have all the basic flower parts unless the description states otherwise.
4. Place the finished flowers with their description cards in a central location in the classroom. Provide time for all the students to observe the flowers.





POLLINATION PARTNERS

Flowers have been 'courting' pollinators for a long time. They have evolved specific colors, shapes, nectars and perfumes to attract them. The most efficient pollinators have been rewarded with a flower designed just for them. Petals have evolved into flat landing platform shapes for bees; foul odors are emitted to lure carrion beetles and flies; and nectar is hidden deep inside long flower tubes where only hummingbirds, moths, or butterflies can reach it. Certain orchids go as far as resembling the females of certain species of bees and wasps, even producing a scent that mimics the mating pheromone. Male bees and wasps are attracted and attempt to mate with the flower, pollinating it in the process. One of the most amazing examples of this coevolution of flowers and pollinators is the yucca plant and yucca moth. The female moth only visits yucca flowers, and at each one she rolls up a large ball of pollen. She carries this pollen ball to another yucca flower and deposits it on the stigma, thereby insuring pollination and seed production. She then lays her eggs in the ovary of this flower, insuring a food source for her hatching larvae which emerge just as the seeds are ripening! It is estimated the larvae only eat about 20% of the seeds before they chew their way out of the ovary and are on their own.

Directions: (continued)

5. Pass *Pollinator Profile Cards* to the groups. Have the students read over their card carefully. Explain that each group will now take on the role of the pollinator described on their card. Review the flower descriptions, and ask the pollinators to choose the one flower that best suits their needs. When you say "Go," the pollinators in each group fly, buzz, or crawl to the flower that is best adapted for pollination by them. Review their choices.

6. Show the students examples or pictures of flowers that are pollinated by the various pollinators and compare them to the flowers they made.

POLLINATORS and their FLOWERS	
Bat:	Organ Pipe Cactus (<i>Stenocereus</i>); Kapok tree (<i>Ceiba</i>); Sausage tree (<i>Keiskeia</i>); Calabash tree (<i>Grecenilia</i>)
Bees:	Marsh Marigold (<i>Callia palustris</i>); Blue-Flag (<i>Iris</i>); Foxglove (<i>Digitalis</i>)
Butterfly:	Wild Blue Phlox (<i>Phlox</i>); Daylily (<i>Heimercallis</i>); Wild Geranium (<i>Geranium</i>)
Carrion fly:	Sinking Benjamin (<i>Tillium</i>); Skull cabbage (<i>Synplacarpus foetidus</i>); Carrion flower (<i>Scaphia</i>)
Hummingbird:	Cardinal flower (<i>Lobelia cardinalis</i>); Red columbine (<i>Aquilegia canadensis</i>); Fuchsia; Banana
Mosquito:	Small flowered orchid (<i>Habenaria elegans</i>)
Moth:	Spanish Bayonet or Yucca (<i>Yucca</i>); Tobacco (<i>Nicotiana</i>); Evening Primrose (<i>Oenothera</i>)
Wind:	Paper Birch (<i>Betula</i>); Cottonwood (<i>Populus</i>); Oak (<i>Quercus</i>); and many other temperate trees, also grasses and sedges.
Note: Each pollinator has a specific flower type that it prefers, but it may visit and pollinate many different types of flowers.	

Flower Description Cards

1. I am a bright red flower shaped like a long tube fringed with tiny petals. Hidden deep in the tube is lots of nectar. I am very showy and stand out in a crowd, but I have no scent.

2. I am a bright blue, sweet smelling flower. I am tubular in shape with five flat petals on the top. Peek inside: I am full of nectar.

3. I am a white flower. I look like a bell with five zigzag petals on top and nectar hidden inside. I have a very strong, pleasant odor that I emit after sunset. Ahhhh!

4. We are a cluster of tiny white star-shaped flowers with nectar and a little pollen.

5. I am a dark maroon flower with three petals. My color has been compared to red meat. Don't get too close because I smell bad, as if I were rotting. Yuck!

6. I am a bright yellow flower with petals spread open wide. They make a nice landing platform so it is easy to drop in for a visit. Follow the racing stripes on my petals to my nectar supply. Watch out for my anthers, they might dust you with pollen.

7. I am a huge, white, funnel-shaped flower on a thick, strong stalk. I smell very sweet and spicy and have lots and lots of nectar and nutritious pollen.

8. We are small green flowers. Nothing fancy, no petals, no sepals, no scent, just anthers full of pollen. We hang around on long stems and dangle in the breeze.

Answers: 1. *Cardinal flower, hummingbird pollinator.* 2. *Wild blue phlox, butterfly pollinator.*
3. *Yucca, moth pollinator.* 4. *Small flowered orchid, mosquito pollinator.*
5. *Stinking Benjamin, carrion fly pollinator.* 6. *Marsh marigold, bee pollinator.* 7. *Organ pipe cactus, bat pollinator.* 8. *Paper birch tree flowers, wind pollinator.*

Pollinator Profile Cards

I am a honeybee. I can't see red, but how I love those bright flashy flowers with distinctive patterns on the petals! People often miss the pattern because they can't see like a bee. Just shine an ultraviolet light on that flower and you'll see it as I do. A tisket a tasket, I love to gather lots of pollen in the 'baskets' on my legs.

I am a hummingbird. Red is my favorite color. Give me a flower with a long tube full of nectar. Don't bother with fancy perfume, because I can't smell a thing.

I am the wind. I don't care much about how a flower looks or smells. I just like to blow pollen about. Whooosh!

I am a carrion fly. I love smelly things, like dead fish or rotting meat. Yum!

I am a little male mosquito. I look for tiny light-colored flowers about my size when gathering nectar.

I am a bat. I have a big appetite, so give me a flower with plenty of nectar and pollen. I am on the lookout for light-colored flowers with strong, sweet and spicy smells, as those flowers are easy to find at night

I am a butterfly. Give me a bright-colored flower that stands out in a crowd. I just unroll my long drinking-straw tongue and sip nectar.

I am a moth. I like flowers that are light in color and have a strong, sweet smell as they are easier to find if you fly by night. My long tongue can find and drink up the hidden nectar.

INSECT EXPERIMENTS FOR THE CLASSROOM
Marriah Schwallier & Joe Culin
Department of Entomology
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***POLLINATION OF
FLOWERS BY MOTHS***

BACKGROUND:

Insects, and some other animals, regularly visit flowers for the sugary nectar and protein-rich pollen they produce. During these visits, a vital service is performed for the plant as the visitors transfer pollen from the male part of the flower (anthers) to the female part of the flower (stigma). This act of pollination is the first step in fruit and seed production.

Many insects, birds, and bats act as pollinators. Both the plants and their animal pollinators have developed unique relationships and structures that allow them to successfully interact. For example, the long tongue (proboscis) of moths and butterflies allows them to reach nectar produced deep inside of flowers. In many cases both the animal and the plant benefits from this interaction as the animal obtains food and the plant is pollinated. However, some animals may steal nectar or pollen without pollinating the plant, and some plants can trap and kill pollinators.

Without the services of pollinators, the plants that animals depend on for food, shelter, or nest sites would not exist. Humans also are dependent on insect-pollinated plants for foods, medicines and clothing. Worldwide three-fourths of all food and feed crops require pollinators to reproduce. We can even thank a species of fly for pollinating the cocoa plant that we use to make chocolate!

Successful pollination depends on pollinators finding the right flowers at the right time. Pollinators locate appropriate flowers by visual and chemical cues. Since the structure of the mouthparts of pollinators differ greatly as do flower structures, the pollinator also has to locate the right type of flower.

Objective

In this activity, students will become hawkmoths and attempt to collect nectar and pollen from flowers while avoiding becoming prey to the predators lurking in the garden. They will investigate the proboscis of the moth as an adaptation allowing it to feed and survive. They also will investigate ways living things interact with each other in the nocturnal garden.

SC Science Standards covered in this activity

Grade 1 - II. A.2

Grade 2 - II. A.2 II. C.1

Grade 3 - II. A.1,2 II. C.1

Grade 4 - II. A.1,2

Grade 5 - II. B.1,2,3

Grade 6 - II. C.1

Materials

Non-noise-making party blowers to make the proboscis of the hawkmoth - 1 per student

Double-sided sticky tape to attach to the tip of the blower

8 oz. White plastic drinking cup - 15 per class

White poster paper - 1 sheet

Small (1/4 inch) yellow pom-poms - 10 per cup for hawkmoth feeding

If you also want to look at pollination of the flowers you will need about 20 pompoms of another color.

Small sticky notepad

String

Glue gun

Hole punch

Procedure

In this activity, students will become hawkmoths and attempt to collect pollen from the moonflower. While feeding, they also must avoid being eaten by the bats and other predators in the garden.

- Construct moonflowers before doing the activity. Use the white cups for the moonflower. Use a hole punch to punch 2 holes in the side of the cup so that you can put a string through the holes and hang the flower from a string tied across the classroom between 2 chairs. Cut flower shapes from white poster paper, and cut a hole the size of the top of the cup in the center of the flower. Place a bead of hot glue around the entire cup just under the lip of the opening and quickly insert cup into the flower opening. You can add heart-shaped dark green leaves to make it look more like a moonflower vine. Put 10 pom-poms in each cup (the pollen). If you want to include flower pollination, add 4 pom-poms of another color to 5 of the cups.
- Cut strips of sticky tape large enough to cover ½ to 1 inch of both surfaces of the party blower tips. This will allow them to pick up pollen using their proboscis.
- Assign 4 students as predators, 2 should be bats while the other 2 can select the type of predator they would like to be. While the hawkmoths are feeding the bats should fly around in the vine, quietly clicking their tongues to simulate a bat's echolocation sounds. The bats must move slowly using a heel-to-toe step. When a hawkmoth hears a bat approaching it can avoid being eaten by sitting down until the bat passes. If a bat tags a standing hawkmoth, it is eaten. When this happened the bat should put a sticky note on the hawkmoth and the moth must leave the garden

area. The other predators are ambush predators and should choose a location to sit snear the vines. These predators can not move, but if a feeding hawkmoth comes too close they tag them and they are also out of the activity.

- All other students in the class are hawkmoths who will feed on the moonflowers. The moths will try to obtain nectar (yellow pom-poms) found in the flowers. While getting nectar, they also collect pollen (other color pom-poms) that is transferred to flowers that only have yellow pom-poms. The moths eat some of the pollen but help the moonflowers by pollinating some of them. Students acting as moths can not use their hands to steady the moonflowers. They have to use the party blowers as their proboscis and blow it to straighten it out, insert it into a flower and collect some pollen. The pollen will stick to the tape. If they get the other color pom-pom on their proboscis and go to a flower that only has yellow, they should pick the pom-pom off of the proboscis and drop it into the flower. If a proboscis is broken it should not be replaced, and that moth has been injured and dies.
- Allow the students to feed for about 2 minutes and then have them sit down on the floor. They should then count the number of pollen grains each collected. They must have collected at least 5 pollen grains to have obtained enough food to survive
- Students experience competition for the food and the threat of a predator.

POLLINATION WEB SITES:

Further information on plants and insect pollinators can be found at the web sites listed below.

<http://www.isis.ut.edu/~fanjun/text/poll.html>

<http://koning.ecsu.edu./plants-Human/pollenadapt.html>

<http://bluehen.ags.udel.edu/deces/beekeeping/pollination.htm>

<http://desertmuseum.org>

For students aged 9 to 12 you may want to read the book *The Moonflower* by Peter & Jean Loewer (ISBN 156145138x).

The idea for the this version of the pollination activity came from Pat Bobbit at Powdersville Elementary School and was based on a similar activity on pollination in *Lantana* developed by Marriah Schwallier.

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Bees! Hardworking PD (Pollination Department) Workers!

A Relay Race

Essential Question:

How do honey bees work as pollinators?

At a Glance:

This game demonstrates how a honeybee hive functions

Background Information:

Honeybees live in a highly organized colony. A colony is like one big family and generally contains one breeding female, or “queen”, about a hundred males – “drones”, and a large population of sterile female “worker” bees. The queen bee lays eggs. Drone bees will leave the colony and mate with young queens from other colonies and fertilize her eggs. Worker bees are the ones that you see most often. Their job is to gather nectar and pollen for the hive. They do not mate.

Worker bees gather nectar and pollen from flowers for food. They use the nectar to make honey and pollen provides nutrients to young bees or brood. Honey is used as food for the brood and it is used as food for the adult bees during the times when there are no flowers.

While the bees are gathering food, they scatter pollen from flower to flower thereby pollinating many flowers. Flowers produce sweet nectar as an incentive for bees to visit and hence, pollinate. When bees leave the hive and find a nice patch of flowers, they need to let the other bees in the hive know. They do this by performing a “waggle” dance that tells the other bees the direction and distance to the flowers.

Getting started:

Assemble all supplies. Choose a playing area either outside or an indoor area such as a gym or hallway.

Place a flower container with tokens half way across the playing area in front of each team. Place a second flower at the far end of the playing area in front of each team. Determine a starting line for the teams and place boxes that represent the beehives at the starting line.

See attached Playing Field Diagram.

Procedure:

1. Review the following information to the learners: Bees gather nectar and pollen from flowers for their own use as food. They use the nectar to make honey and pollen is used to provide

Location: Outside in a playing field or open, flat area

Objectives: Learners will

- 1) name two things that bees get from flowers – nectar and pollen
- 2) describe what bees do with nectar and pollen
- 3) describe how bees communicate with other bees in a hive.

Skills: communicating, role-playing

Supplies:

- pollen tokens: small strips of cardstock or other material that is all one color. There should be no less than 2 pollen tokens per learner.
- nectar tokens: similar to pollen tokens but a different color. There should also be no less than 2 nectar tokens per learner.
- 2 cardboard boxes (or similar container) to represent the beehive. The hive should be empty at the beginning of the game
- two large cans or other containers (with pictures of flowers on them) per team to represent flowers. Each flower should have pollen and nectar tokens in it; there should be no less than one pollen token and one nectar token per each child on a team.
- two bee pictures or puppets (1 per team)

Subject: Science

Time: 25 minutes

important nutrients to young bees or brood. While the bees are gathering food they scatter pollen thereby pollinating many flowers. Flowers produce sweet nectar as an incentive for bees to visit and to therefore pollinate. When bees leave the hive and find a nice patch of flowers - they need to communicate the location of the flowers with the other bees in the hive. They do this by performing a “waggle” dance which tells the other bees the direction and distance to the flowers.

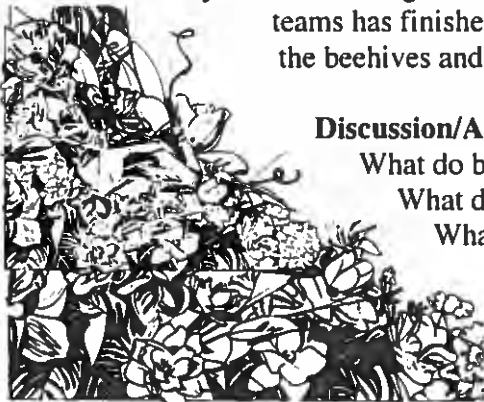
2. In this activity learners will pretend that they are bees and will fly from their hive to flowers in the field where they will collect nectar and pollen, pollinate a flower, fly back to their hive and communicate with other bees by doing a waggle dance.
3. Demonstrate the rules. Break the learners up into two or more even teams (the number of learners in a team will determine the length of the activity). Ask the teams to stand behind a starting line and place the ‘Beehive’ container at the beginning of the line. This is where the bees will deposit all of the nectar and pollen that they collect in the field.

Place a flower container with tokens half way across the playing area in front of each team. Place a second flower at the far end of the playing area in front of each team. See attached Playing Field Diagram.

Explain the rules: The runner holds the bee puppet / picture while running. Each runner in turn must go to the first flower bucket and pick out one pollen token and one nectar token. The runner must then go to the second flower bucket and deposit one pollen token in the bucket. The runner must then pick up one pollen token and one nectar token from that container. The runner now has two nectar tokens and one pollen token. The runner runs back to the hive and places the tokens in the beehive container. Before passing the bee puppet to the next runner in line the current runner must do a waggle dance that includes at least one total rotation of the body. Then the ‘bee’ is passed to the next learner and the previous runner sits at the end of the line.

An additional rule that can be used if the kids in line are getting restless is the presence of a Queen Bee that all the other bees have to listen too. The Instructor plays this role, and they can call out any rule at any time that the bees have to follow, for example “Queen Bee says everyone must hop on one leg”

4. Start the relay race. Encourage all the kids to participate in the race even if one of the teams has finished. When all teams have finished the race, look in the beehives and the flower containers and analyze the contents.



Discussion/Assessment

What do bees pick up when they are visiting flowers?

What do they do with the nectar?

What do they do with the pollen?

How do the bees help the flowers?

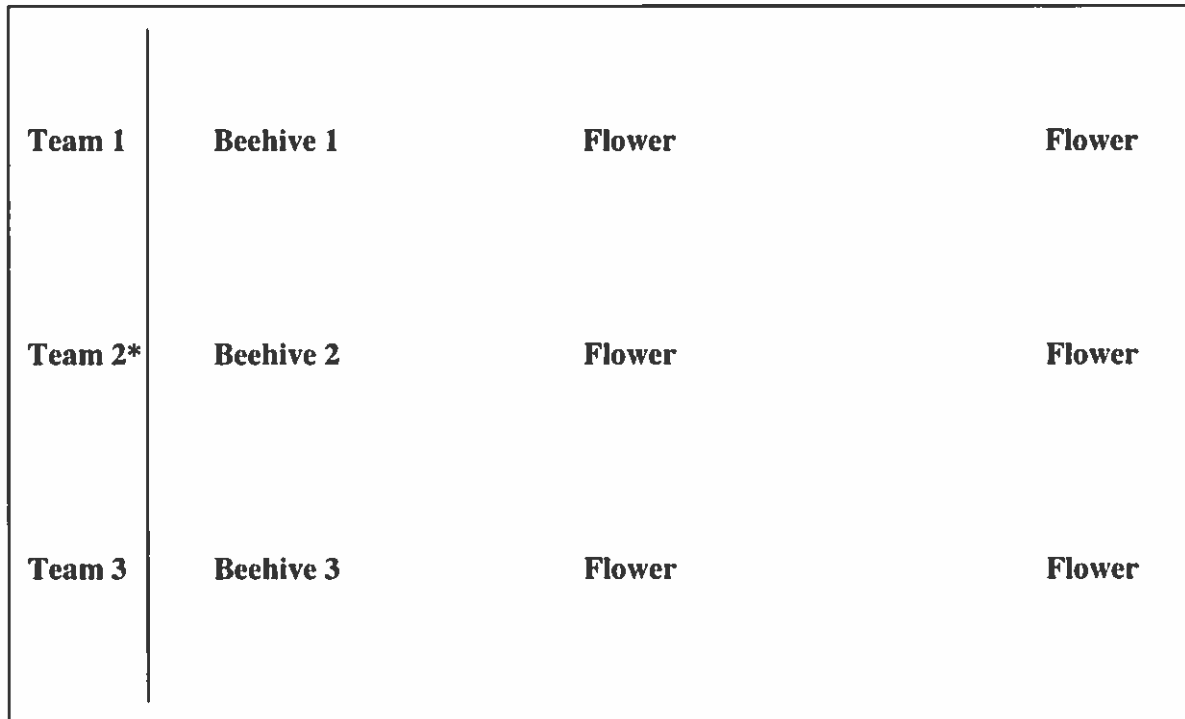
How do the flowers help the bees?

How do bees tell other bees where the flowers are?

Bees, Hardworking PD (Pollination Department) Workers!

A Relay Race

Playing Field Diagram



***Note:** The game can be played with two or more teams of bees (hives).

Nectar

Nectar

Nectar

Nectar

Nectar

Nectar

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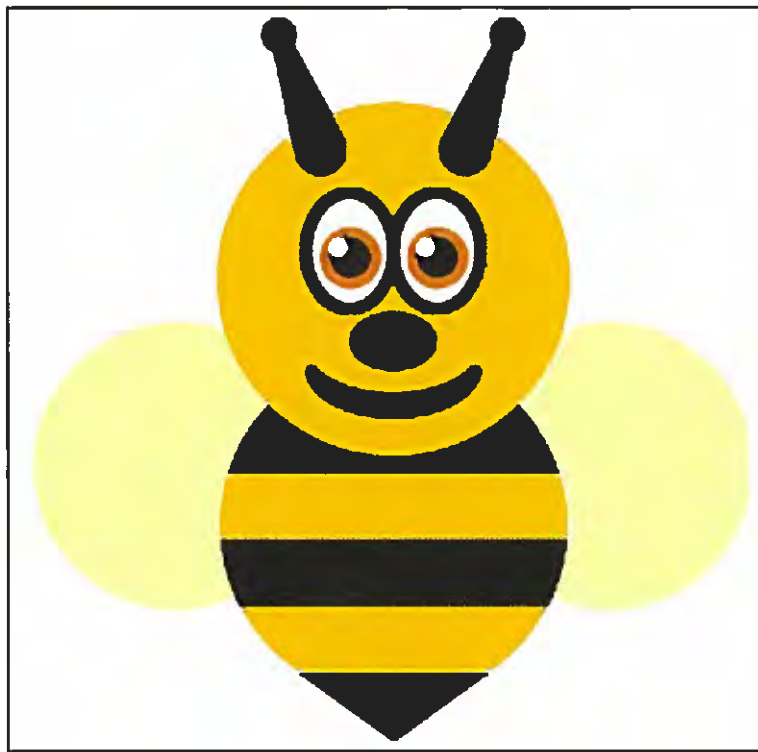
Pollen

Pollen

Pollen

Pollen

Bee image to cut out & attach to stick for Relay Race



Bee hive image to print and attach to box for Pollinator Relay Race

