Honey Bees: A Pollination Simulation

Grade Level(s)	Estimated Time
3 - 5	2 hours

Purpose

Students will identify the parts of a honey bee, the stages of its life cycle, and its role in pollination.

Materials

Activity 1:
- Preserved honey bee, 1 per group
- Hand lenses, 1 per group
- *Honey Bee* PowerPoint
- *Anatomy of a Worker Bee* activity sheets, 1 per student

Activity 2:
- 32 black chenille stems
- 8 containers of 100 mini (5mm) pompoms
- 8 small containers* of water
- 16 medium-sized (1") pompoms*
- 16 jewel bags (1.5" x 2") with yarn tied as a necklace*
- 16 drinking straws*
- Construction paper, 25 pieces

*These items are included in the Pollination Simulation Kit, which is available for purchase from agclassroomstore.com.

Activity 3:
- *Beeswax Modeling Clay Recipe*
  - A Beeswax Modeling Clay Kit is available for purchase from agclassroomstore.com.
- Cardstock or construction paper
- Honeycomb, optional

Essential Files (maps, charts, pictures, or documents)

- Honey Bee PowerPoint
- Beeswax Modeling Clay Recipe
- Anatomy of a Worker Bee KEY
- Anatomy of a Worker Bee Activity Sheet

Vocabulary

beeswax: a substance secreted from glands located on the underside of a worker bee's abdomen
brood: the offspring produced by the colony (eggs and larvae)
cell: a hexagonal wax chamber built from beeswax for brood rearing and storage of honey and pollen
colony: a group living together
hive: a home to a colony of bees
honeycomb: six-sided wax cells in a beehive

metamorphosis: the process of change in the form and habits of an organism during transformation from an immature stage to an adult stage
nectar: a sweet liquid secreted by flowers
pollen: a fine, powder-like material produced by flowering plants
pollination: the transfer of pollen from the anther to the stigma of a plant
propolis: a resin-like material used by bees to construct and seal parts of the beehive
royal jelly: a milky, yellow syrup secreted from a gland in a young worker bee's head; used to feed larvae

Did you know? (Ag Facts)

- Bees pollinate 95 different crops, helping to create nearly one-third of the world's food supply.
- Honey is the only food produced by insects that is eaten by humans on a wide scale.
- A queen bee can lay over one million eggs in her lifetime.
- Worker bees' wings can beat 250 times per second allowing the bee to fly at speeds of up to 15 miles per hour.

Background Agricultural Connections

Honey bees are extremely important to humans. Bees are pollinators. They collect pollen and nectar from flowering trees and plants and transfer pollen from flower to flower. Bees pollinate 95 different crops, helping to create nearly one-third of the world's food supply. Honey bees use the nectar they gather from flowers to make honey, which is the only commercial food produced by insects that is eaten by humans on a wide scale. Honey bees also produce beeswax, which is used to make candles, artists' materials, lubricants, polishes, and cosmetics. Bee venom, pollen, royal jelly, and propolis are other bee-made products used in manufacturing, and for nutritional and medical purposes.

Honey bees live in large groups called colonies. There are three types, or castes, of honey bees—queen, worker, and drone.

The **queen** bee is a female that lays eggs. Each colony has only one queen bee. The queen can live up to four years and can lay over one million eggs in her lifetime. She can lay close to one egg per minute and between 1,000-2,000 eggs a day.
Worker bees are female bees who perform many of the jobs for the colony, including feeding the larvae; cleaning the hive; creating wax and using it to make new cells; grooming and feeding the queen; guarding and protecting the hive; and leaving the hive to collect pollen, nectar, and water. Worker bees live for about six weeks in the summer and longer in the winter months when they are less active.
Drones are male bees responsible only for mating with the queen. They do not work. There are about 100 drones in each colony. They live for about eight weeks in the summer, and are then expelled from the colony and die in the fall.
The size of a honey bee's body depends on its caste and the task it performs. The queen bee is the largest, and the worker bee is the smallest. Honey bees, like all insects, have three main body regions—head, thorax, and abdomen.

The **head** contains two compound eyes, three simple eyes, two antennae, mandibles, and the proboscis. The **compound eyes** are made up of thousands of tiny lenses that allow the bee to see ultraviolet light (invisible to the human eye) and all colors of visible light except red.

The **simple eyes** each have a thick lens that can sense changes in brightness. The honey bee's **antennae** are movable feelers that detect smells and movement. The **proboscis** is a straw-like tongue used to suck nectar or honey. **Mandibles** are jaw-like structures used to knead wax and to chew honey and pollen.

The **thorax** is the honey bee's middle region containing the flight muscles, four wings, and six legs. Honey bees have two **hind wings** and two **forewings** that can beat 250 times per second allowing the bee to fly at speeds of up to 15 miles per hour. They have three pairs of segmented **legs** used for walking, dusting their antennae, brushing pollen off body hairs, and storing pollen. The hind legs of worker bees contain a **pollen basket**—a collection of hairs where pollen is stored for transport.

The **abdomen** is the rear region that contains organs for digestion, reproduction, and respiration as well as the stinger and wax glands. The **stinger** is only found in female honey bees. A worker bee's barbed stinger is used for defense. When stinging, the barb anchors the stinger in the victim while the stinger's pouch pumps venom. After stinging, the bee dies of an abdominal rupture. When stinging insects, the bee's stinger remains attached while the barb tears through the target's exoskeleton. The **honey sac** is a stomach-like organ connected to the digestive tract. The sac stores the nectar until the bee returns to the hive. **Wax glands** are located on the underside of the bee's abdomen. These glands form and excrete wax.

Honey bees have four distinct life stages—egg, larva, pupa, and adult. Complete metamorphosis takes between 16 and 24 days.

The queen lays each **egg** into a different cell of the honeycomb. It is her job to determine whether the egg will grow into a male or female bee. Fertilized eggs will become female workers, and unfertilized eggs will become male drones. After three days, the egg hatches and a worm-like creature, called **larva**, is unveiled. Worker bees feed the larva royal jelly—a milky, yellow syrup secreted from a gland in the worker bee's head. As it grows, the larva sheds its skin four to five times. On about day nine, the larva spins itself a cocoon. A worker bee seals the cocoon into the cell with wax.

Inside the cocoon, the larva transforms into a **pupa**—developing eyes, legs, and wings. When the bee is fully grown, it chews its way out of the cell and emerges as an **adult**. It takes 16 days for a queen bee to develop from an egg to an adult; worker bees take 18-22 days, and drones need 24 days.

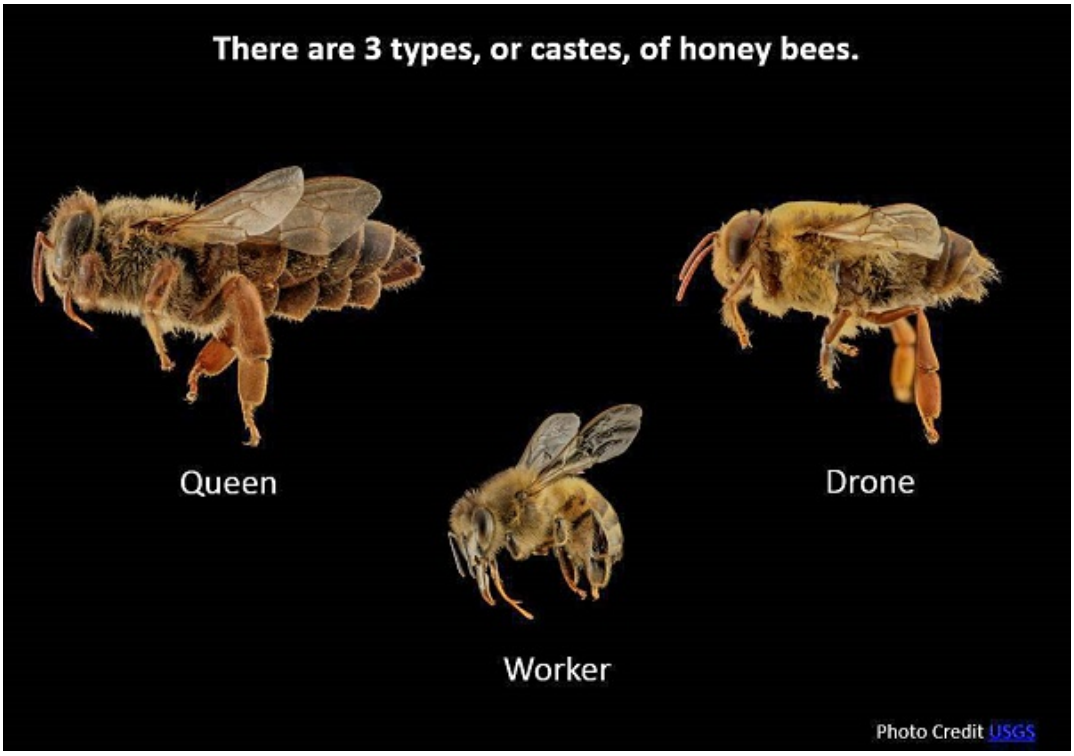
Interest Approach – Engagement

Ask students, "Why are honey bees important to humans?"

Procedures

Activity 1: Bee Anatomy

1. Create groups of 4-5 students. Provide each group with hand lenses and preserved honey bees. Ask the students to examine the bees and, as a group, make a chart listing the details they observed. Provide time for each group to present their observations to the class.

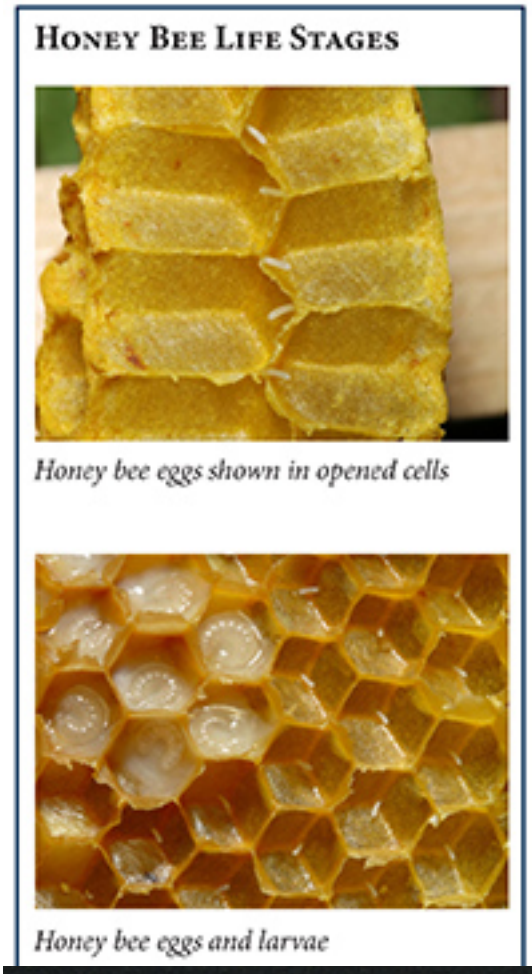


2. Explain to the students that honey bees have three main body regions— the head, thorax, and abdomen. Use the *"Honey Bee" PowerPoint* to discuss the main parts of a worker bee.
3. Ask students to label the parts of a worker bee on the "Anatomy of a Worker Bee" activity sheet.

Activity 2: Pollination Simulation

1. Using the background information as a guide, discuss the roles of each of the three castes of honey bees—the queen, workers, and drones.
   Simulate the role worker bees play in pollination by conducting a pollination simulation. Choose 8 students to represent flowers, 16 students to represent worker bees, and 1 student to represent the queen bee. Numbers of flowers and worker bees may vary according to class sizes. Extra students can represent the worker bees and drones that remain in the hive.
2. Have students create construction paper headbands to differentiate flowers, worker bees, and the queen bee. Draw and cut out flowers to glue onto the flower headbands. Create antennae using chenille stems to staple onto the worker bee headbands. Cut out a crown-shaped headband for the queen bee.
3. Choose a large area, preferably outdoors, to serve as the "garden" and a smaller area to the side of the garden to serve as the "beehive."
4. Each flower will hold one container of mini pompoms to represent pollen and one container of water to represent nectar. The flowers will choose a location inside the garden in which to stand.
5. Each worker bee will carry one medium-sized pompom to represent the bee's hairy body, one jewel bag tied with yarn and worn as a necklace to represent the honey sac, and one straw to represent the proboscis.
6. The worker bees will begin at the beehive with the queen, drones, and other workers whose duties require them to work inside the hive. When the queen bee gives the command, the worker bees will leave the hive in search of nectar from flowers.
7. When a worker finds a flower, they will land their medium-sized pompom into the container of mini pompoms. The worker will then simulate gathering nectar with their proboscis by filling a straw with water using their finger to create a vacuum. The water will be deposited into the jewel bag. When the worker removes the medium-sized pompom from the container, the tiny pompoms will stick to the larger pompom much the same way pollen sticks to the hairs of a bee when it visits a flower.
8. After collecting nectar and pollen from the flower, the worker will find a new flower to visit. Here, the worker will brush off some of the pollen collected from the previous flower into the new flower's container. They will then collect more nectar and pollen before visiting another flower.
9. Once the worker bee has filled their honey sac with nectar, they will return to the hive.
10. For the purpose of this simulation, the worker bee must collect nectar and pollen from each flower before visiting a flower for a second time, and only two bees may visit the same flower at once.
11. Trade roles and repeat the simulation as many times as desired.

Activity 3: Beeswax Life Cycle Models



Honey bee eggs shown in opened cells

Honey bee eggs and larvae

1. Ask the students if humans use any items made by honey bees.
2. Talk about how honey bees make beeswax. Explain that beeswax is secreted from the wax glands of worker bees to create and cap cells inside the hive. Beeswax is used in the production of candles, cosmetics, artists' materials, electronics, lubricants, polishes, inks, and paints. Bees require the protein from pollen and the carbohydrates from honey to create beeswax. It takes 6-10 pounds of honey to make one pound of wax, which is enough to construct 35,000 cells within a hive. A beekeeper will harvest two pounds of wax cappings for every 100 pounds of honey.
3. If possible, obtain honeycomb so students can observe the wax cells and cappings. Honey in the comb can be obtained from beekeepers, specialty stores, online stores, and farmers markets.
4. Use the "Honey Bee" PowerPoint to discuss the life cycle of a honey bee.
5. Make beeswax modeling clay (recipe found in essential files). Instruct students to use the clay to create a honey bee life cycle model by creating an egg, larva, pupa, and adult honeybee. Refer to the "Honey Bee" PowerPoint for photographs of each life stage. Students can work in groups or individually to create their life cycle model.

6. A cell for each life stage can be created out of paper folded into the shape of a hexagon.

Concept Elaboration and Evaluation

After conducting these activities, review and summarize the following key concepts:

- Bees are important to pollinate crops that produce our food. If the plant is not pollinated it will not produce food.
- A colony of bees is very organized with specific workers for individual jobs.
- In addition to pollination, honey bees also make honey.

Enriching Activities

- Use the following videos to further explore the world of honey bees:
  - In *Flight of the Honey Bee* (2:15) a commercial beekeeper illustrates how honey bees play an essential role in the crop production process. Give your students a close-up look at a honey bee covered in pollen and hives traveling across the country to pollinate different crops.

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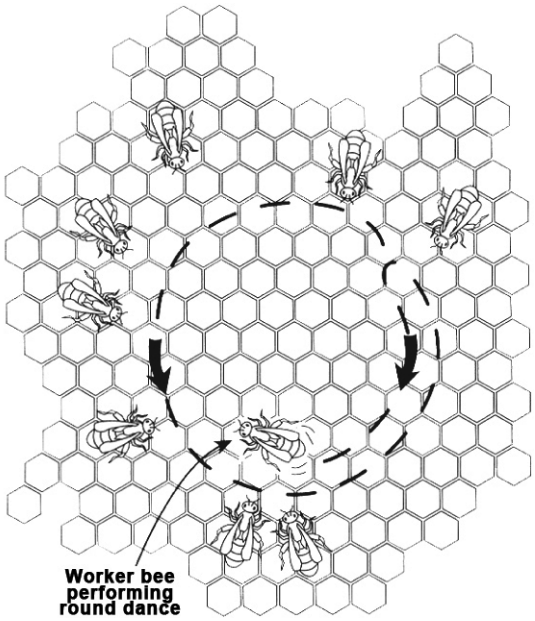
- **Science:**
  - **Third Grade:**
    - Standard 3.L.5: The student will demonstrate an understanding of how the characteristics and changes in environments and habitats affect the diversity of organisms.
  - **Fourth Grade:**
    - Standard 4.L.5: The student will demonstrate an understanding of how the structural characteristics and traits of plants and animals allow them to survive, grow, and reproduce.
- **English Language Arts:**
  - **3-5:**
    - RI-LCS Standard 8: Interpret and analyze the author's use of words, phrases, text features, conventions, and structures, and how their relationships shape meaning and tone in print and multimedia texts.
    - C-MC Standard 1: Interact with others to explore ideas and concepts, communicate meaning, and develop logical interpretations through collaborative conversations; build upon the ideas of others to clearly express one's own views while respecting diverse perspectives

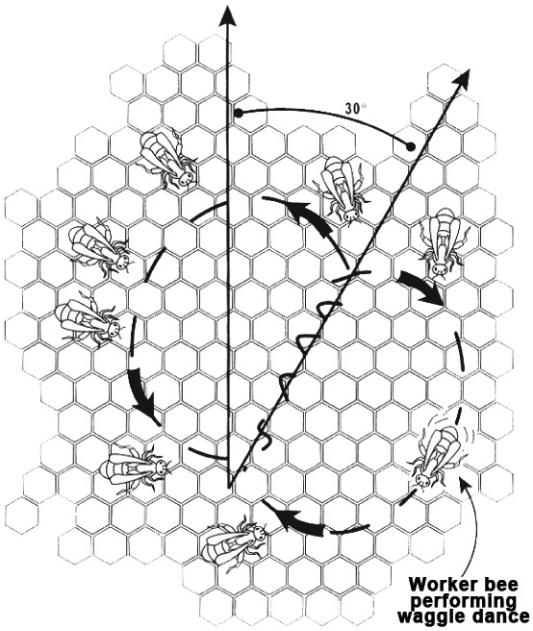
Honey, I'd Love to Dance!

Honey bees communicate with each other by dancing. There are several bee dances, but the most common are the round dance and the waggle dance.



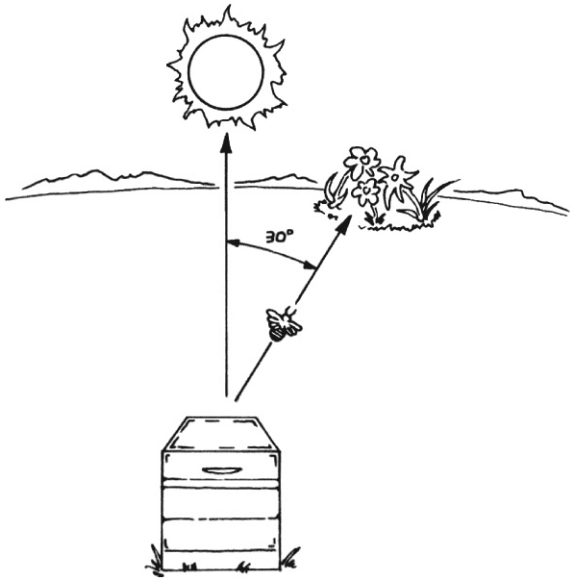
Round Dance

When food is close to the hive (less than 100 yards), a worker bee performs the round dance. She goes round and round, first one way and then the other. The round dance does not show the exact location of the flowers, so fellow worker bees must fly out in many directions looking for them.



Waggle Dance

If the flowers are more than 100 yards away from the hive, the returning bee performs the waggle dance. The bee dances a half circle in one direction, turns, and runs straight while wagging her abdomen. Then she dances a half circle in the other direction. These two half circles form a figure eight.



If the food is in the same direction as the sun, the central run of the dance is straight up the comb. If the food is to the left or the right of the sun, the bee alters the direction of the dance by the correct amount to the left or right of the central line.

The distance between the hive and the food is communicated by the speed of the dance and the buzzing sound made by the dancing bee. The faster the worker dances, the closer the food. The waggle dance shows both location and distance of the flowers, so the bees know where to fly.