



THE HONEY FILES:

A Bee's Life

A Teaching Guide
Grade Levels 4-6





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Honey Bees - Biology



Educator's Overview: Insects and Honey Bee Biology

More than 25,000 species of bees have been identified around the world. In the continental United States, scientists believe there are approximately 3,500 species of bees. Bees known as honey bees are represented by eight to ten species in the genus *Apis*, a name from which comes the word for beekeeping (apiculture) and the word for a bee yard (apiary). The species of honey bee commonly found today in the Americas is *Apis mellifera*, which means honey carrier. This name is not technically correct as the bees carry nectar from flowers, which they then use to produce honey back in the hive. Races of *Apis mellifera* have different physical and behavioral characteristics such as body color, wing length, and susceptibility to disease.

As insects, honey bees pass through four distinct life stages: the egg, larva, pupa and adult. Complete metamorphosis takes between 16 and 24 days depending on the sex of the developing bee. A queen bee lays an egg in an individual wax cell. The egg hatches into a white legless larva on the fourth day. The larva feeds on royal jelly and beebread (a mixture of nectar and pollen) until it reaches mature size and then spins a cocoon around itself. The cell is capped with wax and the larva transforms into the pupa. The pupa develops into a mature adult bee inside the capped cell. When fully developed, the mature bee chews its way out of the cell. Adult worker bees live approximately 45 days during the summer months.

There are three types of adult bees that make up a honey bee colony. The great majority (about 99 percent) of adult honey bees are sterile female worker bees. Worker bees develop from fertilized eggs. Worker bee larvae are fed royal jelly for only three days. Then they are fed beebread (a mixture of nectar and pollen) for the remaining larval stage. Passing through the immature stages (complete metamorphosis) takes 21 days for worker bees.

The male members of the colony are called drones. Drones (male bees) develop from unfertilized eggs that are laid in larger cells. Drones are also fed royal jelly for three days and are then fed beebread. Drones remain in the pupal stage for 15 days and emerge as adults on day 24. Drones have wider bodies than worker bees, rounded abdomens, and no stingers.

Queen bees develop from fertilized eggs in the largest cells in the hive. Larva destined to become a queen bee is fed royal jelly for the entire larval stage. Queen bees develop in only 16 days.

Note — A honey bee hatching as well as various types of honey bees are shown in "The Honey Files: A Bee's Life" videotape.



Honey Bees - Biology.....

Glossary of Honey Bee Anatomical Characteristics

Abdomen — the rear body region of a honey bee composed of nine segments and contains many organs including those for digestion, reproduction and respiration.

Antenna(e) — the moveable, sensitive feelers on an insect's head which detect odor and movement.

Cocoon — the silk chamber a larva spins around itself just prior to the pupal stage of development.

Compound eye — an eye made up of thousands of tiny lenses that allow a honey bee to see ultraviolet light, which is invisible to the human eye, as well as visible light (except red).

Exoskeleton — the hard outer covering which forms a bee's body.

Head — the forward body region of the honey bee's three sections that contains the compound eyes, simple eyes, antennae, mandibles, and proboscis.

Honey sac — the stomach-like organ that is connected by a funnel shaped valve to the digestive tract. The nectar stored here will be unloaded into empty hive cells or passed on to house bees for food.

Legs — a honey bee has three pairs of segmented legs used not only for walking but also to dust off antennae, brush pollen out of the thousands of branched hairs that cover the body, and to store pollen.

Mandible — located on either side of the honey bee's head, these jaw-like structures are used to chew honey and pollen, and to knead wax.

Midgut or ventriculus — the stomach section in the abdomen which digests food.

Ocellus — simple eye with a thick lens that can sense changes in the brightness of daylight.

Proboscis or tongue — a straw-like structure used for sucking nectar or honey.

Pollen basket — a smooth, somewhat concave surface of the outer hind leg that is fringed with long, curved hairs that hold the pollen in place.

Stinger — found in a chamber at the end of the abdomen (in female honey bees only) and is used to defend against intruders.

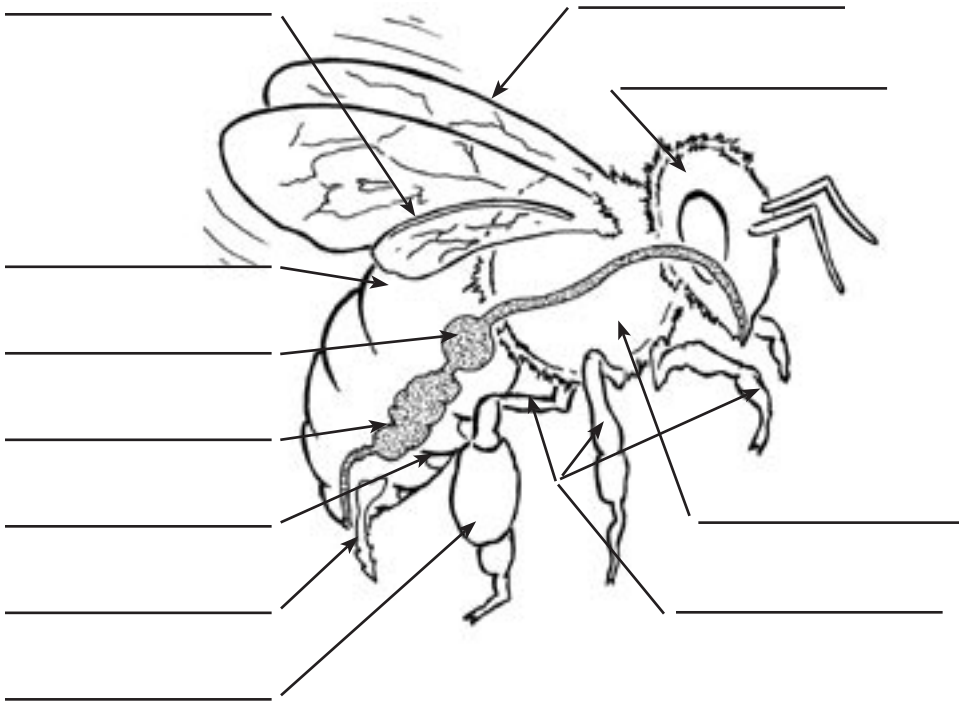
Thorax — the middle section of the honey bee's three sections that contains the flight muscles, the wings and six legs.

Wax gland(s) — four pairs of glands that are specialized parts of the body wall. During the wax forming period in the life of a worker, they become greatly thickened and take on a glandular structure. The wax is discharged as a liquid and hardens to small flakes or scales.

Wing(s) — the honey bee has two sets of flat, thin, membranous wings, strengthened by various veins. The fore wings are larger than the hind wings.

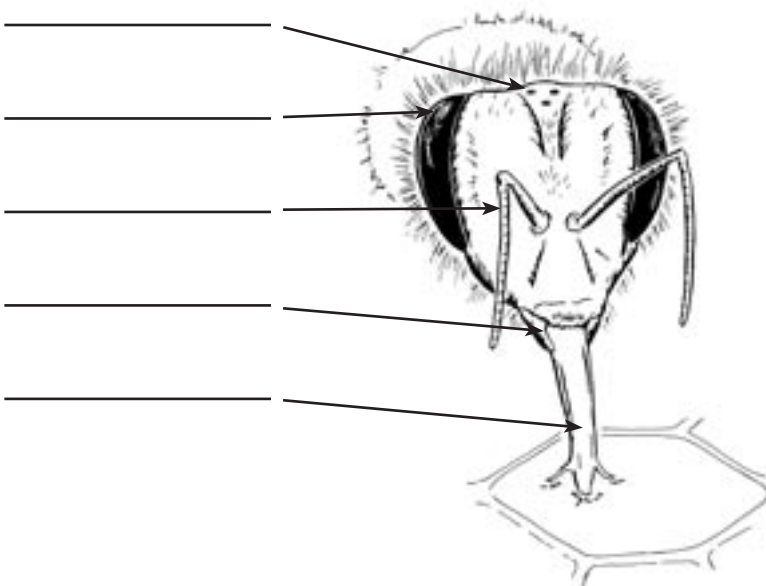
Honey Bees - Biology

Worksheet #1: The Honey Bee Body



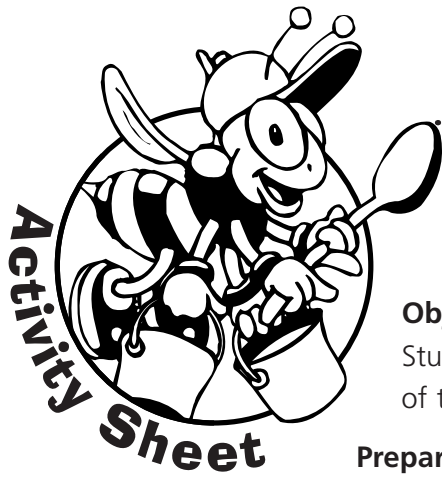
Label the following:

- Abdomen
- Fore wing
- Head
- Hind wing
- Honey sac
- Legs
- Midgut or ventriculus
- Pollen basket
- Stinger
- Thorax
- Wax gland



Label the following:

- Antenna
- Compound eye
- Mandible
- Ocellus
- Proboscis or tongue



Honey Bees - Biology.....

Activity #1: Honey Bee By Design

Objective:

Students will be able to characterize and summarize the functions of the primary anatomical characteristics of a honey bee.

Preparation:

Students complete Worksheet #1.

Assemble art materials.

Gather supplemental books and materials (see Bibliography).

Materials:

Art materials such as egg cartons, clay, pipe cleaners, paper mâché, balloons, styrofoam balls, toothpicks and construction paper

Essential Skills:

Science, Social Studies

Discussion:

Review basic bee body parts from Worksheet #1. Discuss the importance of various body parts of worker bees and how these function for hive survival. Ask hypothetical questions about the life of the hive without certain body functions. For example, what if worker bees couldn't produce wax?

Procedure:

- Have students construct worker bee models using various classroom/household materials and art supplies.
- Make sure they include the basics: head, thorax, abdomen, wings, legs, antennae.
- Instruct them to add as many body features as possible and to be able to explain their functions.

Estimated Time:

1-2 class periods

Honey Bees - Biology



Glossary of Honey Bee Life Stages

Adult — a fully formed, mature honey bee.

Beebread — a mixture of nectar and pollen.

Bee metamorphosis — the four stages of transformation in the life of a honey bee.

Brood — the offspring produced by the colony (eggs and larvae).

Cell — a hexagonal chamber built of beeswax for brood rearing and storage of honey and pollen.

Drone — a male honey bee that is produced from an unfertilized egg.

Drone cell — a brood cell that is larger than the normal worker brood cells and in which the queen deposits drone eggs.

Egg — laid by a queen bee, this is the first stage in the life of a honey bee.

Larva — hatched from the egg the queen bee lays, the larva will pupate and eventually turn into an adult insect.

Nectar — a sweet liquid secreted by flowers of various plants.

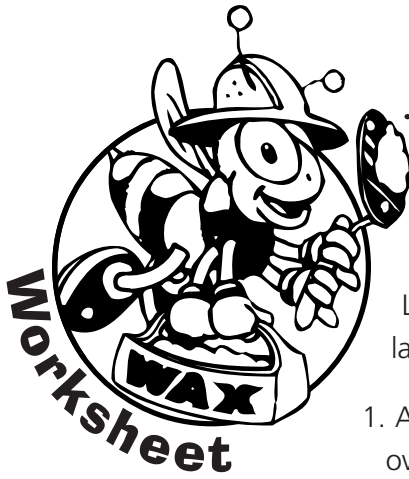
Pollen — the fine, powder-like material produced by the anthers of flowering plants.

Pupa — the third stage in a bee's life, during which the larva's body changes into that of an adult.

Queen — a female bee that lays eggs.

Royal jelly — a milky, yellow syrup that is very high in protein, that young worker bees secrete from glands inside their heads and feed to larvae.

Workers — female bees who build and guard the hive, look after the queen and gather food.



Honey Bees - Biology

Worksheet #2: Honey Bee Life Stages

Like many insects, honey bees go through four stages of development: egg, larva, pupa, and adult. The bee changes dramatically in each stage.

1. A queen bee inserts her abdomen into an empty cell and lays a soft, white, oval egg about the size of a dot over an "i."
2. After three days, a wormlike larva hatches from the egg. The larva is fed by worker bees and grows much larger.
3. On day ten, the larva stops eating and spins a silk covering called a cocoon around itself. An adult worker bee caps the cell with wax to protect the developing pupa. Inside the cocoon, a pupa develops and begins to look more like an insect than a worm. It grows eyes, legs, and wings.
4. Finally, an adult bee chews its way out of the cell.

1. Queen laying eggs.



2. Larva in cell.



3. Pupa in cell.



4. Adult chews out of cell.



Eggs develop into different types of bees based on what they're fed, on the size of the cell they develop inside, and whether or not the egg was fertilized.

Although all bees develop in the same four stages, the time it takes each type of bee to grow is different:

BEE	EGG	LARVA	PUPA	ADULT
Queen	Days 1-3	Days 4-9	Days 10-15	Day 16
Worker	Days 1-3	Days 4-9	Days 10-20	Day 21
Drone	Days 1-3	Days 4-9	Days 10-23	Day 24

Honey Bees - Biology

Worksheet #2 continued

Queen bees develop from fertilized eggs in the largest cells in the hive. Larva destined to become a queen bee is fed royal jelly for the entire larval stage.

Worker bees develop from fertilized eggs. Worker bee larvae are fed royal jelly for only three days. Then they are fed beebread (a mixture of nectar and pollen) for the remaining larval stage.

Drones (male bees) develop from unfertilized eggs that are laid in larger cells. Drones are also fed royal jelly for three days and are then fed beebread.

Answer the following questions with the appropriate answer:

A. Egg B. Larva C. Pupa D. Adult

- ___ Stage at which eyes, legs, and wings grow
- ___ Is fed by worker bees
- ___ Shows the greatest change in size
- ___ Is about the size of the dot on an "i"
- ___ Chews its way out of the cell
- ___ A soft, white oval deposited by a queen bee

True or False

- ___ A drone is fed only royal jelly during the entire larval stage
- ___ Queens develop in the largest brood cells
- ___ A drone takes the longest to develop into a mature adult
- ___ It takes weeks for a honey bee egg to hatch into larva
- ___ Inside a cocoon, the pupa begins to look more like an insect than a worm
- ___ A honey bee egg is about the size of your thumbnail
- ___ Only a drone develops from an unfertilized egg
- ___ All honey bees fully develop in two weeks

What determines whether a honey bee will be a worker or a queen? _____

What type of eggs will become drones (male bees)? _____

What is fed to developing larvae? _____

How does a fully developed honey bee make its way out of the brood cell? _____

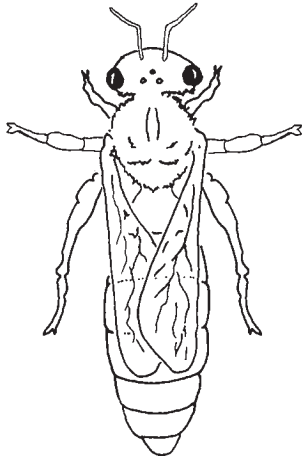


Honey Bees - Biology.....

Worksheet #3: Queen Bees, Worker Bees, and Drones, Oh My!

Honey bees are social insects and live in groups called colonies. Within each colony are three types or castes of honey bee: a queen, worker bees and drones. Members of each caste have a slightly different body depending on the tasks performed. The three types, or castes, of the honey bee are shown here.

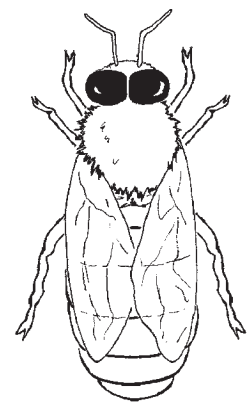
Queen



Worker



Drone



The queen bee is the largest of the honey bees. She has a longer abdomen, a shiny thorax, and does not have pollen baskets on her legs. The queen has a stinger, which she uses to fight off other queens. She may sting multiple times without dying.

Worker bees are the smallest of honey bees. They have long proboscises used to suck up nectar from flowers. Worker bees' hind legs are fringed with stiff hairs that form pollen baskets. Workers have a stinger and a poison gland at the tip of their abdomen. Typically, worker bees can only sting once because their stingers and internal organs are pulled out when they sting and they die.

Drones, the male members of the colony, are somewhat larger than the workers. They have rounded abdomens, huge compound eyes, and powerful wings. Drones do not have long proboscises and must be fed by worker bees. They also do not have stingers and therefore cannot defend themselves. Drones do not have wax secreting glands. The drones only purpose is to mate with the queen. Mating takes place in the air.

Honey Bees - Biology

Worksheet #3 continued

Name three distinct features of each caste of honey bee.

Queen

Worker

Drone

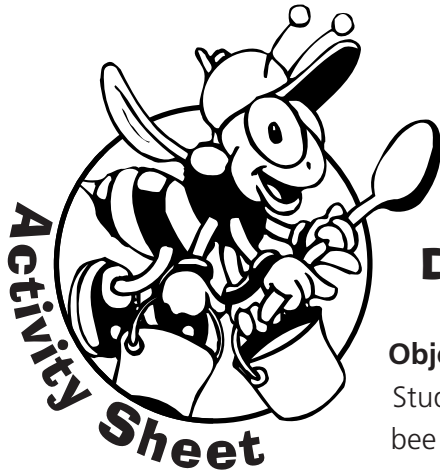
Why can't drones gather their own food? _____

Why can't drones defend the colony? _____

Why can worker bees usually only sting once? _____

What would happen to a honey bee colony if there were no queen? _____

What would happen to a honey bee colony if there were no drones? _____



Honey Bees - Biology.....

Activity #2: Diary of a Honey Bee's Metamorphosis

Objective:

Students will understand the physical characteristics and timeline of honey bee metamorphosis.

Preparation:

Students complete Worksheet #2, "Honey Bee Life Stages."

Materials:

"Honey Bee Biology Glossary," completed Worksheet #2

Essential Skills:

Science, Language Arts

Discussion:

Review the complete metamorphosis of honey bees from Worksheet #2. Remind the students of the developmental differences of queens, drones and workers. Discuss why the different members of the colony take longer to develop or require different foods. Also discuss the specific roles of the different members of the colony.

Procedure:

- Have the students develop a chart that shows the day-to-day progression from egg to adult for workers, drones and queens.
- Have each student choose which caste he/she will be role-playing in journal form.
- Have students write a detailed, day-by-day journal of what it might be like to be a developing honey bee.

Students should write these journals as if they are bees with intellect and emotion.

Honey Bees - Biology



Insect Identification Tips

All animals are classified according to how they look, how they behave, and how their bodies work in comparison with the bodies of other organisms. Honey bees are insects. All insects have six legs and three body sections. Insects usually have antennae and wings as well. Honey bees are often mistaken for other types of flying, stinging insects.

Honey bees are hairy insects that are brownish-orange and black. They have pollen baskets on their legs to carry pollen. They are social insects that feed on pollen and nectar. Honey bees are generally not aggressive and will only sting if feeling threatened.

Bumblebees are big, hairy, yellow and black, square-shaped bees. They live in nests in the ground and generally live in colonies of only a few hundred. The nest is a ball of dry grass and moss with a cushion of pollen in the middle. The queen makes a very small honey pot and fills it with nectar for use in bad weather. Bumblebee colonies last for just a few months, and all the bees except the new queen die at the end of the summer. All female bumblebees can sting more than once but are relatively unaggressive. Bumblebees do not use dances to “communicate” with others.

Carpenter bees are large and resemble bumblebees. Females are totally black and have shiny upper abdomens. Males are blonde or tan-colored and lack stingers. Carpenter bees have powerful jaw muscles and strong mandibles that they use to bore tunnels into dead trees or wooden buildings where they live. They are solitary insects and are unlikely to sting unless handled.

Leafcutter bees live alone, not in groups, and therefore are known as solitary bees. They cut off pieces of leaf and roll them up to make their cells. Leafcutters make their nests in hollow twigs or in other openings about the diameter of a pencil.

Honey Bees - Biology

Insect Identification Tips continued

Sweat bees are solitary bees and are metallic blue or green. They often nest in the soil where the females lay their eggs on pollen balls. Sweat bees are known for licking sweat from people and animals.

Paper wasps are brightly colored black and yellow and are smooth and somewhat shiny. They have two sets of dusky-colored wings, narrow cylindrical legs and no pollen baskets. Paper wasps build their nests out of paper made from plant fiber or wood and like to put them in a hollow tree, in the ground or under the eaves of a house. They are predators and eat insects and spiders. Female paper wasps are aggressive and can sting repeatedly.

Yellowjackets are a type of short, stocky wasp. They have a cross-banded black and yellow abdomen. The head and thorax are black with yellow spots. Their broad abdomen tapers off to a sharp point where the stinger is concealed. Female yellowjackets can sting repeatedly and are quick to attack when disturbed. They nest in weedy brush areas on the ground or underground in an old animal burrow or crevice.

Notes:

Honey Bees - Biology



Worksheet #4: A Bee or Not a Bee — Comparing Honey Bees With Similar Insects

Using the “Insect Identification Tips” page, answer the following questions.

What are two common characteristics of all insects?

What other flying insects are black and yellow and therefore often mistaken for honey bees?

Give two examples of solitary bees.

What insects are likely to make their home in the ground?

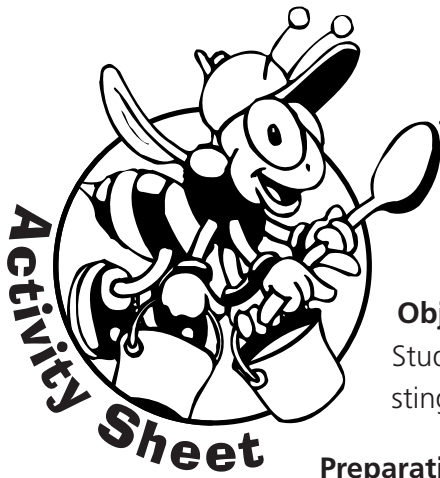
What flying insects tend to be aggressive?

True or False

- Bumblebees are usually not aggressive.
- Bumblebees use dances to communicate with each other.
- Carpenter bees largely resemble bumblebees.
- Leafcutter bees make their homes in large, hollow logs.
- Sweat bees are called such because they perspire.
- Sweat bees look a lot like honey bees.
- Paper wasps have pollen baskets in their legs.
- Paper wasps build their homes from plant fiber or wood.
- Yellowjackets are a type of wasp.
- Wasps and yellowjackets eat only nectar.

On your own:

Why are all bees of primary importance to us? How many kinds of bees live in the United States?
How are solitary bees different from social bees?



Honey Bees - Biology.....

Activity #3: Bee Stings

Objective:

Students will learn why bees sting and why a honey bee dies when it stings a mammal.

Preparation:

Collect information on bee stings: books, posters, medical reports, etc.
Copy artwork of "Honey Bee Stinging Apparatus" for students
Gather materials

Materials:

Straight pins, barbed fish hooks, oranges and copies of "Honey Bee Stinging Apparatus"

Note:

Make certain to account for each and every pin and fishhook so that they don't end up in the bottom of someone's foot!

Essential Skills: Science, Social Studies

Discussion:

Have students think about the many different ways animals defend themselves. Students should give examples of animals that use defense strategies. Ask students if they have ever been stung by a bee and what they were doing when they were stung. Discuss ways to avoid being stung by bees. Explain to students that the honey bee's stinger has a flexible and barbed design. If a honey bee defends herself against less threatening insects, she may survive. However, when a honey bee stings a person or other animal, the honey bee will die. That's because the stinger has barbs that prevent the bee from pulling it out of the person or animal it has stung. When she flies away, she will die because leaving the stinger behind damages her internal organs.

Procedure:

- Distribute and review "Honey Bee Stinging Apparatus."
- Have students research written materials to label and define the parts of a honey bee stinger.
- Distribute straight pins, barbed fishhooks, and oranges. Explain that the oranges represent mammal flesh and that the fishhook is barbed like the stinger of a honey bee.
- Have students stick the straight pin into the peel of the orange and then pull it back out. Was there any resistance? Next, have them do the same thing with the fishhook. Was there more resistance?
- Explain the importance of the stinger remaining in the victim and how this costly sacrifice activates an alarm system that calls other bees into battle. (See Worksheet #5.)

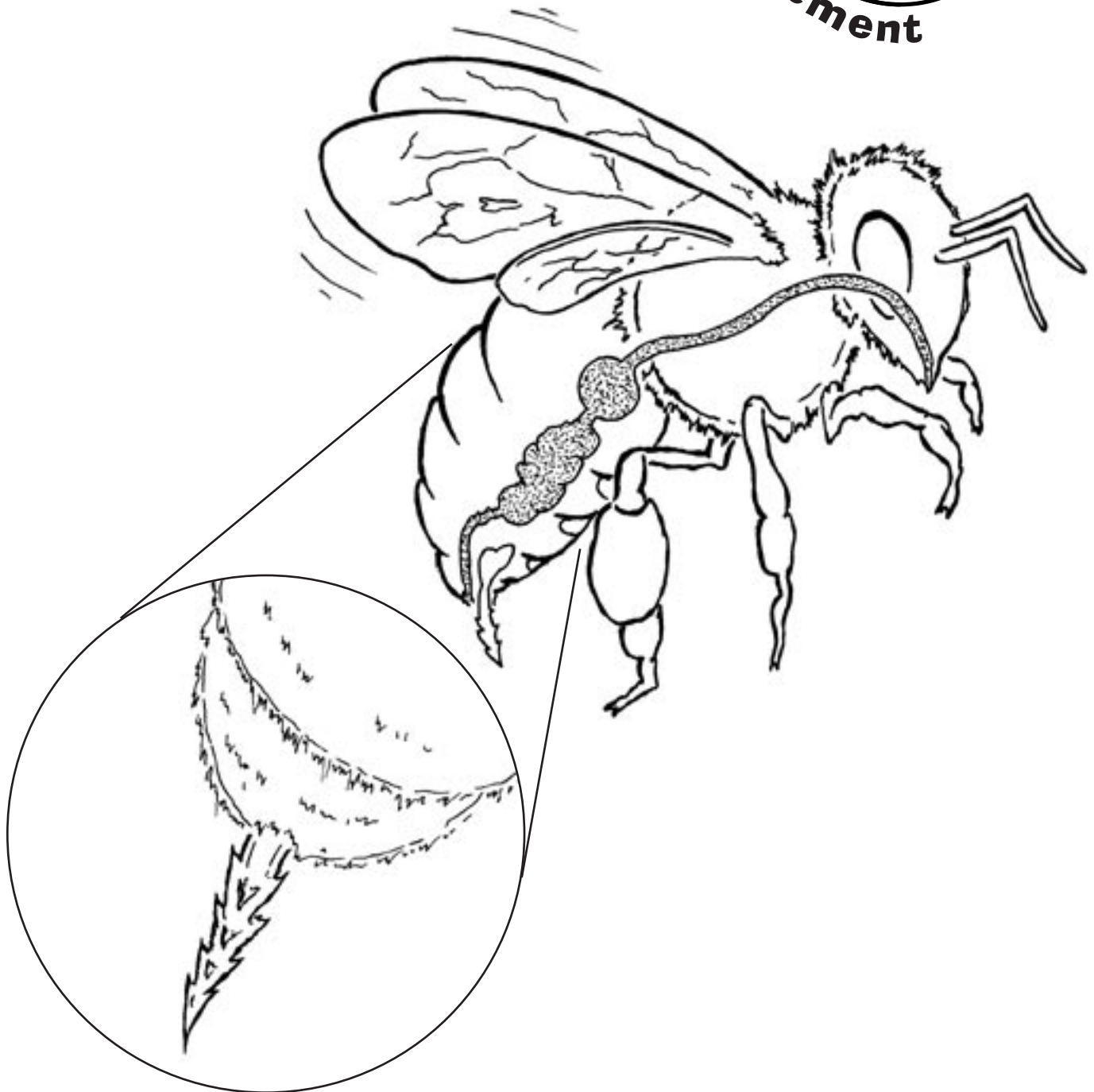
Estimated Time:

1 class period

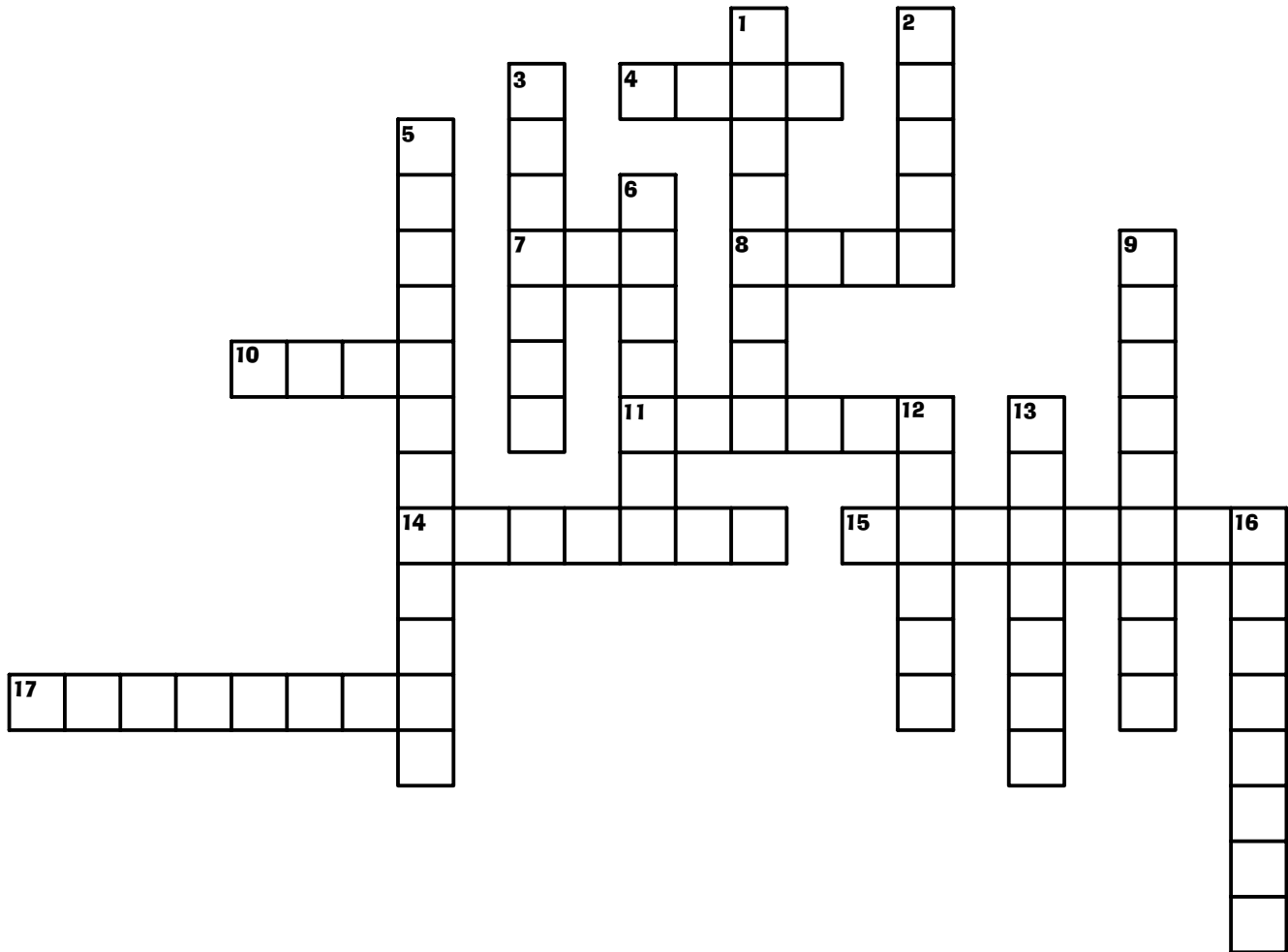
Honey Bees - Biology



Honey Bee Stinging Apparatus



Honey Bees - Crossword Puzzle



Across

4. Honey bee body section where antennae and proboscis are found
7. Abbreviation for National Honey Board
8. Used for walking and for cleaning pollen off body
10. Opposite of different
11. Honey bee stomach used to digest food
14. Used for touch and smell
15. Stomach section used to hold nectar that will be fed to larvae
17. Jaw

Down

1. Secretes substance used for building cells of honey comb
2. Two pairs used in honey bee flight and in fanning hive
3. Honey bee defense mechanism
5. Container-like area on back legs of honey bee
6. Honey bee body section containing the honey sac
9. Straw-like appendage used for sucking nectar
12. Center insect body section where legs and wings attach
13. Simple eye
16. Multi-faceted eye

Honey Bees - Society.....

Educator's Overview: Honey Bee Society

Honey bees live in colonies and are social insects. Within each colony there are worker bees, drones, and a queen. Most of the adult honey bees in any colony are female worker bees that tend the young, gather and store nectar and pollen, make honey, royal jelly and beebread, produce wax, and care for the queen and drones. The male members of the colony, the drones, make up only a small percentage of the hive population and exist only to mate with the queen. The queen's primary duty is to lay eggs...up to 3,000 a day! The queen also produces pheromones that tell the bees that she is on the job. Her pheromone inhibits the development of other queens — hence, only one queen. She is fed and cared for by worker bees and only leaves the hive to mate. She maintains the sperm she collected during mating in a special pouch in her body, and can continue laying eggs for up to two years.





Honey Bees - Society.....

Glossary of Honey Bee Society

Bee dances — a way honey bees communicate to find nectar sources.

Beebread — a mixture of nectar and pollen.

Beeswax — substance secreted from glands located on the underside of the worker's body between the abdominal segments.

Brood — the offspring produced by the colony.

Colony — a group of honey bees living together.

Dehydration — the removal of water from a substance.

Guard bees — the bees that guard the hive entrance.

Hive — a bee's home.

Hive scent — all the worker bees of a colony produce a scent that is characteristic of their colony and is recognized by all the members.

Honeycomb — the six-sided wax cells in a beehive.

House bee — a young worker bee up to 20 days old that works only in the hive.

Mate — to join together as male and female to produce young.

Nectar — a sweet liquid secreted by glands in the flowers of plants.

Nurse bees — the young house bees whose task it is to feed the larvae.

Pheromone — a chemical substance produced by bees that influences the colony's behavior.

Pollen — the yellow or green powdery substance produced by flowers.

Pollen basket — an area on the hind legs of honey bees used to transport pollen.

Propolis — a resin-like material collected from trees by bees and used to construct and seal parts in the beehive and protect the hive from the elements.

Royal jelly — a milky, yellow syrup that is very high in protein, that young worker bees secrete from glands inside their heads and feed to larvae.

Scent gland — found at the tip of the abdomen of worker bees and produces a scent characteristic of that particular colony.

Worker — the female bee that performs all the jobs, both inside and outside the hive, necessary for the survival of the colony.

Honey Bees - Society



Worksheet #5: Honey Bee Duties

Honey bees are social insects that live in the same dwelling and rely on each other for the survival of the hive. In the hive, each bee has a responsibility. The drones mate with the queen. The queen lays eggs. The worker bees do just about everything else.

For the first three weeks of her adult life, a worker bee performs chores inside the hive. Known as house bees to beekeepers, these young adults clean the hive, feed larvae, build wax cells, and make honey. Each bee, guided by an inner clock, does certain chores as she reaches a certain age.

For the second half of the worker bee's life, she works outside. If the air is hot, her first task is to ventilate the hive by fanning her wings just outside the nest. (A honey bee's wings flap over 183 times per second!) The worker's next job is to stand guard outside the hive. Bees can recognize their hive mates by scent and will attack unfamiliar bees and other insects. When a worker bee defends her colony against and stings an enemy, she gives off an alarm pheromone from a gland near her stinger to alert other bees. The last role of the worker bee is that of forager, flying through fields, gardens, and orchards gathering food and supplies. The field worker bee makes about ten trips a day, each one lasting about an hour. She leaves the hive at sunrise and returns from her last flight at sunset. During these travels, the worker gathers not only nectar and pollen, but also water and propolis (bee glue).

Questions:

Which bee is responsible for laying all the eggs? _____

What is the sole job of a drone? _____

List four duties of a house bee.

1. _____
2. _____
3. _____
4. _____

How does a worker bee know when to perform each of her many duties? _____

When does a worker first leave the hive? _____

Honey Bees - Society

Worksheet #5 continued

List three things field worker bees gather.

1. _____

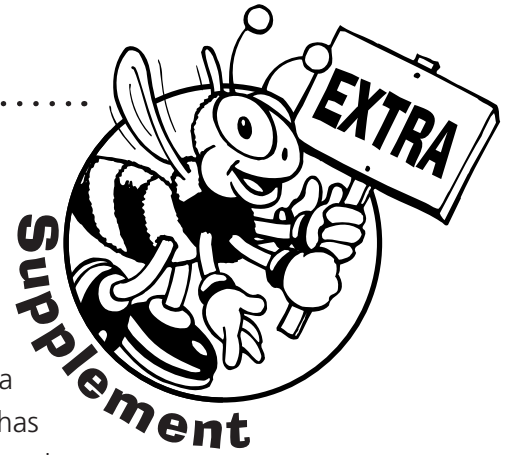
2. _____

3. _____

What does foraging mean? _____

How many trips will a single worker bee make in one day? _____

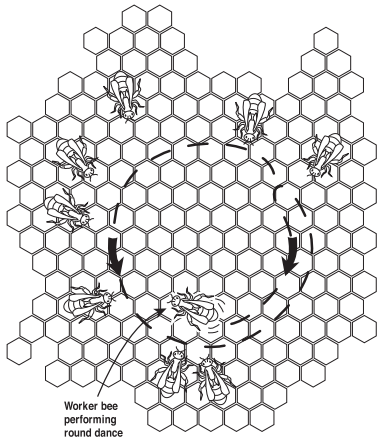
Honey Bees - Society



Honey, I'd Love to Dance

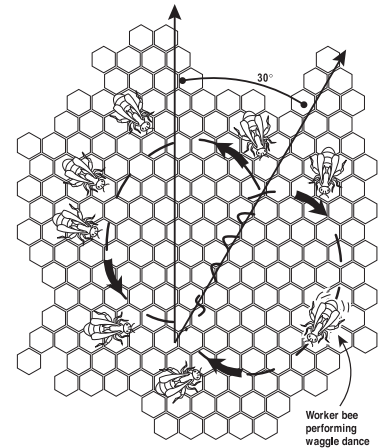
Honey bees communicate with each other by dancing. After a honey bee has found food she tells the other bees when she returns to the hive. The bee will dance on the honeycomb, while the other bees feel the dancing bee and learn where the food is. By smelling the dancing bee and getting a taste of her load of nectar, the other bees can tell what type of flower she has visited. Different dances are used when the food is close to or far away from the hive. Bees have receptors on their feelers and legs which they use to feel the dance.

There are several bee dances, but the most common are the round dance and the waggle dance.



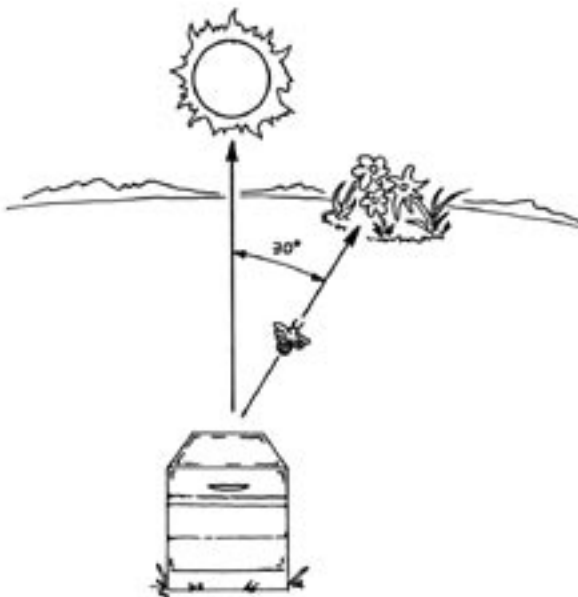
Round Dance

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 right of the sun, the bee alters the direction of the dance by the correct amount to the left or right of the upright 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.



Honey Bees - Society.....

Activity #4: Dances With Bees

Objective:

To understand how and why honey bees communicate within their society.

Preparation:

Copy "Honey, I'd Love To Dance" supplemental information sheet.

Also, gather materials, hide treat bags and write directions for scouts.

Materials:

Bags of treats (candy, cookies, honey sticks, raisins, etc.) The number of bags needed depends on the number of teams for the activity. Written directions for each scout.

Note:

This activity needs lots of room. Outdoors works best!

Essential Skills:

Science, Social Studies, and Drama

Discussion:

Ask students how humans communicate nonverbally (body language, hand signals, facial expressions).

Have a few of them demonstrate in a charades-type manner.

Students should read "Honey, I'd Love To Dance." Review the messages bees communicate through their dances. Review both dances and what each movement means. Explain that they now have the opportunity to find food (treat bags) and to communicate its whereabouts to fellow team members.

Procedure:

- Divide the class into teams (2-4 depending on class size).
- Have each team choose a scout (the bee that will originally find the food source and communicate its whereabouts through bee dances to the team members).
- Give each scout written directions to a different treat bag and send the scouts out to find them. Do not let the other students witness their search.
- When the scouts return, have them communicate the direction and distance of the treat bag to their team members using either the round dance or the waggle dance. No verbal or "human" body language allowed!
- Once all the teams have found their reward, follow-up with a class discussion about the ease or difficulty of communicating through dance. Is it difficult to judge distance without a tape measurer or other tools? Do they believe honey bees are intelligent creatures?

Estimated Time:

1 class period

Note—Bee dances are demonstrated in "The Honey Files: A Bee's Life" videotape as well.

Honey Bees - Society



Activity #5: Pheromones

Objective:

Students will learn about pheromones and how honey bees use them to communicate.

Preparation (for Day 2):

Gather supplies. Place each scent in a different jar and close the lid to keep the odors from escaping. Make a maze in the classroom out of tables, desks, and chairs. Hide honey sticks around the room.

Essential Skill:

Science

Materials:

Jars with lids, peppermint extract, vanilla, lemon, banana, vinegar and cinnamon. Honey sticks (one for each team). Blindfolds.

Discussion:

Introduce students to the idea that honey bees have senses but that they are much different from human senses. For example, bees can see many colors but they cannot see red. Humans on the other hand can't see ultraviolet light, but honey bees can. Humans and bees also perceive odors differently. Humans use their noses to smell, while honey bees use their antennae to detect pheromones, which are chemicals they emit in certain situations. Ask students what honey bees "smell." Lead the students to an understanding of individual hive smells: the odor a queen uses to attract drones for mating, the alarm pheromone that signals hive members to defend the hive, and the "queen substance" pheromone that maintains behavioral control of the colony.

Honey Bees - Society

Activity #5 continued

Procedure:

DAY 1

- Discussion (See previous page)
- As a class, come up with navigational instructions for each of the scents. For example, a scent of lemon could mean "Turn right." Vanilla could mean "Back up" or "The honey is here!" The students should take careful notes on the meaning of each scent. Remind students to bring these notes with them to class the following day for a maze honey hunt.
- Divide students into teams of 4-5. Each team represents a colony of bees.

DAY 2

- Construct a maze in the classroom.

For Each Team:

- Hide a honey stick.
- Place the scent jars along the maze route where they would lead to the honey.
- Blindfold one member of the team to search through the maze for the honey using only the scents as clues. The other members of the team should guide the bee for safety reasons but cannot tell the blindfolded team member where to go.
- Have other teams take notes of each team's successes or failures in finding the honey.
- After all teams have participated, discuss the difficulties each team experienced.

Estimated Time:

2 class periods

Honey Bees - Society



Worksheet #6: What Bees Eat

Children are most likely to encounter honey bees that are foraging on flowers. Bees may fly long distances (up to six miles from the hive) in search of food and may be quite far from home when they are seen in your yard.

Worker bees gather both pollen and nectar from flowers to feed larvae and other members of the colony. Nectar is the sweet fluid produced by flowers to attract bees and other insects, birds and mammals. Worker bees drink the nectar and store it in a pouch-like structure called the honey sac. They fly back to the hive and pass the nectar to other "house bees." The house bees mix the nectar with enzymes and deposit it into a cell where it remains exposed to air for a time to allow some of the water to evaporate. The bees help to speed the evaporation by fanning the open cells with their wings. After the enzymes are added and the water is evaporated, the nectar becomes honey. The bees then cap the honey cells with beeswax.

Honey bees have lots of little hairs on their body. Pollen sticks to the hairs while the bees are visiting the flowers. A furry little bee wiggling around inside the flower picks up a lot of pollen. After getting pollen on their body hairs, the bees move it to a special area on their hind legs called pollen baskets. Foraging bees returning to the hive often have bright yellow or greenish balls of pollen hanging from these pollen baskets.

Pollen is the yellowish or greenish powder-like substance that comes from flowers. It may be quite sticky. Honey bees mix the pollen with some nectar to form a mixture called beebread that is a protein-rich food used to feed larvae.

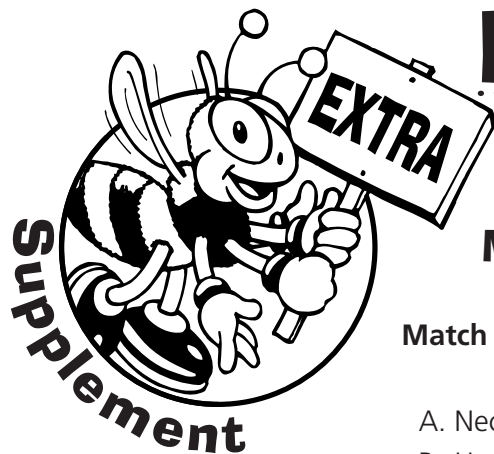
Answer the following questions:

1. When bees search for food, it is called _____.
2. Worker bees gather _____ and _____ to feed to the larvae and other bees.
3. The sweet fluid produced by flowers is known as _____.
4. When nectar is mixed with enzymes from a honey bee it becomes _____.
5. How do bees help the process of evaporating water from the honey? _____

6. How do bees gather pollen while visiting flowers? _____

7. The special areas on the hind legs of honey bees for storing pollen are called _____.
8. Nectar and pollen mixed together to feed larvae is called _____.
9. How do honey bees store honey for future use? _____

10. Honey bees can fly up to _____ miles in search of food.



Honey Bees - Society.....

Supplemental Worksheet: Matching Hives

Match the following definitions with the words listed below.

- A. Nectar
- B. Honeycomb
- C. Hive
- D. Pollen
- E. Pheromone
- F. Beeswax
- G. Royal jelly
- H. Workers
- I. Colony
- J. Beebread
- K. Brood

_____ A group of honey bees living together

_____ A bee's home

_____ A milky, yellow syrup that is very high in protein, that young worker bees secrete from glands inside their heads and feed to larvae

_____ A sweet liquid secreted by glands in the flowers of plants

_____ The offspring produced by the colony

_____ Female bees with only partially developed ovaries

_____ Six-sided cells of wax

_____ A substance produced by bees that affects the colony's activities

_____ Yellow powdery substance produced by flowers

_____ A substance secreted from the glands located on the underside of worker bees

_____ Bee food made from nectar and pollen

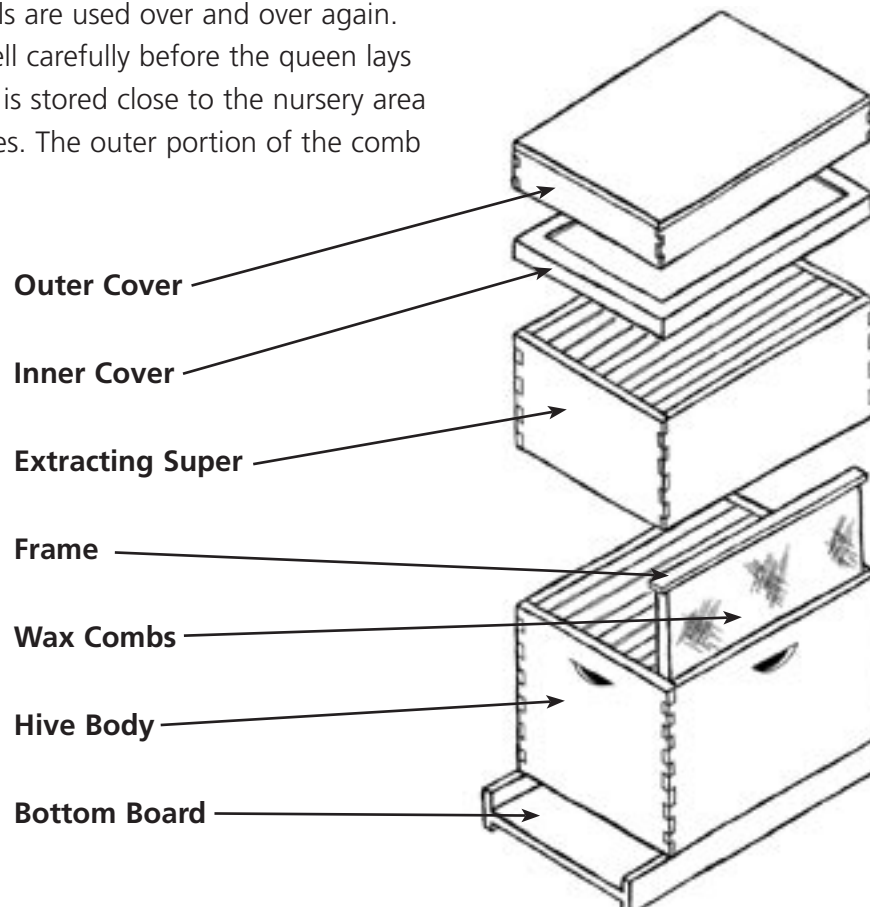
Honey Bees - The Hive

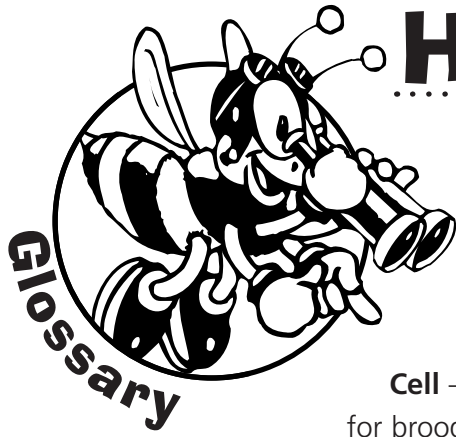


Educator's Overview: The Hive - The Honey Bee's Home

Honey bees live in large groups of 30,000 to 60,000 bees called a colony. Each colony occupies its own nest or hive. Wild honey bees usually build their hives in hollow trees or other sheltered places. Wooden homes that beekeepers provide for honey bees are also called hives. The interior of these homes include wax produced from the bodies of worker bees. The wax is secreted in small flakes from the underside of the honey bees' abdomens. The bees then chew the wax to make it pliable and build one or more large sheets called wax combs. The combs are built vertically, side by side. Each comb consists of six-sided wax structures called cells. Thousands of cells make up each comb and are used for storing honey and pollen and also as nurseries for developing bees.

There are generally two sizes of cells within the hive. Most of the cells, measuring approximately 0.20 inches across, are used for raising worker bees. Slightly larger cells, about 0.25 inches across, are used for rearing drones. Both kinds of cells are used for storing pollen and honey. Cells in the middle part of the comb are generally used as the nursery. This helps to protect the young developing bees from changes in weather and other dangers. Nursery cells are used over and over again. Worker bees clean each cell carefully before the queen lays another egg inside. Pollen is stored close to the nursery area in order to feed young bees. The outer portion of the comb is used for honey storage.





Honey Bees - The Hive

Glossary of the Hive — The Honey Bee's Home

Brood cells — cells that house developing bees.

Cell — a hexagonal wax chamber built at a slight upward angle by honey bees for brood rearing and storing pollen and honey.

Circumference — the length of the perimeter (outside) of any closed figure.

Colony — a group of animals living together.

Comb — a structure made up of hexagonal wax cells.

Diameter — the length of a straight-line segment through the center of a sphere.

Hexagon — a polygon having six sides and six angles.

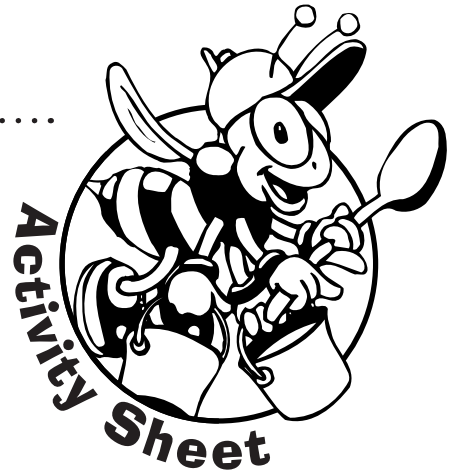
Hive — a home to a colony of bees.

Polygon — a closed figure bound by three or more line segments.

Propolis — a sticky substance collected from trees by bees and used as glue to construct and seal parts in the beehive and protect the hive from the elements.

Wax — the substance excreted from the glands located on the underside of a honey bee between its abdominal segments.

Honey Bees - The Hive



Activity #6: Polygons for Everyone

Objective:

To understand why honey bees use hexagons instead of triangles, squares, pentagons, or octagons.

Preparation:

Gather books, pictures, diagrams or other information on different types of polygons.
Cut strips of construction paper.

Materials:

Strips of construction paper 2" x 9", rulers, long balloons (the type entertainers use for making animal shapes) and tape

Essential Skills:

Geometry/Math

Discussion:

Ask students to define polygon, diameter and circumference. Ask for examples of polygons and list them on the board. Also on the board, write the number of sides of each polygon and what the length of each side would be if the total circumference were 9" and all sides were equal.

Example:

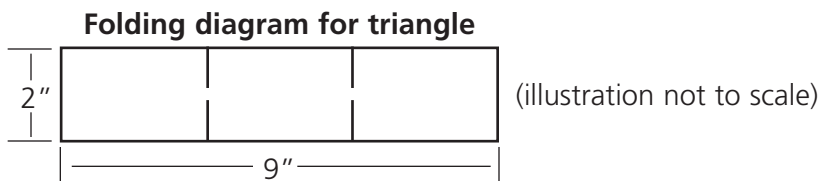
Triangle	3 sides	$3" \times 3 \text{ sides} = 9"$
Square	4 sides	$2.25" \times 4 \text{ sides} = 9"$

Honey Bees - The Hive

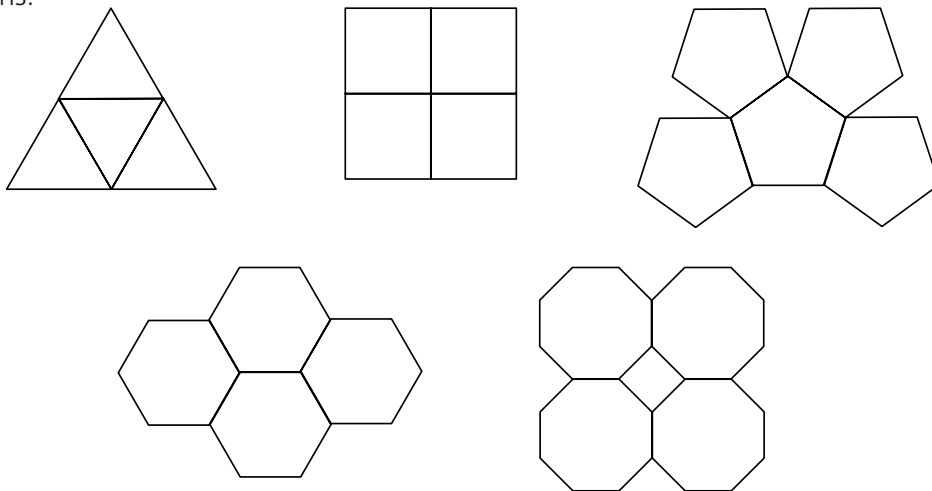
Activity #6 continued

Procedure:

- Give each student at least 5 strips of construction paper.
- Instruct the students to properly measure the dimensions listed on the chalkboard for each type of polygon and to fold each strip on the measurement lines in order to form the polygon. Students can use tape to connect the ends of the strip to complete the polygon.



- Have the students construct their triangles as you demonstrate the measuring, folding, and taping of a triangle.
- Have the students then construct the 4 remaining polygons on their own. Have plenty of extra paper strips on hand for mistakes.
- Once everyone has completed all the polygons, put students in groups of 4-5 to build structures of like polygons.



- Give each group a few balloons to blow up to diameters of approximately 1", 1.5" and 2" to represent developing bees. Students should then see how balloons fit inside each polygon.
- Have groups discuss the benefits/drawbacks of each structure in terms of how they fit together, strength of structure, if there is any wasted space between the polygons, if there is any wasted space within the polygon when the balloon is inserted, etc.
- Come together as a class to discuss group findings.

Estimated Time:

1-2 class periods

Honey Bees - The Hive



Worksheet #7: Home, Sweet Honey, Home

Using the "Glossary of the Hive" terms, answer the following questions:

What do we call honey bee homes? _____

A group of honey bees living together is called a _____ .

Honey bee homes are made up of several wax panel-like structures called _____ .

A multi-sided, geometric shape with three or more line segments is called a _____ .

A shape with six equal sides and six angles is called a _____ .

The small, six-sided wax compartments inside the hive are called _____ .

List three uses for these six-sided compartments.

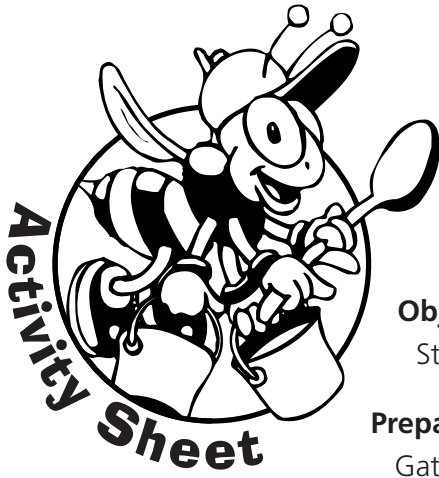
1. _____ .

2. _____ .

3. _____ .

The cells that house the developing honey bees are called _____ .

The substance collected and used as glue by honey bees to construct and seal parts in the beehive and protect the hive from the elements is called _____ .



Honey Bees - The Hive.....

Activity #7: A Honey of a Hive

Objective:

Students will understand the structure and function of a honey beehive.

Preparation:

Gather supplemental materials on beehives and honeycombs: books, pictures, diagrams and/or posters.

Gather art supplies.

Materials:

Pink, orange and yellow construction paper cut to 4.5" x 12" pieces (at least 100 of each), white construction paper and tape.

Essential Skills:

Science, Geometry, Art

Discussion:

How are communities laid out? Do large cities like New York function like suburban or rural communities? What is the purpose of residential and commercial areas? Do honey bees lay out their communities (hives) with a purpose?

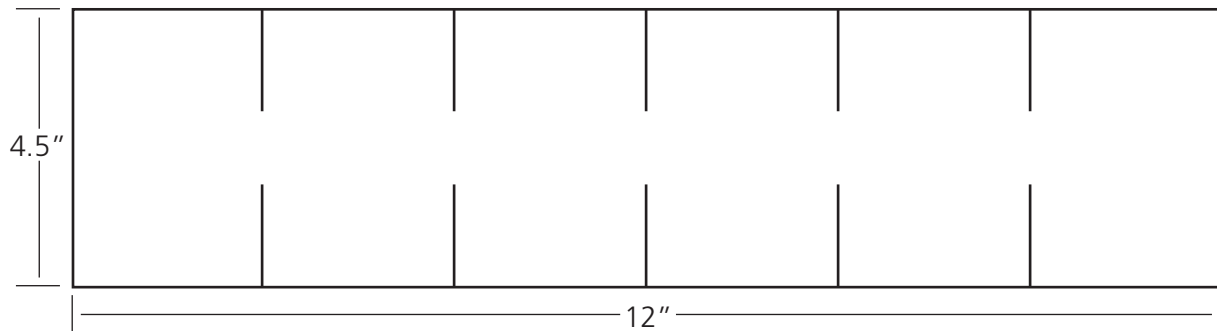
Honey Bees - The Hive

Activity #7 continued

Procedure:

- Have students research hives and how they are structured.
- Have students complete Worksheet #7 on beehives using the "Glossary of the Hive" as well as supplemental materials.
- Discuss as a class the following: How is a honey bee community laid out? Why are the brood cells put in the center of the hive? Why is pollen stored close to the nursery? Why is the honey stored in the outer parts of the hive?
- Review Worksheet #7, "Home Sweet Honey, Home."
- Give each student several sheets of 4.5" x 12" orange, pink and yellow construction paper.
- Have the students construct a hexagon out of each sheet by measuring six 2" sections from the 12" paper and folding it like in the previous activity. They will need to tape the ends together after folding.

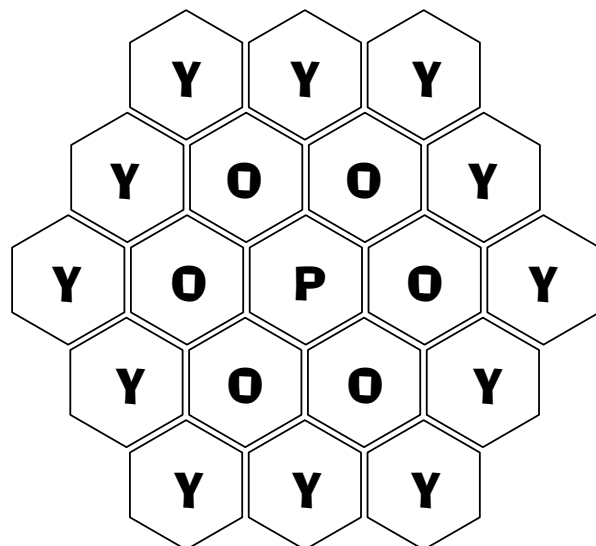
Sample of paper strip divided into 6 sections (illustration not to scale)

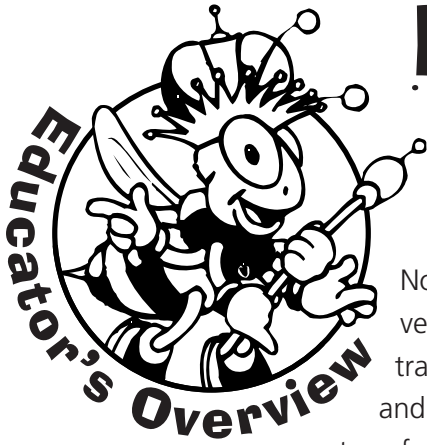


- When all hexagons are completed, have students join the hexagons together with tape to form a comb with brood cells (pink) in the center, pollen cells (orange) around the brood cells, and finally honey cells (yellow) on the outside.
- Have students make shapes representing eggs, different size larvae, and cocooned pupae out of white construction paper.
- Place shapes inside brood cells.
- Display honeycomb in classroom.

Estimated Time:

1 class period





Pollination

Educator's Overview: Pollination

Not only does a flower contain the parts necessary for reproduction, it also is very flashy about advertising its rich supply of nectar and pollen. Flowers trade sweet nectar and protein-rich pollen in return for the service that insects and other creatures perform: pollination. Pollination is simply the transfer of pollen grains from an anther to a stigma.

For many plants, the production of seeds that will grow depends on the transfer of pollen from one flower to another flower of the same kind. Most pollination occurs when insects and other creatures brush against the pollen-bearing parts of a flower and pick up pollen. When the creature goes to another flower for more food, some of the pollen from the first flower sticks to the second flower. In this way, the flowers are pollinated.

In general, pollinators are attracted to plants that offer an abundance of food. Different insects are attracted to different types of flowers depending on color, scent, and size. Bees see higher colors of the human visible spectrum plus ultraviolet and tend to prefer blue, purple and yellow flowers that have a sweet scent. Butterflies are attracted to orange, yellow, pink and blue flowers that have a large landing pad. Moths are active at night, requiring flowers that are open and providing nectar at night. Large, white flowers are particularly easy for moths to see at night.

Although insects are responsible for the majority of pollen being transferred, pollination occurs in other ways. Creatures other than insects seeking nectar, like birds and bats, can also transfer pollen. Wind and water are other sources of pollination.

When the pollen grains that have been transferred to the stigma germinate, a pollen tube is sent down to release sex cells to fertilize the ovules. After fertilization, the ovules become seeds, and the ovary wall becomes the fruit.

About one-third of the total human diet is derived directly or indirectly from insect-pollinated plants. An estimated 80 percent of insect crop pollination is accomplished by honey bees. Honey bees are needed to pollinate a variety of fruits, berries, vegetables, tree nuts, oil seeds and legumes. A 1999 Cornell University study reported that the direct value of honey bee pollination is over \$14 billion annually. This value only reflects the value of increased crop yields and quality due to honey bee pollination. The study does not assign a value for honey bee pollination of home gardens, wildlife, etc.

Note — Honey bees gathering pollen are shown in "The Honey Files: A Bee's Life" videotape.

Honey Bees - Pollination



Glossary of Flower Parts

Anther — the bright sac that produces and contains the pollen grains.

Filament — the stalk that supports the anther.

Nectar — a sweet liquid reward for pollinators that is produced by flower glands called nectaries.

Nectaries — the tissue at the base of a flower (sometimes elsewhere) that secretes nectar.

Ovary — the base of the female portion of the flower containing the ovules which become seeds.

Petals — the colorful, thin structures that surround the sexual parts of the flower and not only attract pollinators but also protect the pistil and stamen.

Pistil — the female elements of the flower including the stigma, style and ovary.

Pollen grains — the powdery particles that contain the male sex cell (gametes); also a nutritious, protein-rich food for bees.

Sepals — commonly green, leaflike structures that protect the bud prior to opening.

Stamen — the male part of the flower consisting of anther and filament.

Stigma — sticky surface where the pollen lands and germinates.

Style — the narrow region of the pistil between the stigma and the ovary.



Pollination

Worksheet #8: Flower Power

Flowers are beautiful and often fragrant to us, but for the plant, flowers serve a critical function. Flowers are how plants produce seeds to reproduce. In many cases, the flower contains both male and female parts. In order to reproduce, pollen, the male contribution, must somehow be transferred to the female part of the flower called the stigma.



Using the "Glossary of Flower Parts," label the following parts of a flower:

- | | |
|----------|---------------|
| Anther | Pollen grains |
| Filament | Sepal |
| Ovary | Stigma |
| Petals | Style |

Pollination



Activity #8: Flower Surgery

Objective:

Students learn the different parts of flowers and how flowers help plants to reproduce.

Preparation:

- Collect flowers in advance and store in water. Make sure you have a variety of colors, sizes and forms of flowers. Look for flowers that exhibit easily identifiable parts such as lilies, wild roses, columbines, irises, petunias, snapdragons, and sunflowers.
- Dissect a few flowers and label parts beforehand.
- Students should have completed Worksheet #8, "Flower Power," and have it for reference.

Materials:

Variety of fresh flowers, a single-edge razor blade or scissors, straight pins and pieces of cardboard or corkboard

Essential Skill:

Science

Discussion:

Do all flowers have strong scents? Are some scents more pleasing than others? Why are flowers so colorful? Do some flowers require force to open and extract the nectar? (Snapdragons, for example.)

Procedure:

- Show previously dissected flowers.
- Give each student a flower.
- Have the students carefully dissect the flower and pin the parts onto the cardboard.
- Using Worksheet #8 as a reference, students then label each flower part pinned to the cardboard.

Follow-up Discussion:

Are some flowers easier to dissect than others? Were some parts easier to identify than others? Did every flower contain pollen? Why or why not?

Estimated Time:

1 class period



Pollination

Activity #9: Pollen, Pollen, Everywhere

Objective:

Students learn how pollen can be transferred from one flower to another by way of insects and wind.

Preparation:

At home, prepare three bowls of instant rice using three different colors of food coloring in the water. When rice has absorbed the water, spread each color of rice out on waxed paper to cool and to keep grains from sticking together. Once the rice is cool and slightly dry, place each color of rice in a large plastic bag.

Materials:

Three colors of cooked instant rice, newspaper, hairbrushes (one for each team)

Note:

This is a fun but messy activity. A broom and dustpan is a necessity!

Essential Skills:

Science

Discussion:

What are different ways plants are pollinated? What is the best method of pollination?

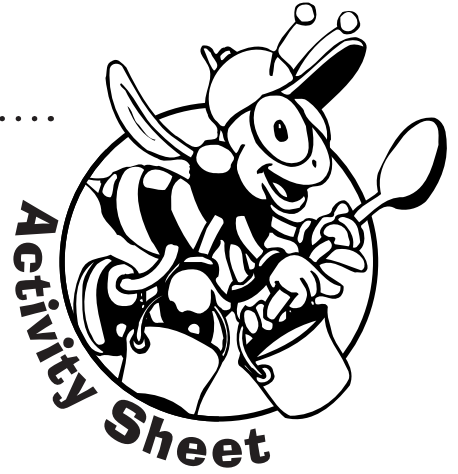
Procedure:

- Divide class into teams of 4-5 students.
- Give each team the following supplies:
 - Newspaper to cover work area
 - Hairbrush to represent a bee
- A handful of each color (A, B, and C) of cooked rice (pollen) placed in piles at least 12" apart
- Have students place the bristles of the hairbrush in color 'A' of rice and then into color 'B' of rice.
- Discuss what happens to the rice (pollen) when the hairbrushes (bees) move from one pile to the other. (The rice gets mixed up.) Tell the students that flowers must receive pollen from the same kind of flower to make seeds or fruit.
- Next, have the students blow on the color 'A' pile in the direction of the color 'C' pile. What happens to pile 'C'? Is there as much color 'A' mixed in with color 'C' as there is 'A' mixed with 'B'? Which method wasted more rice (pollen)?
- Ask the students to come up with other ways they could imitate pollination.
- Clean up.

Estimated Time:

1 class period

Pollination



Activity #10: Bee Watching, Be Careful

Objective:

To watch bees and other insects in their natural environment and learn what flowers attract them.

Preparation:

Make copies of the "Bee Watching, Be Careful Data Sheet."

Materials:

1 data sheet per student

Note:

This activity can only be done when bees are active. Also, warn students who may be allergic to bee stings to do this activity only if bees can be observed through a window.

Essential Skills:

Science, Math

Discussion:

Where are honey bees most likely to be found? What types of flowers attract honey bees? What other insects are attracted to flowers? Do many different insects visit the same flowers? Do all insects visit flowers at the same time each day?

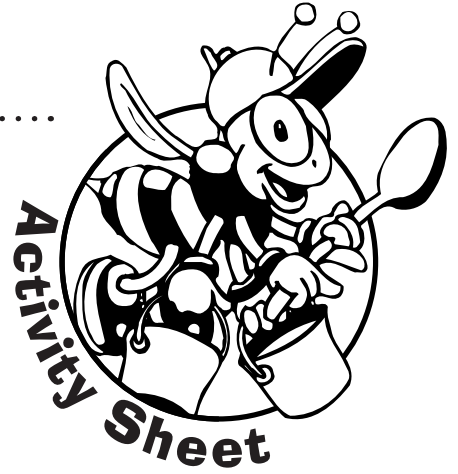
Procedure:

- Give each student a copy of the data sheet on the next page.
- Instruct the students to choose garden areas near their home that they can visit several times a day. Tell them that the more variety of flowers, the better.
- Review "Insect Identification Tips."
- Students are to observe the flowers in these garden areas at different times of the day for several days and record their findings on the chart provided.
- At the end of the set time frame, students should write up at least five conclusions from their collected data. For example, "most of the honey bees were observed in the morning between 9:00 a.m. and 11:00 a.m. The large, yellow lilies attracted the most honey bees as well as a variety of other insects."

Estimated Time:

30 minutes or less of class time

Pollination



Activity #11: Bees—A Bum Rap?

Objective:

Students will learn about cultural attitudes toward bees and how honey bees are portrayed in literature.

Preparation:

Collect books, poems, videos, art and music that relate to honey bees. Duplicate excerpts from written materials.

Materials:

See bibliography below.

Essential Skills:

Language Arts, Social Studies

Discussion:

What do the students think of bees? Are they intrigued, frightened, disinterested? How do they think literature has portrayed honey bees?

Procedure:

- Read and discuss the meanings of the following proverbs from *Insect Fact and Folklore*, by Lucy W. Clausen. Published by Collier Books, NY, 1954.
"Busy as a bee." "Make a bee line." "Where there is honey, there are bees."
"A drop of honey will not sweeten the ocean."
"The diligence of the hive produces the wealth of honey."
- Have students find and read aloud literature/poems about bees as well as current periodical articles about bees. Discuss the ways bees are portrayed. Does the author seem to have knowledge about honey bees?
- Have students find and read forms of poetry that refer to bees. Discuss.
- Have students write their own Haiku with a bee theme.

Estimated Time:

1 class period

Children's Literature with References to Bees:

An Aesop's Fable: The Selfish Bees, by A. InGatti.

Aesop's Fables published by Gulliver Books, Harcourt Brace Javanovich, NY, 1992.

Best-loved Folktales of the World, by J. Cole. Published by Anchor Books, Doubleday, NY, 1982.

Buzz, Buzz, Buzz, by B. Barton. Published by Macmillan Publishing CO., NY, 1973.

The Honey Hunters, by F. Martin. Published by Candlewick Press, Cambridge, MA, 1992.

Poems of Emily Dickenson. Published by T.Y. Crowell Co., NY, 1964.

Winnie-the-Pooh, by A. Milne. Published by E. P. Dutton & Co., NY, 1954.



Pollination

Worksheet #9: Honey Bees— More Than Just Honey

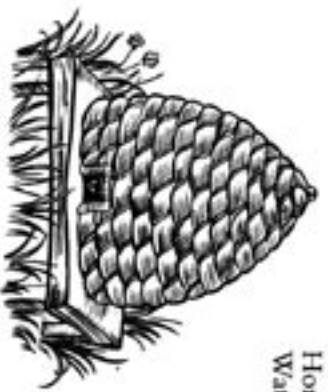
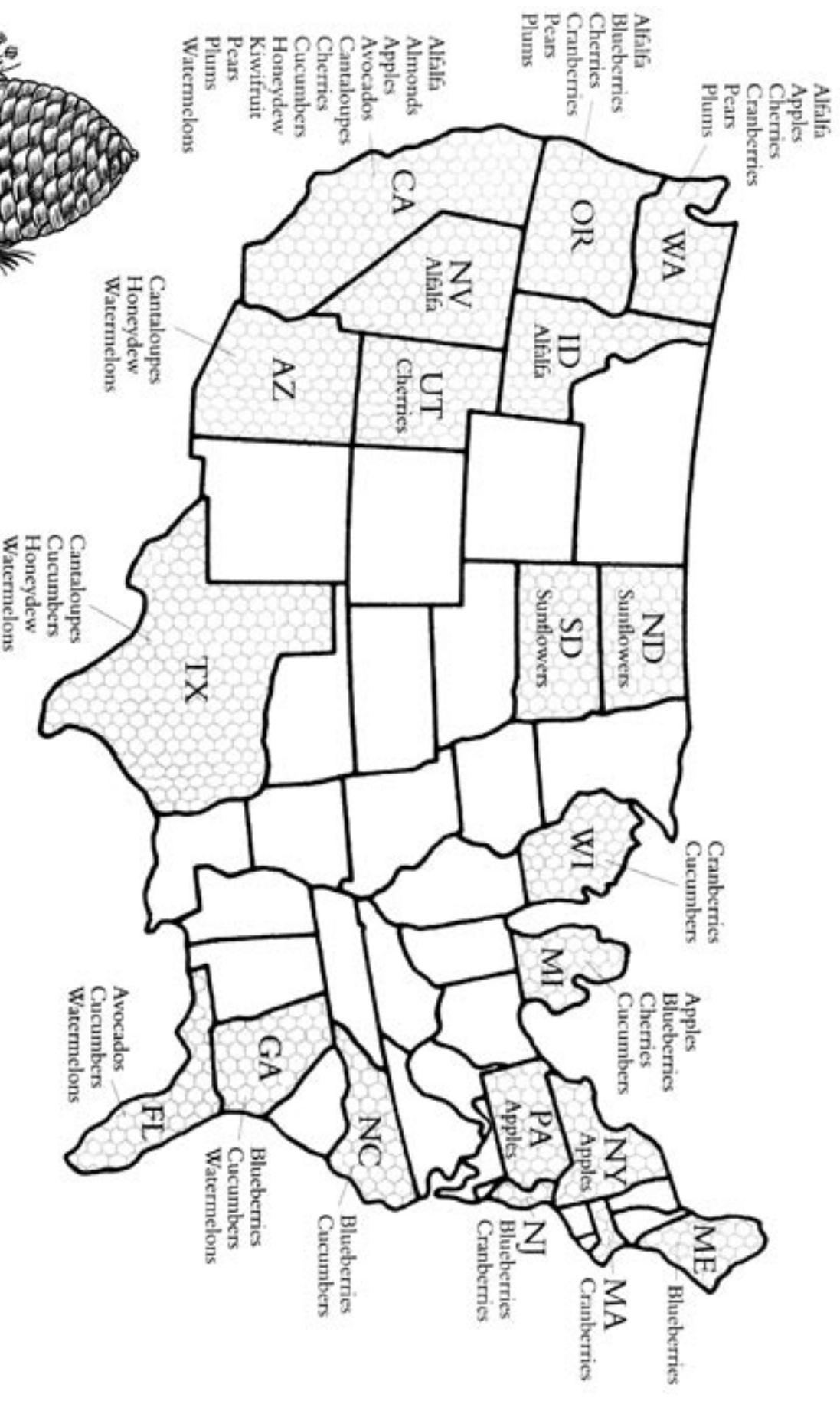
Honey bees are productive insects which thrive in colonies of 30,000 to 60,000 bees. Beekeepers maintain colonies in wooden hives that can be transported to field sites for the pollination of food crops and the collection of honey. One-third of our food supply is dependent, either directly or indirectly, on insect pollination.

Although some crops are pollinated by bee species other than honey bees, honey bees are the only ones that can be easily managed, moved around, and will pollinate a wide variety of crops.

Using “The Buzz on Honey Bee Pollination” map, answer the following questions:

1. How many states have crops pollinated by honey bees? _____
(Careful! You'll find the answer on the bottom of the map.)
2. What region of the United States uses honey bees to pollinate alfalfa crops? _____
3. Which two states rely on honey bees to pollinate sunflowers? _____ & _____
4. Honey bees pollinate watermelons in what region of the United States? _____
5. In which two states do honey bees pollinate avocados? _____ & _____
6. What crops does Wisconsin use honey bees to pollinate? _____ & _____
7. List three states that are producing apples, thanks to honey bees:
_____, _____, and _____.
8. List three states that produce blueberries with the help of honey bees:
_____, _____, and _____.
9. Which state seems to rely the most on the honey bee? _____
10. Name five fruits that rely heavily on honey bees for pollination.
_____, _____, _____,
_____, and _____.

Map of Honey Bee Pollination



Honey bees pollinate crops in all 50 states. This map highlights the major crop producing states where honey bee pollination is highest.



Honey

Educator's Overview: Honey

Honey is the only food consumed by humans that is produced by insects.

Honey is the sweet, viscous fluid produced by honey bees from the nectar of flowers. Worker honey bees transform the floral nectar that they gather into honey by adding enzymes to the nectar and reducing the moisture. The honey is stored in the wax cells of the hive (honeycomb).

Honey is a rich source of carbohydrates — mainly fructose (about 38.2 percent) and glucose (31.0 percent). The remaining carbohydrates include maltose, sucrose and other complex carbohydrates. On average, honey is about 17.1 percent water. Honey is sweeter than table sugar.

In addition, honey contains small amounts of a wide array of vitamins, minerals and amino acids as well as several compounds which function as antioxidants — compounds that delay damage to cells or tissues in our bodies.

Throughout history, honey has been enjoyed for its sweetness as well as its healing properties.

Honey is an entirely natural product. It contains neither additives nor preservatives.

The color and flavor of honeys differ, depending on the nectar source (the blossoms) visited by the honey bees. The color ranges from nearly colorless to dark brown, and the flavor varies from mild to bold. As a general rule, lighter-colored honeys are milder, and darker-colored honeys are bolder.

Honey also comes in a variety of forms including liquid, whipped and comb honey. Liquid honey, which is free of visible crystals, is extracted from the comb in the hive by centrifugal force, gravity or straining. Whipped honey is finely crystallized honey. Honey crystallizes more or less rapidly depending on the ratio of fructose and glucose in the honey. While most honey will crystallize in time, the crystallization of whipped honey is controlled so that, at room temperature, it can spread like butter. In many countries, whipped honey is the preferred form of honey. Comb honey is honey contained in the cells of the honey bees' wax comb in which it was produced.

Note — Various types of honey are shown in "The Honey Files: A Bee's Life" videotape.

Honey



Worksheet #10: The History of Honey

Honey bees (as well as many other insects) are one of science's greatest mysteries because they have remained unchanged for twenty million years, while the world changed around them. Bees and flowers evolved in the age of dinosaurs. By 20 million B.C., mammals replaced dinosaurs and honey bees had evolved. After the Ice Age, man hunted bees with torches and stole their honey. The smoke from these torches calmed the bees so that people could take the honey.

As the years passed, man learned to work with bees. Many agree that the first evidence of beekeeping (as opposed to foraging honey from wild bee colonies) appears in the paintings of ancient Egypt, dating from around 2500 B.C. Ancient Egyptians are believed to have kept bees in mud and clay hives. Thousands of years later, the ancient Greeks studied new ways of raising honey bees. By 50 B.C. the Romans were using melted, dyed beeswax to paint pictures. In the Middle Ages, beekeepers wearing wicker veils kept bees in straw skeps, which were put in stone shelters called bee boles.



Pilgrims brought the first honey bees to North America in the 1600s. By the 1850s, honey bees were found all the way across the continent in California. Pioneers used boxes to trap honey bees and then released them so that the bees could be followed back to the hive. In 1852, a teacher and part-time beekeeper invented the movable-frame beehive and the honey business boomed.

Honey

Worksheet #10 continued

Answer the following questions:

Why are honey bees so interesting to scientists? _____

After the Ice Age, what did man use to hunt bees? _____

What helps calm bees? _____

Who were the first beekeepers? _____

What did the Romans use in the first century B.C. to paint pictures? _____

In what did beekeepers keep bees during the Middle Ages? _____

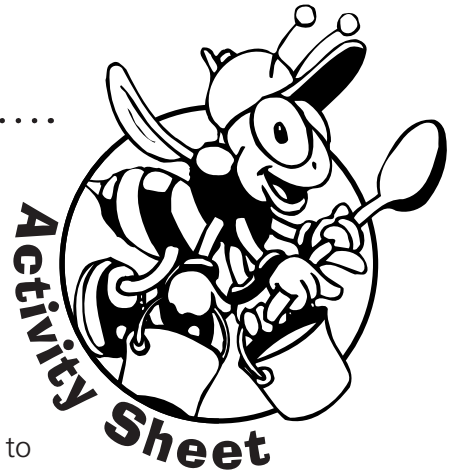
How did honey bees first come to America? _____

Approximately how many years did it take the honey bee to migrate across the American Continent?

Why did pioneers trap honey bees in boxes? _____

What was invented in 1852 that helped the honey business to boom? _____

Honey



Activity #12: The Many Uses of Honey

Objective:

Students will research the ways in which honey is used.

Preparation:

Set up a field trip to a local grocery store or health food store. Make sure to get permission from the store manager. If an outing is not possible, ask each student to bring in a package of a product containing honey. Ask them to put their names on the products if they wish to have them returned.

Materials:

Copies of "The Many Uses of Honey Data Sheet" on the next page and examples of products containing honey.

Essential Skill:

Science

Discussion:

What kinds of products contain honey? Have students take notes on what types of products contain honey. (Cereals, cookies, health foods, cosmetics, etc.) What is honey used for in food products? Why would honey be used instead of another sweetener? Show students examples of products containing honey. Explain how to find ingredient lists, and why ingredients are listed in a particular order. (Ingredients are listed in order of amount contained in the product.)

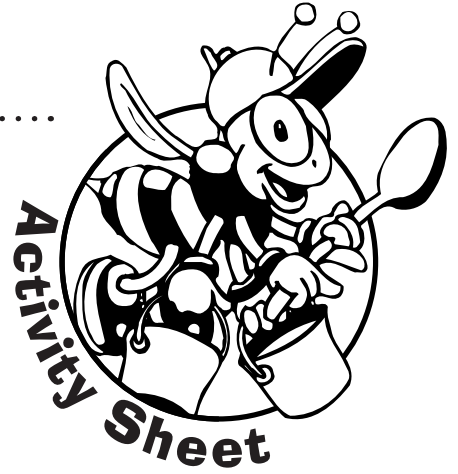
Procedure:

- Give each student a copy of "The Many Uses of Honey Data Sheet" on next page. Explain each section of the chart.
- Have the students work in pairs.
- If going to a grocery store:
 - Give the students 30 minutes to find products containing honey. Ask them to fill out each section as completely as possible. Have them share their findings with other pairs of students when back in the classroom.
- If using products brought in by the students:
 - Set products up around the room and give students time to walk around, observe each product, and fill out his or her chart.
- As a class, discuss the findings and formulate conclusions.

Estimated Time:

1-2 class periods

Honey



Activity #13: The Color of Honey, A Taste Sensation

Objective:

Students will learn that the source of nectar influences the color and flavor of honey.

Preparation:

Speak with local beekeepers, honey distributors or the National Honey Board for information about honey in your area. Gather materials. Prepare student samples: spoon small amounts of each kind of honey onto waxed paper. Prepare small glasses of water for rinsing between tastings.

Materials:

Information from local beekeepers or the National Honey Board about honey sources in your state, different kinds of liquid honey (at least three), waxed paper and small glasses of water.

Essential Skill:

Science

Discussion:

The color and flavor of honeys differ depending of the nectar source visited by the honey bees. There are more than 300 unique types of honey available in the United States. Honey is produced in every state, but depending on the floral source location, certain types of honey are only produced in a few regions. Ask students if they know what type(s) of honey might be produced in your state. See if they are familiar with regional crops in your area and whether or not those crops are pollinated primarily by honey bees. Share the following information about some common honeys and their floral sources.

(For additional information on honey varieties, visit www.honey.com.)

Honey

Activity #13 continued

ALFALFA—Alfalfa honey, produced extensively throughout the United States, is light colored and pleasingly mild in flavor and aroma.

BASSWOOD—Basswood honey is often characterized by its distinctive “biting” flavor. Basswood honey is generally light colored and strong in flavor.

BUCKWHEAT—Buckwheat honey is dark and full-bodied.

CLOVER—Clover honey has a pleasing, mild taste. Depending on the location and type of clover, clover honey varies in color from almost clear to light amber to amber.

ORANGE BLOSSOM—Orange blossom honey, often a combination of citrus sources, is usually light in color and mild in flavor with a fresh scent and light taste reminiscent of the blossom.

TUPELO—Tupelo honey is a honey produced in northwest Florida. It is heavy bodied and is usually light golden amber with a greenish cast and has a mild taste.

WILDFLOWER—Wildflower honey is often used to describe honey from miscellaneous and undefined flower sources.

Procedure:

- Have students research local honeys.
- Distribute honey samples to students.
- Have students examine the samples for color and fragrance differences.
Ask if they can determine the nectar source simply by look and smell.
- Have students taste each sample. Can they determine the nectar source from the honey’s flavor?
Ask students if they can make a correlation between color and taste. As a general rule, light-colored honey is milder in taste and dark-colored honey is stronger.

Estimated Time:

1 class period

Honey



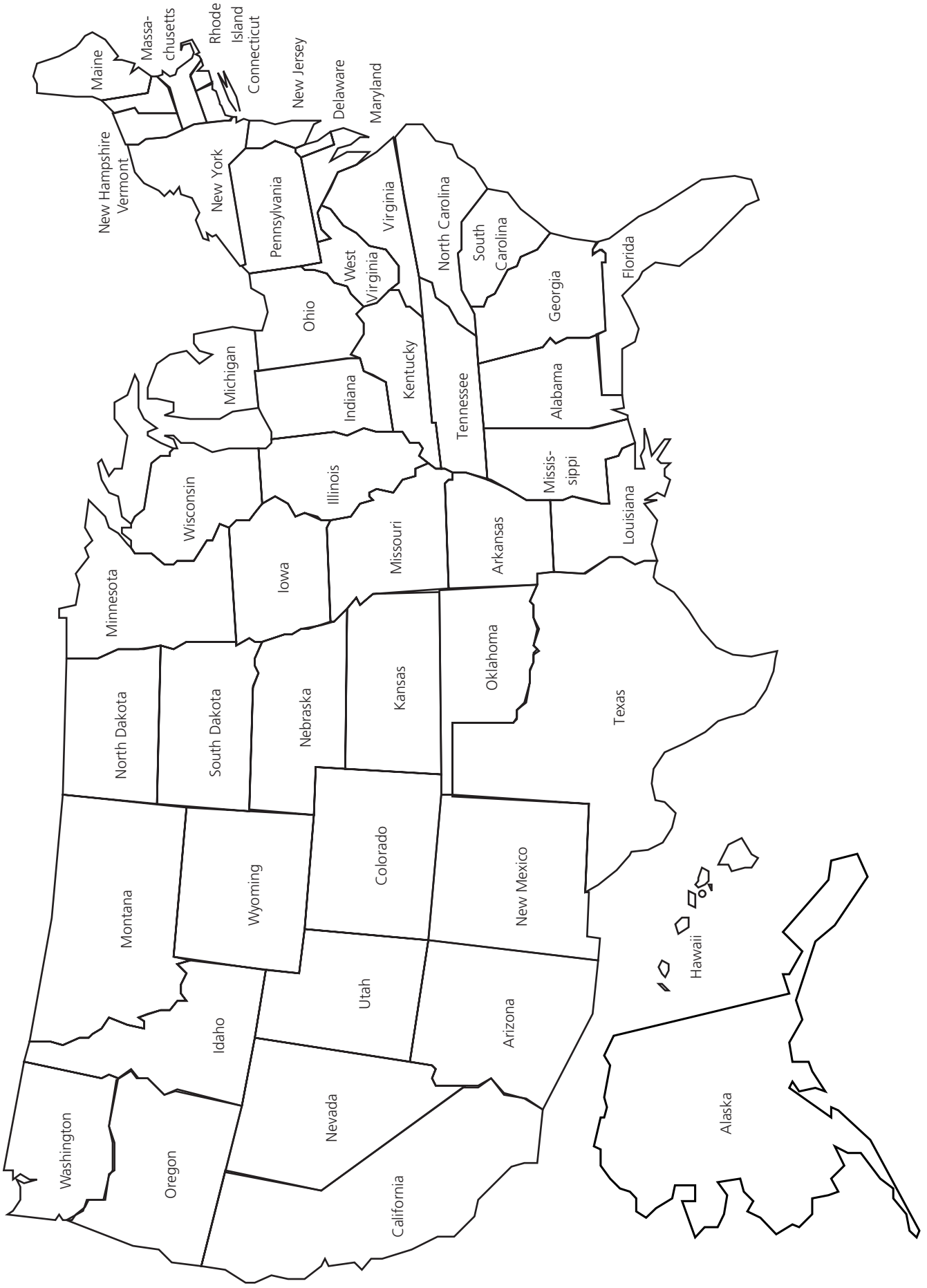
Worksheet #11: Honey Around the Country

Can You Follow Directions?

Using the map on the next page and markers or crayons, complete the following:

1. Clover honey is America's most common honey and is grown in fields and yards across the country. Outline the United States in dark green.
2. Apple blossom honey is harvested by beekeepers after their bees have pollinated apple orchards. Apples are grown in many states, but Washington is probably the most famous apple producing state. Color Washington red.
3. Orange blossom honey is valued for its fragrance and is harvested in Florida and California. Color Florida orange.
4. Alfalfa is a pasture crop fed to horses and cows. Alfalfa honey is found in many states including Colorado, Idaho and Nevada. Color these three states yellow.
5. Avocado honey is produced in California and Florida. Color California, where most avocados are grown, light green.
6. Buckwheat honey is one of the darkest and most robust honeys. Buckwheat is sometimes grown in Virginia. Color this state brown.
7. Sourwood honey typically has a light color, but sometimes when it is harvested in North Carolina it has a bluish-purple tint. Color North Carolina violet.
8. Goldenrod honey may be used to sweeten many products like graham crackers. Goldenrods can be found in the woods, meadows and hills of Georgia. Color Georgia gold.
9. Basswood honey, with its mint flavor, is usually collected by beekeepers in June. Basswood can be found in Michigan. Color Michigan blue.
10. Fireweed honey is an unique honey from Alaska. Color Alaska pink.

Honey Around the Country



Honey



Activity #14: How Dense Can It Be?

Objective:

Students will understand that different liquids have different densities.

Preparation:

Gather materials.

Materials:

A large, clear plastic container, vegetable oil, honey, water colored with food coloring, variety of small objects (nuts, grapes, dried pasta, small plastic toys, metal nuts or washers, cherry tomatoes)

Essential Skill:

Science

Discussion:

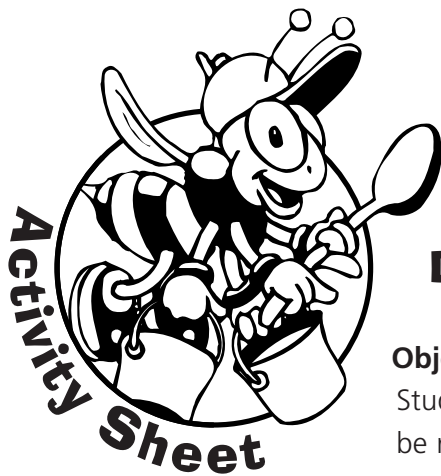
Have you ever wondered why many salad dressings have to be shaken before poured onto your salad? Or have you ever noticed that ice cream floats on top of root beer? Why is this? What is density? Are all liquids of the same amount the same weight? Will certain liquids support the weight of an object while others will let it sink?

Procedure:

- Have the students predict the outcome of pouring the three liquids together.
- Pour the oil, colored water, and honey into the clear container.
- Have students observe the side of the container. What is happening? The liquids separate into three layers, with the honey on the bottom, the water in the middle, and the oil on the top. Liquids do this because some of them are lighter, or less dense, than others. A lighter liquid will float on top of a heavier, or more dense, liquid.
- Once the layers have separated, gently drop different objects into the container to see what floats. What happens? Some of the objects will sink to the bottom. Others will float at different levels depending on how heavy they are. Objects float best in dense liquids because these support their weight.
- As a class or as a home project, let students try the same experiment with other liquids such as salt water, rubbing alcohol, etc. Ask them to first predict the outcomes.

Estimated Time:

20 minutes



Honey

Activity #15: Why Does Honey Come In Different Forms?

Objective:

Students will understand why honey crystallizes and how it can be reliquefied.

Preparation:

Collect materials.

Materials:

Small, clear bowl, 1/2 cup whipped honey (or crystallized honey), a shallow baking pan (cake or pie pan), hot water and a thermometer

Essential Skill:

Science

Discussion:

Honey is a rich source of carbohydrates — mainly fructose (about 38.2 percent) and glucose (about 31.0 percent). Honey is about 17.1 percent water. The consistency of honey, whether it is liquid or creamy, depends largely on the ratio of the two main natural sugars in honey (fructose and glucose) as well as the amount of water in the honey. This ratio of fructose and glucose in the honey is different depending on the source of nectar. The more fructose the honey contains, the less it crystallizes. The more glucose it contains, the more it crystallizes. Crystallization is a natural and complex phenomenon that can occur at any time and does not alter the taste or nutritional properties of honey. Honey packers can blend specially selected honeys in order to obtain honey that is creamy, smooth, and easy to spread.

Procedure:

- Place 1/2 cup whipped or crystallized honey in a clear glass bowl.
- Place a thermometer into the honey. Record the temperature after 1 minute.
- Fill a shallow baking pan with about 1 inch of hot water.
- Place bowl containing the honey into the pan of hot water.
- Replace water as often as necessary to keep it hot.
- Record temperature of honey every five minutes until honey has liquefied.
- At what temperature did the honey liquefy? Would all types of honey liquefy at the same temperature? *(No, honey coming from different types of nectar would liquefy at different temperatures depending on the ratio of fructose to glucose.)*
- Cover the bowl of honey with plastic wrap and keep it in the classroom. How long does it take for the honey to recrystallize?

Estimated Time:

Less than 1 class period

Honey



Activity #16: Tongue Mapping

Objective:

Students will understand the human sense of taste and how it is linked to smell.

Preparation:

Collect materials

Materials:

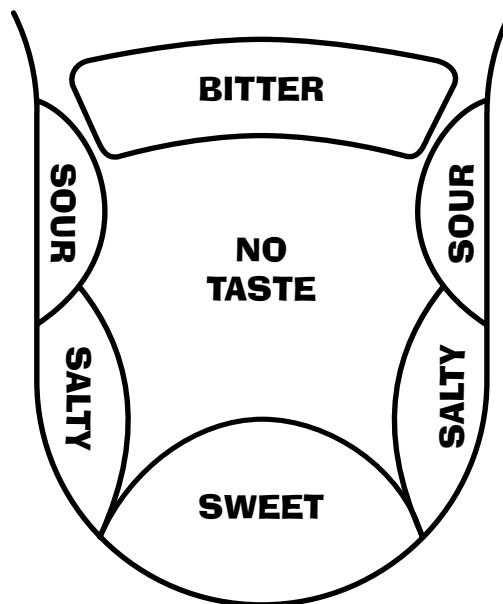
Table salt, unsweetened grapefruit juice, honey, vinegar, cotton swabs, white sheets of paper, 4 different colors of crayons or markers, a cup of water for each student

Essential Skill:

Science

Discussion:

Think about the different kinds of tastes there are when you eat. There are actually only four identifiable taste sensations. Can your whole tongue taste each of the four? Taste is the ability to respond to dissolved molecules with taste receptor cells clustered in taste buds. Although each taste bud contains receptor cells representing all four taste sensations, each taste bud responds best to only one.



Honey

Activity #16 continued

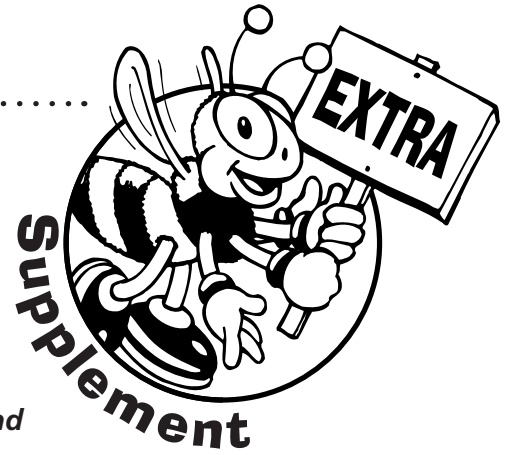
Procedure:

- Instruct the students to find out where they taste each of the taste sensations by making a map of their tongue.
- Have students work in groups of 3-4 but caution them not to share cotton swabs or to “double dip.”
- Give each group four dishes, each containing a small amount of one of the tasting ingredients and a little water mixed with it.
- Each student should have a cup of water to rinse his/her mouth between tastes, 4 swabs, a sheet of paper, crayons or markers.
- Have each student draw a big “U” onto the paper to represent a tongue.
- Have each student begin by dipping a cotton swab into the honey. They should touch it to at least four different parts of their tongue. Wherever they taste sweet, they should mark it on their tongue map with one of the crayons.
- Instruct them to rinse their mouths very well with water between tastes. Then use a different swab and a different solution to do the next parts of the map for salty, bitter, and sour.
- Once the students have completed mapping their tongues, come together as a group to discuss their maps. Do their tongues taste the same flavors in the same spots? Where are the central areas of taste for sweetness, saltiness, sourness, and bitterness.
- Discuss that many flavors are recognized mainly through the sense of smell. That is why when a person has a cold, food loses its taste. Give each student a small piece of chocolate and ask him or her to hold their nose while they eat it. Explain that they will have trouble identifying the chocolate flavor because the familiar flavor of chocolate is sensed largely by odor.

Estimated Time:

1 class period

Honey



Kid's Recipes

Ovens are hot, knives are sharp, blenders are fast and microwaves can be tricky. The point? Kids need adult helpers in the kitchen. Adult supervisors can read recipes with kids so the directions are clear. Adult helpers can also assist with kitchen utensils, machines and appliances. Play it safe and prepare these honey recipes together.

Banana Pops

- 1-1/3 cups topping, such as ground toasted almonds, toasted coconut, candy sprinkles or graham cracker crumbs
- 4 bananas, peeled
- 8 wooden craft sticks
- 1/2 cup honey

Spread toppings of your choice on a plate or plates. Cut bananas in half crosswise. Insert a craft stick into each cut end. To assemble, hold 1 banana over plate or waxed paper to catch drips. Spoon about 1 table-spoon honey over banana, rotating and smoothing honey with back of spoon to coat all sides. (Or squeeze honey from a plastic honey bear container and smooth out with spoon.) Roll banana in topping of choice until coated on all sides, pressing with fingertips to help topping adhere. Place pops on waxed paper-lined cookie sheet. Repeat with remaining bananas, honey and toppings. Serve at once. **Makes 8 servings.**

Bee Nutty Choco-Chip Cookies

- 1/2 cup honey
- 1/2 cup peanut butter
- 1/2 cup butter or margarine
- 1/4 cup packed brown sugar
- 1 egg
- 1-1/2 teaspoons vanilla
- 2 cups flour
- 1/2 teaspoon each baking soda and salt
- 1 cup chocolate morsels
- 1/2 cup coarsely chopped roasted peanuts

Combine honey, peanut butter, butter and brown sugar in a large bowl; beat until light and fluffy. Add egg and vanilla; mix thoroughly. Combine flour, soda and salt; mix well. Stir into peanut butter mixture. Stir in chocolate morsels and peanuts. Using 1/4 cup for each cookie, drop onto ungreased cookie sheet; flatten slightly. Bake at 350°F 8 to 10 minutes or until lightly browned. Remove to rack and cool.

Makes 16 cookies.

Honey

Kid's Recipes continued

Berry Striped Pops

- 2 cups strawberries
- 3/4 cup honey, divided
- 6 cups kiwifruit, peeled and sliced
- 2 cups sliced peaches
- 12 3-oz. paper cups or popsicle molds
- 12 popsicle sticks

In a blender or food processor, puree strawberries with 1/4 cup honey. Divide mixture evenly between 12 cups or popsicle molds. Freeze until firm, about 30 minutes. Meanwhile, rinse processor; puree kiwifruit with 1/4 cup honey. Repeat process with peaches and remaining 1/4 cup honey. When strawberry layer is firm, pour kiwifruit puree into molds. Insert a popsicle stick and freeze until firm, about 30 minutes. Pour peach puree into molds and freeze until firm and ready to serve. **Makes 12 servings.**

Kaleidoscope Honey Pops

- 2-1/4 cups water
- 3/4 cup honey
- 3 cups assorted fruit, cut into small pieces
- 12 3-oz. paper cups or popsicle molds
- 12 popsicle sticks

In a pitcher, whisk together water and honey until well blended. Place 1/4 cup fruit in each mold. Divide honey-water mixture between cups. Freeze until partially frozen, about 1 hour. Insert popsicle stick; freeze until firm and ready to serve. **Makes 12 servings.**

Honey

Kid's Recipes continued

Honey Lemonade with Frozen Fruit Cubes

- 1-1/2 cups lemon juice
- 3/4 cup honey
- 9 cups water
- 28 pieces assorted fruit

In pitcher, whisk lemon juice with honey to dissolve. Whisk in water. Place 1 piece of fruit in each compartment of 2 ice trays. Fill each compartment with honey lemonade. Freeze until firm. To serve, divide frozen fruit cubes between glasses; fill with remaining lemonade. Serve in tall glasses. **Makes 6 servings.**

Honey Care to Take a Dip

- 1 pint (16 oz.) lowfat plain yogurt
 - 1/4 cup honey
 - 2 Tablespoons orange juice
 - 1/2 teaspoon grated orange peel
- Assorted fruits for dipping such as sliced apples, pears and strawberries

Combine yogurt in a small bowl with honey, orange juice and orange peel; mix well. Serve with sliced fruit. **Makes 2-1/4 cups.**

Honey Crispies

- 1/2 cup powdered sugar
- 1/2 cup honey
- 1/2 cup peanut butter
- 1-1/2 cups crispy rice cereal
- 1/2 cup raisins
- 1/2 cup chocolate or multicolored candy sprinkles

Place a sheet of waxed paper on a cookie sheet so cookies won't stick. Combine powdered sugar, honey and peanut butter in a medium bowl. Stir until mixed well. Stir in cereal and raisins. Using hands, shape mixture into 1-inch balls. Roll balls in sprinkles and place on a cookie sheet. Refrigerate for 1 hour. Cookies should feel firm when touched. Serve right away or place in tightly covered container and store in refrigerator.

Makes about 30 cookies.

Honey

Kid's Recipes continued

Honey Make Mine Chocolate Sauce

- 1/4 cup honey
- 1 cup semi-sweet chocolate chips
- 2 Tablespoons butter or margarine
- 1 teaspoon vanilla

In a medium bowl, combine all ingredients; mix well. Cover with waxed paper and microwave on HIGH (100%) 1 minute and stir. Microwave 1 to 1-1/2 minutes longer. Pour into a jar. Cover with a lid. Keep refrigerated. **Makes 1-1/4 cups.**

Peanutty Honey Goo

- 1 cup natural peanut butter
- 2/3 cup whipped honey

Gradually stir peanut butter into honey; mix thoroughly. **Makes 1-2/3 cup.**

Cinnamon Honey Buns

- 1/4 cup butter or margarine, softened and divided
- 1/2 cup honey, divided
- 1/4 cup chopped toasted nuts
- 1 teaspoon ground cinnamon
- 2 loaves (1 lb.) frozen bread dough, thawed according to package directions
- 3/4 cup raisins

Grease 12 muffin cups with 1 tablespoon butter. To prepare honey-nut topping, mix together 1 tablespoon butter, 1/4 cup honey and chopped nuts. Place 1 teaspoon topping in each muffin cup. To prepare filling, mix together remaining 2 tablespoons butter, remaining 1/4 cup honey and cinnamon. Roll out bread dough onto floured surface into 18x8-inch rectangle. Spread filling evenly over dough. Sprinkle evenly with raisins. Starting with long side, roll dough into log. Cut log into 12 (1-1/2-inch) slices. Place 1 slice, cut-side up, into each prepared muffin cup. Set muffin pan in warm place; let dough rise 30 minutes. Place muffin pan on foil-lined baking sheet. Bake at 375°F 20 minutes or until buns are golden brown. Remove from oven; cool in pan 5 minutes. Invert muffin pan to remove buns. **Makes 12 buns.**

Honey

Kid's Recipes continued

Super Fast Honey Snacks

- Drizzle honey over fresh grapefruit halves. Microwave one to two minutes — depending on how cold the grapefruit was to start — for a warm treat.
- Microwave honey in a small microwave-safe bowl or pitcher for 15 to 30 seconds. Pour warm honey over toaster waffles, fresh slices of apples or berries.
- Toast English muffins and spread with cream cheese. Top with slivered almonds and drizzle with warm honey.
- Mix 1/2 cup peanut butter with 1/4 cup honey. Use as a dip for carrot and celery sticks, and pear and apple slices.

Note: Honey should not be fed to infants under one year of age. Honey is a safe and wholesome food for older children and adults.

For more recipes, visit the National Honey Board Web site — www.honey.com



Beekeepers

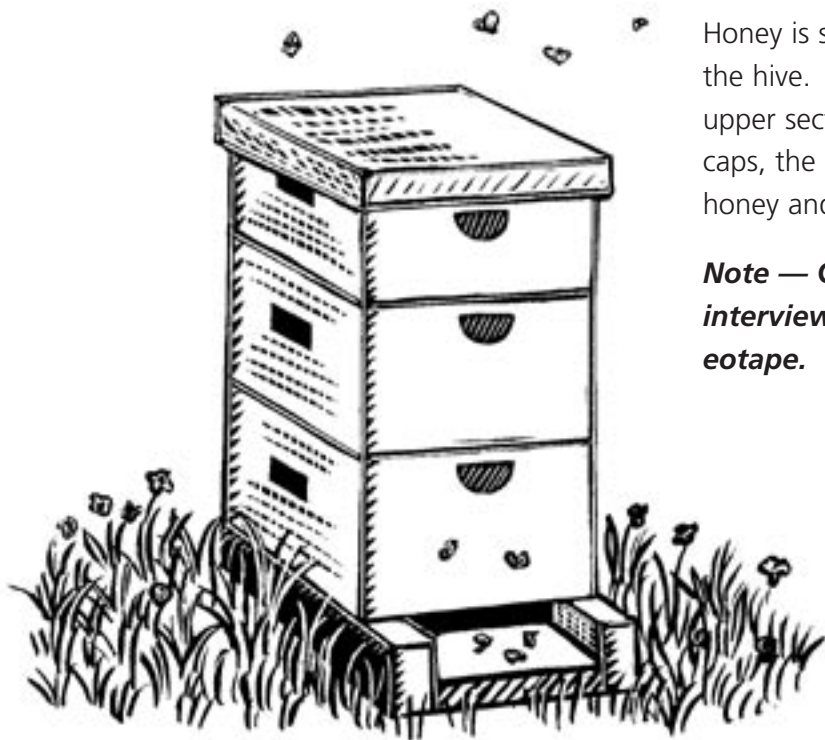
Educator's Overview: Beekeepers

Throughout the year, honey bees face many environmental hazards: scalding heat waves, freezing weather and honey thieves, like bears and skunks. Fortunately for bees, there are beekeepers who look out for their best interests. They keep the hives protected from the weather and make sure they are always near plenty of flowers and water. Beekeepers raise colonies of bees for several products, the most important of which is honey. Anyone who keeps bees is performing an important ecological service as well, because many plants are dependent on bees for pollination.

There are an estimated 139,600 to 212,000 beekeepers in the United States. The vast majority of beekeepers are hobbyist beekeepers who manage less than 25 hives of bees. About four percent are part-time beekeepers with 25 to 299 hives. An estimated 1,600 beekeepers are commercial beekeepers who manage more than 300 colonies of bees each.

About one-half of commercial beekeepers are migratory beekeepers. They rent their bees to farmers, following the pollination seasons of the various crops.

Modern beehives consist of wooden box-like sections stacked on top of each other. Each box (or super) holds 8-10 wooden frames, each containing a thin sheet of wax foundation. The bees build their combs on these foundations provided by the beekeepers, and therefore save time and effort in honey making.



Honey is stored in the combs in the upper parts of the hive. When the bees have filled the combs in this upper section with honey and covered them with wax caps, the beekeeper takes them away to extract the honey and sell the wax for many products.

Note — Commercial and hobbyist beekeepers are interviewed in "The Honey Files: A Bee's Life" videotape.

Beekeepers



Glossary of Beekeeper's Equipment

Bottom board — wooden stand on which the hive rests; is usually set on blocks or bricks to keep it off the ground.

Coveralls — light colored suit with elastic at the ankles and wrists.

Extractor — a drum containing a rotating basket that helps to remove honey from the comb with centrifugal force.

Frame — a wood and/or plastic rectangle used to hold beeswax comb. A hive body or brood chamber typically contains eight to ten frames.

Gloves — protect hands from stings.

Helmet — used to drape the veil and to protect the head.

Hive body or brood chamber — found just above the bottom board, a large wooden box (called a "super") that contains eight to ten hanging frames of comb used to raise young bees.

Hive tool — used to pry apart frames and hive parts that are stuck together with wax and propolis.

Honey super — frames of comb in which bees store surplus honey that is then harvested.

Inner cover — may be used to prevent bees from attaching comb to outer cover and provides insulating air space.

Outer cover — provides weather protection.

Queen excluder — sometimes placed between the brood chamber and the honey super, it is used to keep the queen from going into the honey chamber to lay eggs.

Smoker — a tool used to calm the bees; the smoke masks the bees' alarm pheromone and when bees smell smoke, they gorge themselves on honey and are less likely to sting. Pine, straw, grass and burlap make good smoker fuel.

Strainer — a mesh of coarse screen or cloth used to filter out large debris from extracted honey.

Uncapping knife — a cutting tool used to remove the wax caps from the honeycomb cells.

Veil — a fine fabric or screen worn to protect the face and neck.

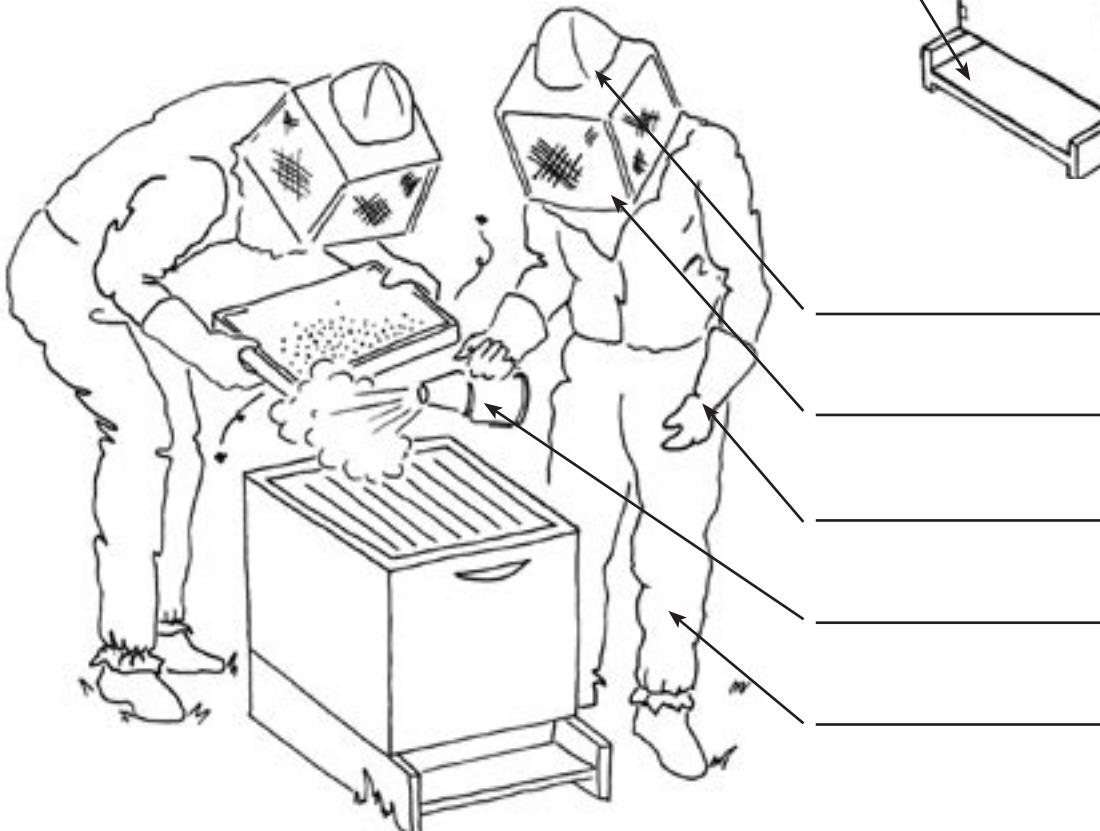
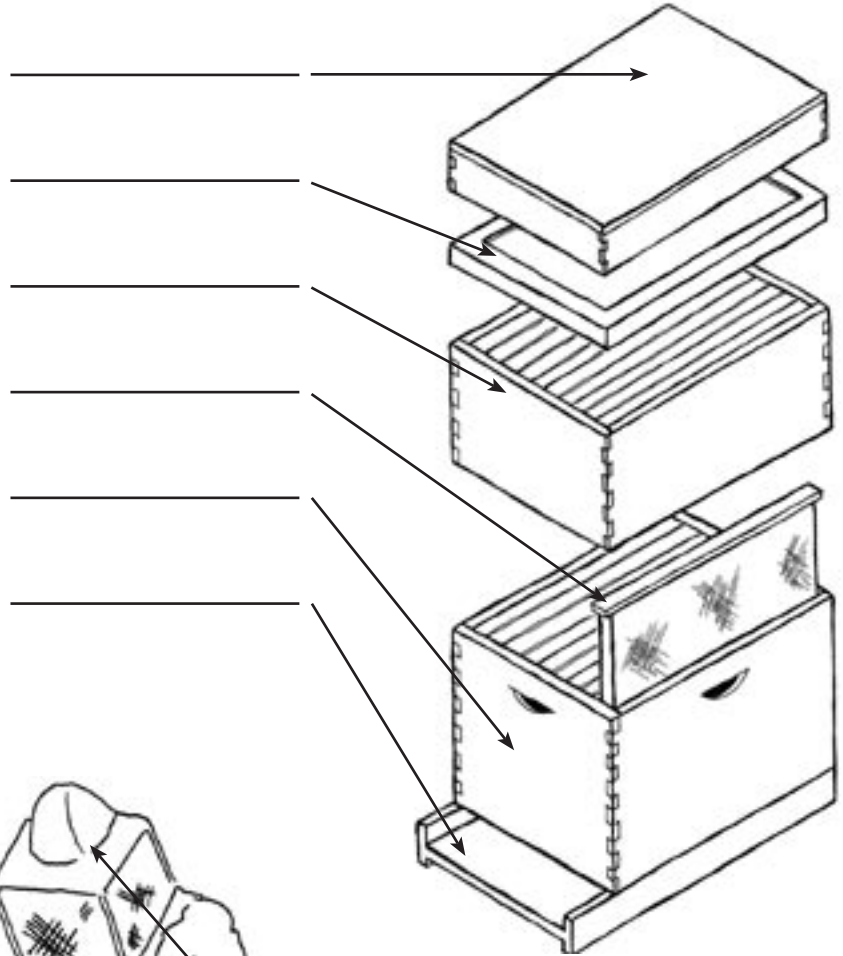


Beekeepers

Worksheet #12: A Beekeeper's Equipment

Using the list of hive elements and beekeeper's tools, label the following.

- | | |
|----------------------------|-------------|
| Bottom board | Honey super |
| Coveralls | Inner cover |
| Frame | Outer cover |
| Gloves | Smoker |
| Hive body or brood chamber | Veil |
| Helmet | |



Beekeepers



Worksheet #13: Additional Honey Bee Products

In addition to honey, honey bees produce beeswax and royal jelly. Honey bees also gather pollen and propolis. Sometimes, beekeepers harvest these products as well as honey from the beehives.

Beeswax

Honey bees need wax to build cells in the hive for raising their young and storing food. This wax is not a plant product, but rather a bee secretion. Bees secrete a thin, translucent film from their abdominal wax glands and extract it with their legs. They then bring it to their mouths and chew it with their mandibles, to make it easier to work with.

Beekeepers extract the honey from these wax combs and then sell the wax to be made into lipstick, candles, shoe and floor polish, buffing wax, and artists' crayons.

Pollen

When a worker bee gathers nectar, she is also covering her body with pollen from flowers. She collects the pollen with her legs, kneads it with nectar from her mouth in order to make balls, and fixes it onto her pollen baskets on her rear legs. Pollen is sometimes used as an ingredient in health foods and as a supplement.

Propolis

Propolis is a sticky substance collected from the leaf buds of trees that secrete it to protect and promote new growth. Bees use it to construct and seal parts in the beehive and protect the hive from the elements. Propolis is sometimes used as an ingredient in health foods and as a supplement.

Royal jelly

A whitish fluid secreted from glands in the heads of worker bees, royal jelly is the food of the whole brood during the first three days of life. From the fourth day, only the eggs that will become queens and the queen herself receive this food. Royal jelly is sometimes used in cosmetics and as a supplement.

Beekeepers

Worksheet #13 continued

Answer the following questions:

Other than nectar, name two other products that honey bees gather for the hive.

1. _____

2. _____

Other than honey, name two products that honey bees produce.

1. _____

2. _____

Beeswax is not a _____, but rather a bee secretion.

List three products made with beeswax.

1. _____

2. _____

3. _____

What do bees use to transport pollen back to the hive?

What is royal jelly? _____

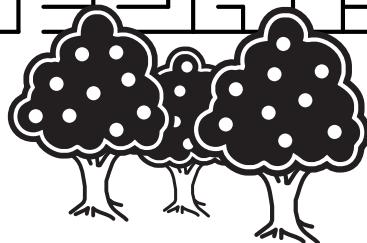
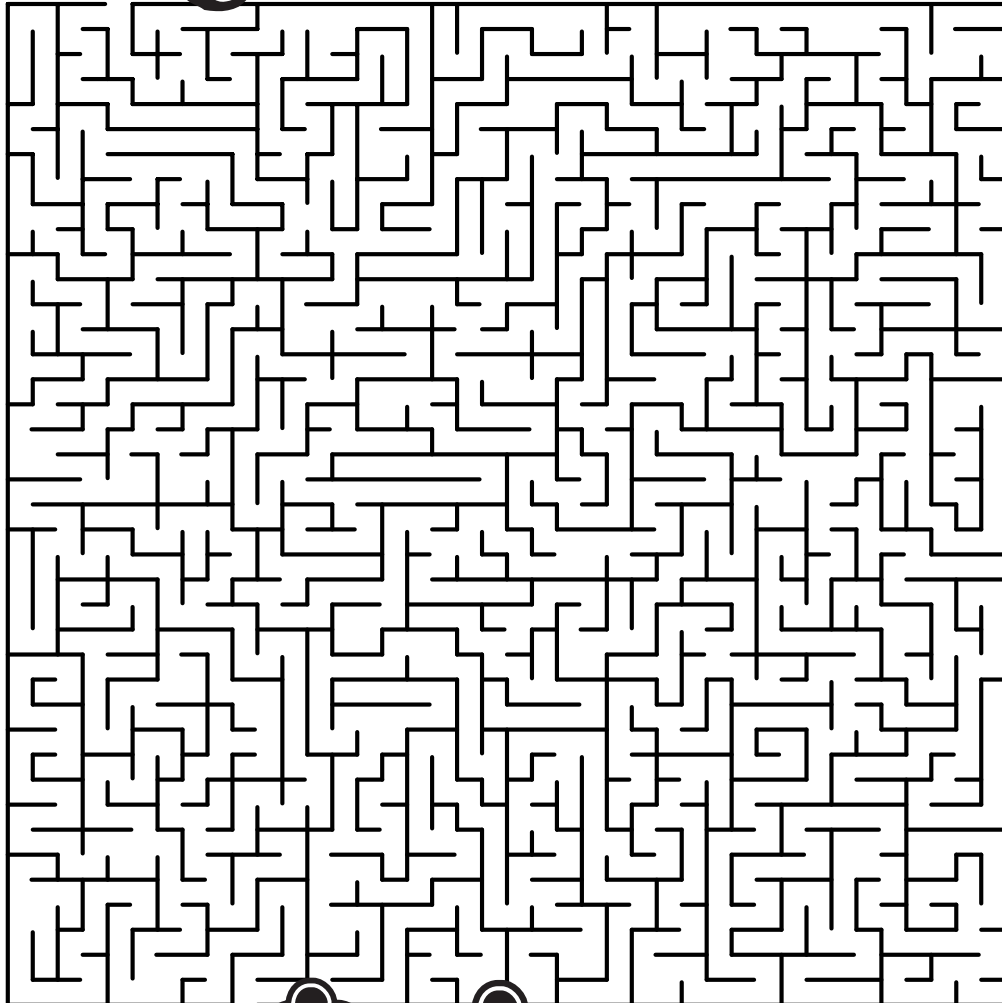
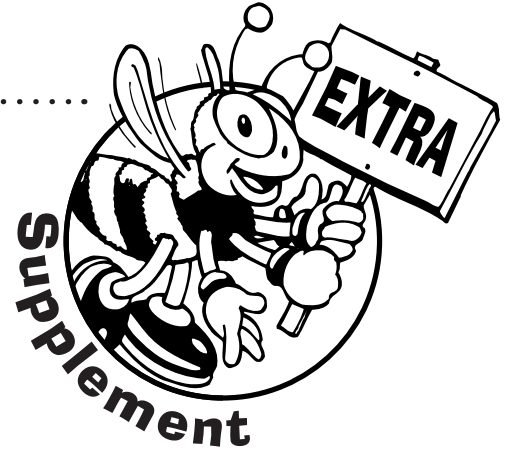
Which bees eat royal jelly after the first three days of life? _____

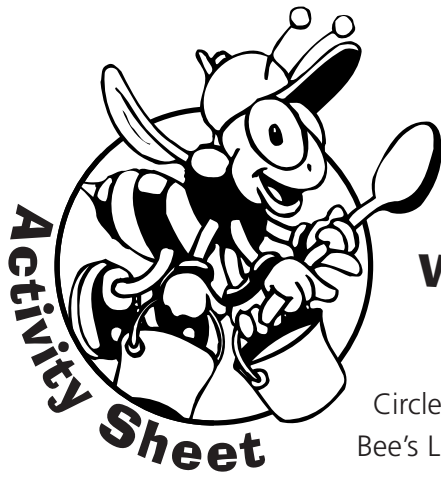
Where does propolis come from? _____

For what purpose do bees use propolis? _____

Beekeepers

Many beekeepers move their bees to pollinate various agricultural crops. Help this beekeeper move his hives to the orchard.





Additional Activities

“The Honey Files: A Bee’s Life” Videotape Worksheet

Circle the best answer to the following questions based on “The Honey Files: A Bee’s Life” videotape.

- 1. How much honey can a honey factory make without the help of bees?**
 - A) There is no such thing as a honey factory. Only honey bees make honey.
 - B) About 10 pounds per year.
 - C) About 200 pounds per year.
 - D) About 35,000 pounds.
- 2. Why do people care about bees?**
 - A) Bees make honey.
 - B) Honey is the only food consumed by humans made by an insect.
 - C) Bees help pollinate fruits, vegetables and other crops.
 - D) All of the above.
- 3. How much honey does one worker bee make in her lifetime?**
 - A) 1/12 of a teaspoon of honey.
 - B) 1 cup of honey.
 - C) 1 gallon of honey.
 - D) 5,000 pounds of honey.

Part 1

- 4. What types of honey bees are found in a hive?**
 - A) Queen.
 - B) Drones.
 - C) Workers.
 - D) All of the above.
- 5. What jobs do worker bees perform to help the hive?**
 - A) Build wax cells.
 - B) Gather nectar and pollen.
 - C) Protect hive from intruders.
 - D) All of the above.

Additional Activities

Videotape Worksheet continued

6. What is the average life span of a worker bee?

- A) About 2 days.
- B) About 45 days.
- C) 5 years.
- D) 85 years.

7. What does a “smoker” do?

- A) A smoker sends signals that the bees should return to the hive.
- B) A smoker is a tool used by a beekeeper to calm the bees.
- C) A smoker helps chase the bees from the hive.
- D) A smoker is used to burn the pieces to make a wooden hive.

8. How is the flavor and color of honey determined?

- A) It depends on the food coloring and flavorings added by the beekeeper.
- B) It is determined by the type of bees.
- C) It is determined by the flowers visited by the bees.
- D) All of the above.

9. What is a centrifuge?

- A) The center of the hive.
- B) A large spinner used to extract honey from the honey comb.
- C) A bee that leaves the hive to join a new hive.
- D) A piece of honey comb in the center of a honey jar.

10. What year was the first man-made beehive used?

- A) 2500 B.C.
- B) 25 A.D.
- C) 1850.
- D) 2000.

Part 2

11. What is the combination of nectar and pollen that is fed to larvae called?

- A) Larvae jam.
- B) Honey.
- C) Beebread.
- D) Nectarines.

Additional Activities

Videotape Worksheet continued

12. What's the first thing a worker bee does when she emerges from her cell as a new adult?

- A) Cleans the cell.
- B) Builds a new wax cell.
- C) Flies out in search of nectar.
- D) Thanks the queen.

Part 3

13. What part of her body does a bee use to suck nectar from flowers?

- A) Antennae.
- B) Wings.
- C) Proboscis.
- D) Thorax.

14. How many flowers must bees visit to make just 1 pound of honey?

- A) 2 flowers.
- B) 12 flowers.
- C) 2,000 flowers.
- D) 2 million flowers.

15. How do bees communicate where to find flowers?

- A) Point their antennae to the flowers.
- B) Perform bee dances.
- C) Buzz loudly.
- D) Create a flower map.

16. What fraction of the human diet is benefited by insect pollination?

- A) 1/100.
- B) 1/10.
- C) 1/3.
- D) All.

Additional Activities

Videotape Worksheet continued

17. What does a “migratory beekeeper” do?

- A) Moves bees to pollinate crops for farmers.
- B) Migrates from Europe.
- C) Migrates from Asia.
- D) Travels to Mexico each summer.

18. How much surplus honey is made in an average hive?

- A) 1 teaspoon.
- B) 1 pound.
- C) 40 pounds.
- D) 80 pounds.

Part 4

19. How many times per minute does a honey bee flap her wings?

- A) 10 times.
- B) 100 times.
- C) 1000 times.
- D) More than 11,000 times.

Part 5

20. How do bees cool the hive?

- A) The bees carry ice cubes to the hive.
- B) They fan their wings to blow cool air into the hive.
- C) They stay inside during daylight hours.
- D) They only bring cool nectar into the hive.

21. How do you change crystallized honey into liquid honey?

- A) You put it in the refrigerator.
- B) You put it in the freezer.
- C) You add milk.
- D) You place the honey container in very warm water.



Additional Activities

Circle the following honey bee words in the puzzle below:

BEEKEEPER, BEESWAX, BUZZ, CLOVER, COLONY, COMB, DRONE, FLOWER, FORAGE, GARDEN, HEXAGON, HIVE, HONEY, INSECT, NECTAR, PETAL, POLLEN, POLLINATION, QUEEN, WORKER

B N P O L L I N A T I O N
J E E Y W R L T V Y F N J
V X E L T L A C L O V E R
E D U S L V T O C R T K T
K R W A W O E L D K Q R C
H O N E Y A P O Q U F O E
I N E Y Y Y X N M L M B S
V E C N G Q L Y O B Q E N
E Y T O Y L E W U A D E I
Q K A G M N E G R G O K Q
B U R A B R Z K E W E E W
U W E X X K U G K R A E C
Z O E E S N E D R A G P L
Z S K H N C X J O F F E Q
F O R A G E L D W H U R U

Additional Activities



Honey Bee Trivia Questions

Divide the class into teams to play this Honey Bee Trivia Game. Students choose the level of difficulty and earn points by correctly answering a question from that point category.

Larva = 1 point questions

Pupa = 2 point questions

Adult = 3 point questions

Larva Questions —1 point each

- What is the food fed to the baby queen bee?
(*Royal jelly*)
- How does a worker bee tell the others when she has found a good source of food?
(*She "dances"*)
- How many times can a single worker bee sting a mammal?
(*Once*)
- What is the only purpose of the drone?
(*To mate with the queen*)
- What are two reasons honey bees are beneficial?
(*Honey production and pollination*)
- How many sides does an individual honeycomb cell have?
(*Six*)
- What do bears and people have in common that can affect bees?
(*They both like honey*)
- What kind of animal is the honey bee?
(*An insect*)
- Which is larger, a worker or a queen?
(*Queen*)
- What is the purpose of a bee veil?
(*To protect the head and face of a beekeeper*)

Additional Activities

Honey Bee Trivia Questions continued

- What are scout bees?
(Worker bees that find new food sources)
- How many days does it take a honey bee egg to hatch?
(Three)
- What is the process called when an insect develops in stages from egg to maturity?
(Metamorphosis)
- How did honey bees originally get to America?
(Honey bees were brought by the pilgrims)
- Name the three body sections of an insect.
(Head, thorax, abdomen)
- What is beebread?
(Pollen mixed with nectar)
- What is the name of the polygon used as honey bee cells?
(Hexagon)
- How many states have crops pollinated by honey bees?
(All 50)
- Name two fruits that rely heavily on honey bees for pollination.
(Apples, blueberries, cherries, watermelon, cantaloupe, honeydew, pears, plums)
- What is the most common type of honey in the United States?
(Clover)

Pupa Questions — 2 points each

- What does a beekeeper use to calm bees?
(Smoke)
- What is the male part of the flower where the pollen is developed and contained?
(Anther)
- Give three tasks of the worker bee.
(Any of the following: hive cleaning, feeding the brood, caring for the queen, feeding the drones, guarding the hive, fanning the nectar, building cells, collecting pollen and nectar)

Additional Activities

Honey Bee Trivia Questions continued

- How many wings do honey bees have?
(Four)
- Name the straw-like appendage that bees use to suck nectar.
(Proboscis)
- Where in the hive does the queen lay eggs?
(Brood chamber or brood cells)
- Where does royal jelly come from?
(It is secreted from a gland in the head of a worker bee)
- Name two tools that a beekeeper would use.
(Any of the following: smoker, hive tool, heat knife, extractor, strainer)
- What are a honey bee's mandibles?
(Jaws)
- Which type of bees develops from unfertilized eggs?
(Drones)
- Why can't drones help to defend the colony?
(Drones do not have stingers)
- Name the two main types of dances honey bees use to communicate.
(Round dance and waggle dance)
- Where do bees store pollen on their return flight to the hive?
(Pollen baskets on their hind legs)
- What is nectar?
(The sugary liquid found in flowers)
- What do you call the colorful, thin structures of a flower that attract insects and protect the pistil and stamen?
(Petals)

Additional Activities

Honey Bee Trivia Questions continued

Adult Questions — 3 points each

- The color of honey is a result of what?
(The kind of blossoms the bees are gathering nectar from)
- Which spends more days in the cell as an immature bee, the worker or the queen?
(Worker bees take five days longer to completely develop)
- Why are honey bees called social insects?
(They share the same dwelling and practice division of labor)
- What is it called when the ovules of a plant receive the pollen developed in the anthers?
(Pollination)
- Name two products, besides honey, that bees make.
(Wax, royal jelly)
- Why is it a good idea to wash your clothes after being stung?
(Because when bees sting they leave behind a pheromone that attracts other bees)
- Name two things a beekeeper needs to do to help the hive survive through a long winter.
(Feed the bees and shelter the hive)
- Why are the stingers of the wasp and hornet reusable while the stinger of the honey bee kills the bee?
(The honey bee's stinger is barbed. Hornet and wasp stingers are smooth)
- Why can't drones gather their own food?
(They do not have a long enough proboscis and can therefore not suck nectar)
- What is propolis?
(The sticky substance collected by bees used to construct and seal parts in the hive and protect the hive from the elements)
- What do you call the female elements of a flower?
(Pistil)
- What do you call the male elements of a flower?
(Stamen)

Additional Activities

Honey Bee Trivia Questions continued

- Name three products made with beeswax.
(Lipstick, other cosmetics, shoe and floor polish, artists' crayons, buffing wax)
- What is a migratory beekeeper?
(A beekeeper who moves hives around the country pollinating crops for farmers)
- When humans first kept bees, how did they do it?
(In logs or clay pots)
- What attracts bees?
(Sweet scents, bright colors and movement)
- How long does an adult worker bee live in the summer?
(An average of 45 days)
- What does foraging mean?
(Searching out food and water)



Additional Activities

Honey Bee Math

Answer the following questions using these honey bee facts.

Weight of average worker bee: 80 milligrams

Amount of nectar the honey sac can hold: 70 milligrams

Amount of pollen a worker can carry in the pollen baskets: 20 milligrams

Maximum number of eggs laid daily by the queen: 3,000

Average number of trips a worker bee makes outside the hive each day: 10 trips

Average speed of a worker bee in flight: 15 miles per hour

Average distance from hive a worker bee travels in one trip: 1-1/2 miles

Average life of a worker bee in the summer: 45 days

1. What is the average total weight a worker bee carries in both nectar and pollen per trip?
Amount of nectar _____ + amount of pollen _____ = _____ Total Weight
2. What is the amount of nectar one worker bee could contribute to the colony in one day?
Amount of nectar carried in one trip _____ x number of trips in one day _____ = _____ Total Nectar
3. What is the ratio of the total weight of a full load of nectar and pollen carried by the worker bee in one trip as compared to her body weight?
4. If you could carry the same amount of weight in comparison to your body weight as a honey bee, how much weight could you carry?
5. Approximately how many weeks does a worker bee live in the summer?
6. About how long would it take a worker bee to fly to a garden 2 miles away?

Additional Activities

Honey Bee Math continued

7. If a worker bee completes 10 trips to a garden $\frac{3}{4}$ of a mile away, how many total miles has she flown?
How much time has she spent flying in that day?

8. How many miles does the average worker travel in one day?

9. What is the maximum number of eggs a queen bee could lay in one week?

10. How many days would it take a queen to lay 12,000 eggs?

11. What is the maximum number of eggs a queen bee could lay in a year?

12. If a hive has 48,000 bees, approximately how long would it take the queen to lay that many eggs?

13. If a hive has 60,000 bees and 1 percent of those bees are drones, how many drones are in the hive?

14. Since there are 1,000 milligrams in a gram, about 28 grams in an ounce, and 16 ounces in a pound, how many milligrams of pollen would equal one pound?

15. Since a bee can beat her wings 183 times per second, how many times can she beat her wings in one minute?

Additional Activities

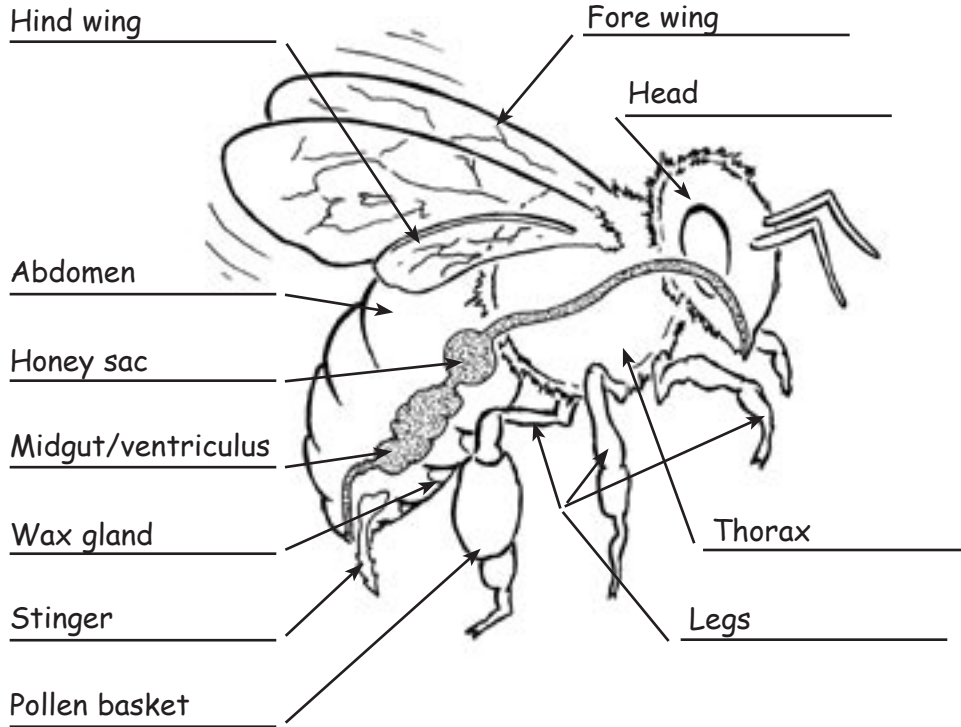
Honey Bee Math continued

16. If one worker bee will gather $\frac{1}{12}$ of a teaspoon of honey in her lifetime, how many bees would be necessary to gather 1 pint of honey?
(3 teaspoons = 1 tablespoon, 16 tablespoons = 1 cup, 2 cups = 1 pint)
17. If honey bees visit 2 million flowers to make one pound of honey, how many flowers would the bees need to visit to make a ton of honey?
18. If you wanted to make four hexagons on a flat surface out of toothpicks, what is the least amount of toothpicks needed for your design?
19. During its first day, a larva eats so much that its weight increases five and a half times. If the same thing happened to a student weighing 70 pounds today, how much would he or she weigh tomorrow?
20. If a worker bee can visit ten flowers a minute, and visits 600 flowers before returning to the hive, how long will she be out foraging?

Answer Key

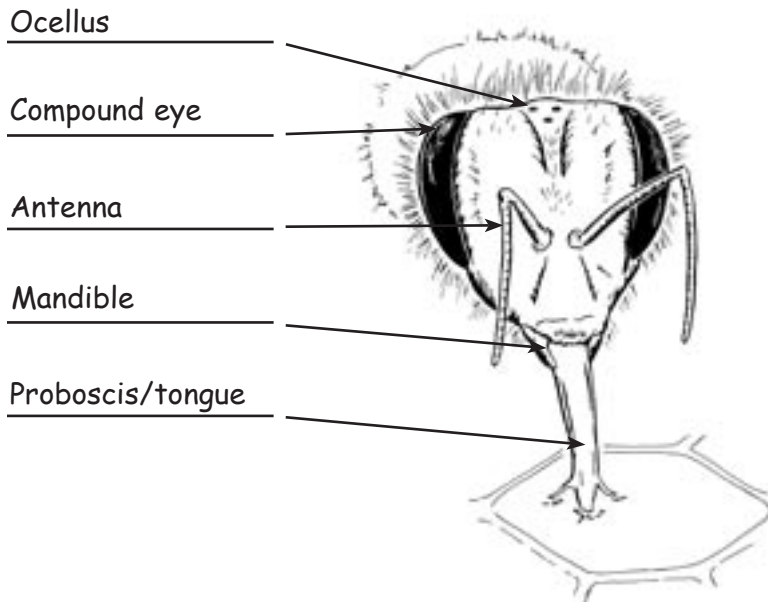
Answer Keys

Worksheet #1



Label the following:

- Abdomen
- Fore wing
- Head
- Hind wing
- Honey sac
- Legs
- Midgut or ventriculus
- Pollen basket
- Stinger
- Thorax
- Wax gland



Label the following:

- Antenna
- Compound eye
- Mandible
- Ocellus
- Proboscis or tongue

Answer Key

Worksheet #2

- C Stage at which eyes, legs, and wings grow
- B Is fed by worker bees
- B Shows the greatest change in size
- A Is about the size of the dot on an "i"
- D Chews its way out of the cell
- A A soft, white oval

True or False

- F A drone is fed only royal jelly during the entire larval stage.
- T Queens develop in the largest brood cells.
- T A drone takes the longest to develop into a mature adult.
- F It takes weeks for a honey bee egg to hatch into larva.
- T Inside a cocoon, the pupa begins to look more like an insect than a worm.
- F A honey bee egg is about the size of your thumb nail.
- T Only a drone develops from an unfertilized egg.
- F All honey bees fully develop in two weeks.

What determines whether a honey bee will be a worker or a queen?

Larva destined to become a queen is fed only royal jelly.

What type of eggs will become drones (male bees)?

Unfertilized eggs

What is fed to developing larvae?

Royal jelly for the first three days, then beebread

How does a fully developed honey bee make its way out of the brood cell?

It chews its way through the wax cap.

Worksheet #3

Queen

Largest honey bee
Long abdomen
Shiny thorax
Reusable stinger

Worker

Smallest of honey bees
Long proboscis
Pollen baskets
Stinger

Drone

Larger than workers
Rounded abdomen
Huge compound eyes
No stinger
No wax glands

Answer Key

Worksheet #3 continued

Why can't drones gather their own food?

Proboscis is too short to gather nectar.

Why can't drones defend the colony?

Drones don't have stingers.

Why can worker bees usually only sting once?

The worker's barbed stinger stays in its victim and when the bee pulls away, part of her abdomen pulls off.

What would happen to a honey bee colony if there were no queen?

The colony would die off as soon as all the bees died because there would be no more eggs laid.

What would happen to a honey bee colony if there were no drones?

The queen could not mate and therefore would no longer lay eggs. The colony would die.

Worksheet #4

What are two characteristics of all insects?

Six legs and three body sections

What other flying insects are black and yellow in color and therefore often mistaken for honey bees?

Bumblebees, carpenter bees, paper wasps, yellowjackets

Give two examples of solitary bees.

Sweat bees and leafcutter bees

What insects are likely to make their home in the ground?

Sweat bees, bumblebees and yellowjackets

What flying insects tend to be aggressive?

Paper wasps and yellowjackets

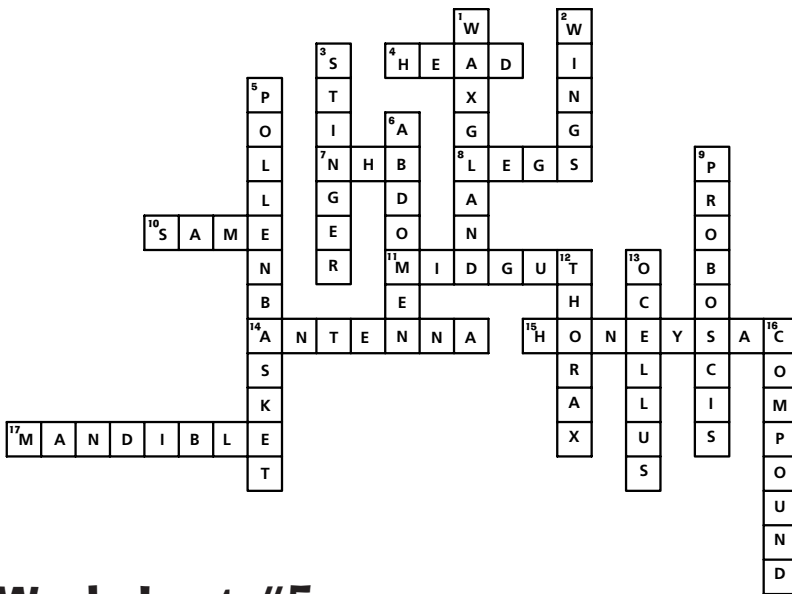
True or False

- T Bumblebees are usually not aggressive.
- F Bumblebees use dances to communicate with each other.
- T Carpenter bees largely resemble bumblebees.
- F Leafcutter bees make their homes in large, hollow logs.
- F Sweat bees are called such because they perspire.
- F Sweat bees look a lot like honey bees.

Answer Key

Worksheet #4 continued

- F Paper wasps have pollen baskets in their legs.
- T Paper wasps build their homes from plant fiber or wood.
- T Yellowjackets are a type of wasp.
- F Paper wasps and yellowjackets eat only nectar.



Worksheet #5

Which bee is responsible for laying all the eggs?

Queen

What is the sole job of a drone?

To mate with the queen

List four duties of a house bee:

Clean the hive

Feed larvae

Build wax cells

Make honey

How does a worker bee know when to perform each of her many duties?

Worker honey bees are guided by an inner clock.

When does a worker bee first leave the hive?

After approximately 3 weeks

Answer Key

Worksheet #5 continued

List three things field bees gather.

(Three of the following): Pollen, nectar, propolis and water

What does foraging mean?

Gathering food and supplies

How many trips will a single worker bee make in one day?

Approximately 10

Worksheet #6

When bees search for food, it is called foraging.

Worker bees gather pollen and nectar to feed to the larvae and other bees.

The sweet fluid produced by flowers is known as nectar.

When nectar is mixed with enzymes from a honey bee it becomes honey.

How do bees help the process of evaporating water from the honey? Fan their wings.

How do bees gather pollen while visiting flowers? Pollen sticks in the hairs that cover a honey bee's body.

The special areas on the hind legs of honey bees for storing pollen are called pollen baskets.

Nectar and pollen mixed together to feed larvae is called beebread.

How do honey bees store honey for future use? In wax cells.

Honey bees can fly up to 6 miles from the hive in search of food.

Supplemental Worksheet: Matching Hives

- I A group of honey bees living together
- C A bee's home
- G A milky, yellow syrup that is very high in protein, that young worker bees secrete from glands inside their heads and feed to larvae.
- A A sweet liquid secreted by glands in the flowers of plants
- K The offspring produced by the colony
- H Female bees with only partially developed ovaries
- B Six-sided cells of wax
- E A substance produced in the queen's mandibular gland
- D Yellow powdery substance produced on flowers
- F A substance secreted from the glands located on the underside of worker bees
- J Bee food made from nectar and pollen

Answer Key

Worksheet #7

What do we call honey bee homes? Hives

A group of honey bees living together is called a colony.

Honey bee homes are made up of several wax panel-like structures called honeycomb.

A multi-sided, geometric shape with three or more line segments is called a polygon.

A shape with six equal sides and six angles is called a hexagon.

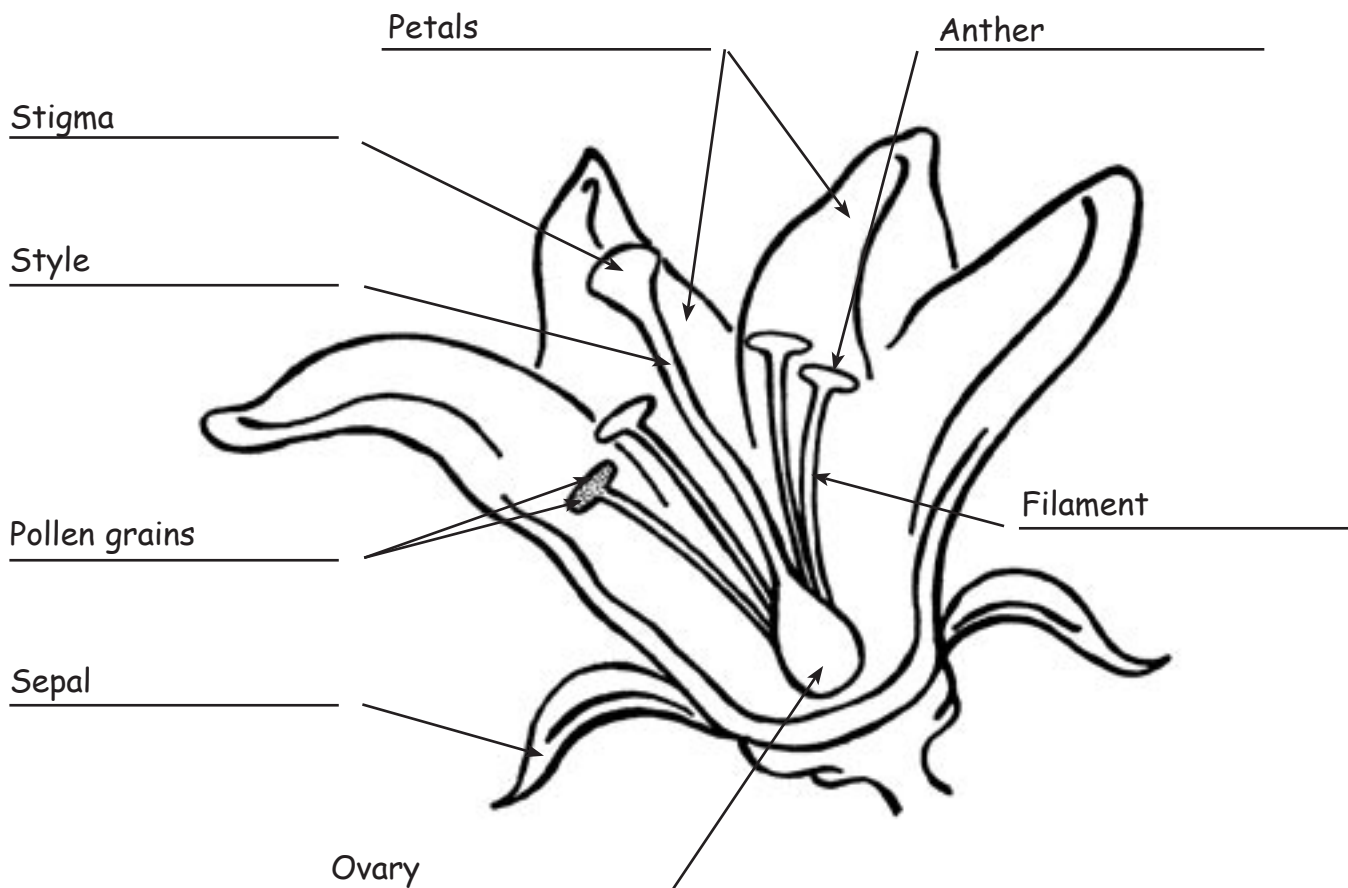
The small, six-sided wax compartments inside the hive are called cells.

List three uses for these six-sided compartments. Raising baby bees, storing pollen, storing honey.

The cells that house the developing honey bees are called brood cells.

The substance collected and used as glue by honey bees to construct and seal parts in the hive is called propolis.

Worksheet #8



Answer Key

Worksheet #9

How many states have crops pollinated by honey bees? All 50

What region of the United States uses honey bees to pollinate alfalfa crops? West or Northwest

Which two states rely on honey bees to pollinate sunflowers? North Dakota and South Dakota

Honey bees pollinate watermelons in what region of the United States? South

In which two states do honey bees pollinate avocados? California and Florida

What crops does Wisconsin use honey bees to pollinate? Cranberries and cucumbers

List three states that are producing apples, thanks to honey bees. Michigan, New York, Washington

List three states that produce blueberries with the help of honey bees. (any three of the following):

Michigan, Maine, New Jersey, North Carolina, Georgia, Oregon

Which state seems to rely the most on the honey bee? California

Name five fruits that rely heavily on honey bees for pollination (any five of the following):

Apples, watermelons, cherries, cranberries, blueberries, pears, plums

Worksheet #10

Why are honey bees so interesting to scientists?

Honey bees have remained unchanged for twenty million years.

After the Ice Age, what did man use to hunt bees? Torches

What helps calm bees? Smoke

Who were the first beekeepers? Ancient Egyptians

What did the Romans use in the first century B.C. to paint pictures? Dyed beeswax

In what did beekeepers keep bees during the Middle Ages? Straw skeps

How did honey bees first come to America? Pilgrims brought honey bees to America.

Approximately how many years did it take the honey bee to migrate across the

American Continent? Approximately 200 years

Why did pioneers trap honey bees in boxes?

Pioneers wanted to follow bees back to their hives so that they could get the honey.

What was invented in 1852 that helped the honey business to boom? Movable-frame beehive

Answer Key

Worksheet #12

- Bottom board
- Coveralls
- Gloves
- Frame
- Hive body or brood chamber
- Helmet
- Honey super
- Inner cover
- Outer cover
- Smoker
- Veil

Outer cover

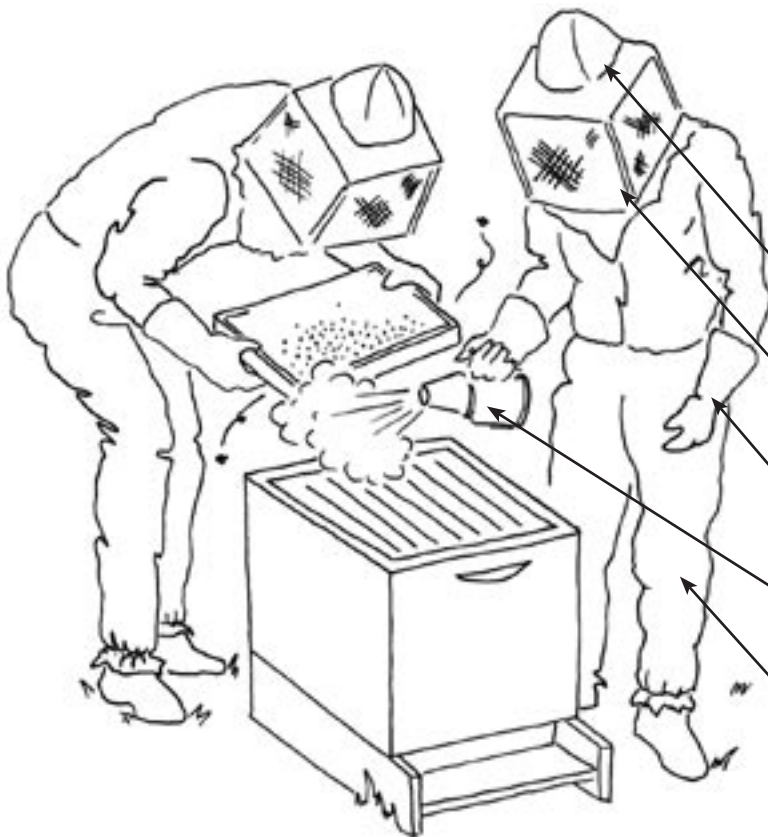
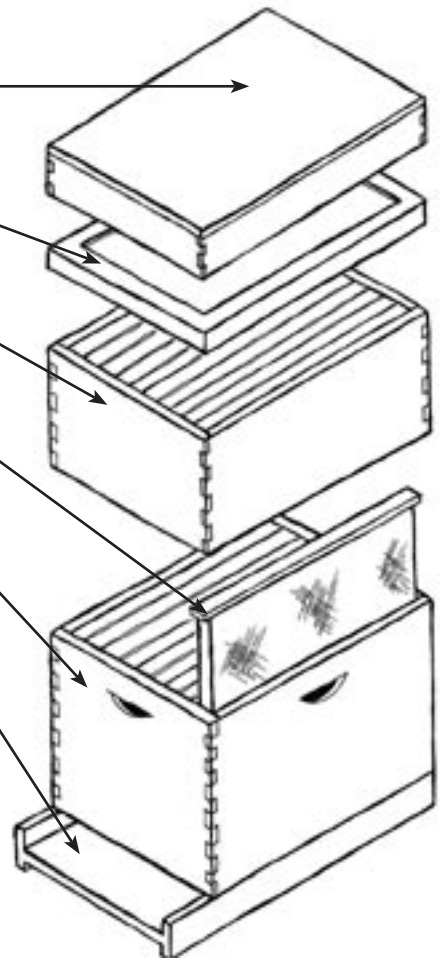
Inner cover

Honey Super

Frame

Hive body or brood chamber

Bottom board



Helmet

Veil

Gloves

Smoker

Coveralls

Answer Key

Worksheet #13

Other than nectar, name two other products that honey bees gather for the hive.

(two of three) pollen, propolis, water

Other than honey, name two products that honey bees produce. beeswax, royal jelly

Beeswax is not a plant product but rather a bee secretion.

List three products made with beeswax (any three of the following):

lipstick, candles, shoe and floor polish, buffing wax, artists' crayons

What do bees use to transport pollen back to the hive? pollen baskets

What is royal jelly?

Royal jelly is a whitish fluid secreted from the glands on the head of worker.

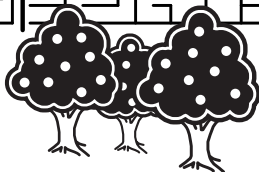
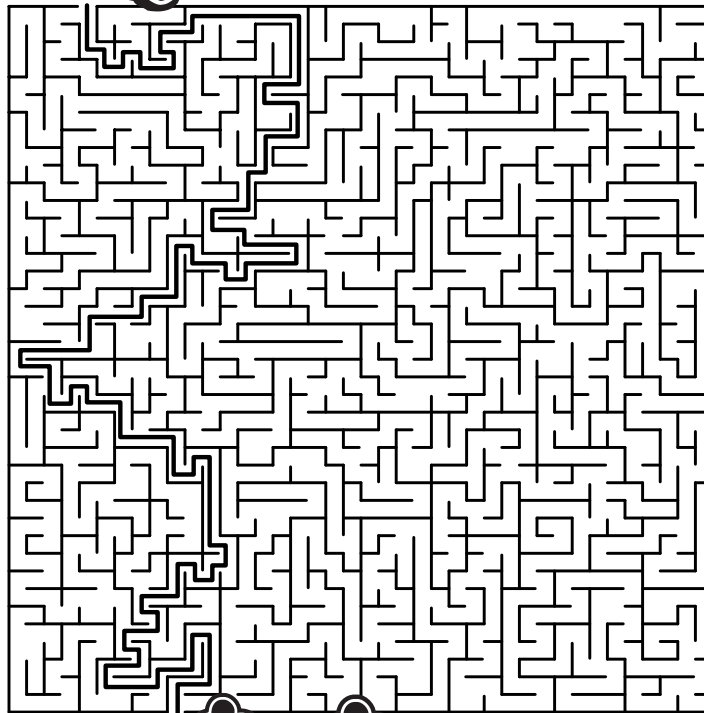
Which bees eat royal jelly after the first three days of life? Queens

Where does propolis come from? Propolis comes from the leaf buds of trees.

For what purpose do bees use propolis? Bees use propolis to seal and protect the hive.

Supplemental Worksheet

Migratory Beekeeper Maze



Answer Key

Videotape Worksheet

1. a 2. d 3. a 4. d 5. d 6. b 7. b
8. c 9. b 10. a 11. c 12. a 13. c 14. d
15. b 16. c 17. a 18. d 19. d 20. b 21. d

Honey Bee Math

- 90 milligrams
- 700 milligrams
- $90/80 = 1.125$
- Student's weight $\times 1.125$
- $45 \text{ days}/7 = \text{approximately } 6\text{-}1/2 \text{ weeks}$
- 8 minutes
- $1.5 \text{ miles roundtrip} \times 10 \text{ trips} = 15 \text{ miles}; 1 \text{ hour}$
- $1.5 \times 2 = 3 \text{ miles roundtrip} \times 10 \text{ trips} = 30 \text{ miles}$
- $3,000 \times 7 = 21,000$
- $12,000/3,000 = 4 \text{ days}$
- $3,000 \text{ eggs} \times 365 \text{ days} = 1,095,000 \text{ eggs}$
- $48,000/3,000 = 16 \text{ days}$
- $60,000 \times .01 = 600 \text{ drones}$
- $1,000 \times 28 = 28,000 \text{ milligrams in } 1 \text{ ounce}$
 $28,000 \times 16 \text{ ounces} = 448,000 \text{ milligrams in } 1 \text{ pound}$
- $183 \times 60 = 10,980 \text{ beats in } 1 \text{ minute}$
- 12 bees to make 1 teaspoon $\times 3 = 36 \text{ bees to make } 1 \text{ tablespoon of honey}$
 $36 \times 16 = 576 \text{ bees to make } 1 \text{ cup of honey}$
 $576 \times 2 = 1,152 \text{ bees to make } 1 \text{ pint of honey}$
- $2,000,000 \times 2,000 = 4,000,000,000 \text{ flowers visited to make } 1 \text{ ton of honey}$
- 19 toothpicks
- $70 \times 5\text{-}1/2 = 385 \text{ pounds}$
- $600/10 = 60 \text{ minutes or } 1 \text{ hour}$

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For information on ordering "The Honey Files: A Bee's Life" videotape, call the National Honey Board at (303) 776-2337 or visit www.honey.com.



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