National Institute of Food and Agriculture

U.S. DEPARTMENT OF AGRICULTURE

STEMsational Ag: The Virtual Farm

MIDDLE TENNESSEE STATE UNIVERSITY

Module 10: Feed the Bees

UNIT 2: BEE LIFE

Grades 6 - 8

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STEMsational Ag—The Virtual Farm

Welcome to Module 10
Unit 2: Bee Life

Introduction:

- Draw on a dry erase board or blank paper what you think a honeybee looks like and where a honeybee lives.
- If you're in a classroom setting, discuss with the class the different features that you include in your drawing.
- Individual learners, discuss your drawing with a parent or another adult.

Pre-assessment:

- Fill out the KWL chart.
- In a classroom setting, discuss what the students write down under the "What I Know" column.
- Individual learners, discuss your responses with a parent or another adult.
- "What I Learned" will be filled in at the end of the lesson in the post-assessment.

KWL Chart: Organize Your Thoughts!

KWL Chart: Organize Your Thoughts!

Write everything you know about honey bees, 5 things you want to know, and 5 things you learned once the lesson is completed.

I KNOW	I WANT TO KNOW	I LEARNED

Purpose:

Students will gain an understanding of the lifecycle of a honeybee, how to differentiate between a worker, queen, and drone bee, and know the main tasks honeybees must complete to keep the colony running smoothly.

Student Learning Outcomes for the Unit:

- Student will create a lifecycle of a honeybee.
- Student will be able to differentiate between a worker, queen, and drone bee.
- Student will be able to identify and explain the main tasks worker bees must complete to keep the colony running and achieve pollination of our flowers and agricultural crops.

National Agricultural Literacy Outcomes

Food, Health, and Lifestyle Outcomes, Theme 3

T3.6-8

I. Identify sources of agricultural products that provide food, fuel, clothing, shelter, medical, and other non-food products for their community, state, and/or nation.

Vocabulary:

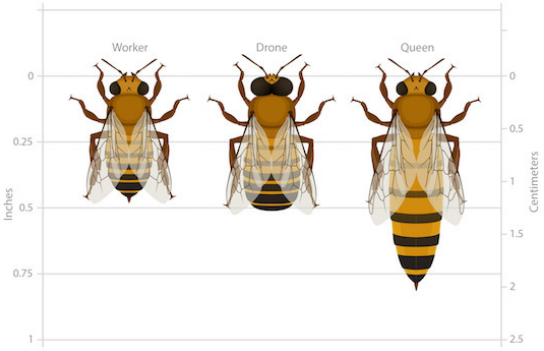
- **Brood:** immature bees that have not yet emerged from their cells. Brood can be in the form of eggs, larvae, or pupae at different ages
- **Cell:** the hexagonal compartment of comb built by honeybees
- **Colony:** all the worker bees, drones, queen, and developing brood living together in one hive or other dwelling
- **Comb:** a mass of six-sided cells made by honeybees in which brood is reared and honey and pollen are stored; composed of two layers united at their bases
- **Drone:** the male honeybee
- **Forager bee:** worker bees generally two to three weeks old that work to collect nectar, pollen, water, and propolis for the colony
- **Guard bee:** worker bee that protects the colony from predators
- **Hive:** the structure used by bees for a home

Vocabulary: (cont.)

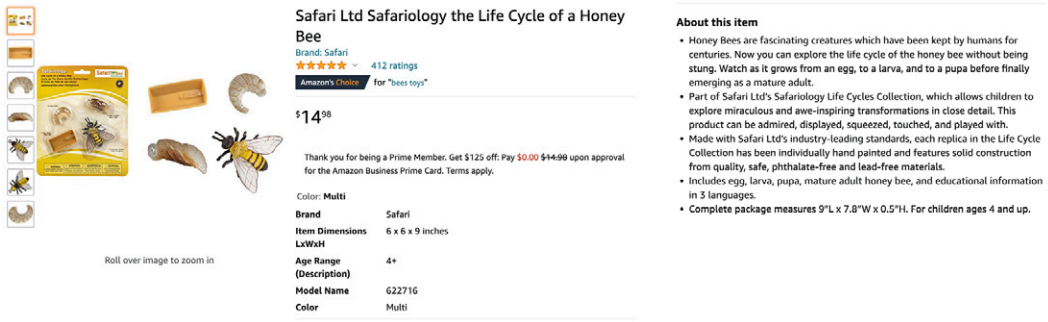
- **Larva (plural, larvae):** the second stage of bee metamorphosis; a white, legless, grublike insect
- **Life cycle:** the series of changes that the members of a species undergo as they pass from the beginning of a given developmental stage to the inception of that same developmental stage in a subsequent generation (a queen bee lays an egg, a larvae hatches from the egg, this is the baby bee, a larva grows into a pupa, this is a teenager bee and finally the pupa grows into an adult honeybee.)
- **Nectar:** a sweet and often fragrant liquid secreted by the nectaries of plants for attracting animals. Nectar is the raw product of honey
- **Nurse bee:** young bees, three to ten days old, which feed and take care of developing brood
- **Pollen:** the male reproductive cell bodies produced by anthers of flowers. It is collected and used by honeybees as their source of protein
- **Pupa:** the third stage in the development of the honeybee, during which it changes (pupates) from a larva to an adult bee
- **Queen:** a female bee with a fully developed reproductive system, and she is larger and longer than a worker bee
- **Royal jelly:** a highly nutritious glandular secretion of young bees, used to feed the queen and young brood
- **Scout bees:** worker bees searching for a new source of pollen, nectar, propolis, water, or a new home for a swarm of bees
- **Stinger:** the modified structure of a worker honeybee used as a weapon of offense. Honeybees have a barbed stinger which stays embedded in the recipient of sting cause the bee to later die
- **Worker bee:** a female bee whose reproductive organs are undeveloped. Most of the honeybees are worker bees, and they do all the work in the colony except for laying fertile eggs

Materials Needed:

- Supplies for building the honeybee lifecycle model:
  - 1 piece-Construction paper
  - 1-Empty toilet paper or 1 paper towel roll cut into ½ inch pieces (make 4 hexagons)
  - 1 bottle-Clear glue
  - 1-Grain of rice
  - 1-Dry, C-shaped pasta noodle (example, macaroni noodle)
  - 1-Small container of white play dough or modeling clay
    - You can find honeybee cutouts used in the course on this website from **Arizona State University, "Bee Bonanza: The Story of Honey Bees,"** **https://askabiologist.asu.edu/bee-colony-life**



    - Optional: You can purchase **"Lifecycle of the Honey" on Amazon**



- 6-Labels (type them or write them on paper and cut them out)
- 1-Pair of scissors

Complete One of the Activity Options

Option 1

For a classroom activity, have a beekeeper come in and talk to students about beekeeping.

Option 2

Video call a beekeeper and take a tour of their apiary.

Option 3

Look at the screenshots and read the narration from
"Bees and Beekeeping for Kids" (pages 7-22)" and
"What You'd See If You Could Walk Into a Beehive (pages 23 - 35)

Bees and Beekeeping for Kids

https://youtu.be/4D_6ugaukIY

Hi Junior Rangers! Welcome back to the Ranger Zak Show. Let's play a game. I'm going to think of a food, and you have to tell me what I'm thinking of. Sound good? Well, okay. The food I'm thinking about is golden in color. It's sweet, sticky, goes great on biscuits, doesn't have to be refrigerated, and never goes bad even after 3,000 years.

Is your tummy rumbling? And, your mouth watering yet? Well, if it is, you're probably thinking what I'm thinking. It's honey, and we all know where honey comes from, right?

That's right! Bees!

So today, let's see what all the buzz is about as we learn about the busy bee.

Well, Junior Rangers, today we have two very special guests, Jr. Ranger Gavin and Jr. Ranger Grady. Say hi, boys!

Gavin is 11 years old, and he's been keeping and learning about bees since he was eight. *Actually, seven and a half.* Seven and a half!

And Grady, how old are you? *I'm five.* Five? You must be the youngest beekeeper on the planet. *Well, maybe.* Well, boys, before we get started, can you tell the Jr. Rangers at home why we're wearing these fancy-looking clothes? *This is a bee suit, and it prevents us from being stung.*

That's right, Junior Rangers! Many of you know, that when bees are scared or protecting the hive, they might give you a painful sting. But, here's something you may not know ...

Not all bees can sting. And those that can don't really want to sting you. Just like when you get scared, you might give a little shout. Well, when a bee gets scared, they might give a little sting which makes bees scary at first.

But the more that we learn about these amazing little creatures, the more that we can see them for the beautiful and important animals that they are.

Gavin, were you scared of bees when you first started beekeeping?

Yes, I was. When I first started beekeeping, I got stung for the first time, and it really scared me.

But, after learning about the bees and keeping them for a while, I learned that they aren't so scary.

It looks like you've come a long way since then. So Gavin, can you tell me what we're going to be doing in the hive today?

Today we're doing an inspection. And, in that inspection, we're looking for eggs, larvae, worker bees, drone bees, and the queen bee.

Okay, Ranger Zak, we're gonna get into this hive, and you're gonna be in charge of the smoker.

You got it, Gavin.

The smoke inside this can helps relax the bees before we open the hive.

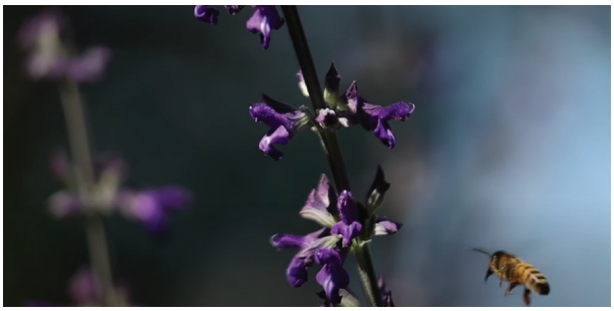
This hive is made up of two boxes, and a single box could contain thirty thousand bees. So there could be sixty thousand bees flying around us right now!

Bees make their home in hives and all the bees living together in the hive is called a **colony**. Inside a colony, you'll find several types of bees.

When you see a bee buzzing from flower to flower, chances are you're looking at a **forager** (one of the jobs of a worker bee). Her main goal in life is to visit as many flowers as she can. When she lands on a flower, she uses her long tongue called a **proboscis** to slurp up nectar which she stores in her honey stomach.

That's right! Bees have a special stomach for honey, but we'll get to that later.

A single forager may visit 5,000 flowers a day, drinking up nectar and collecting pollen.



This is a queen bee. We can tell that it's the queen because it's bigger than the other bees. Her body is larger because her main job is to be an egg-laying machine. She lays as many eggs as she can and ensures that there are enough bees to keep the colony running. And even though she doesn't wear a crown, she still gets waited on hand and foot. The worker bees feed and groom her so that she can focus on pumping out those eggs.

She lays the eggs inside a little baby cradle of wax. See these here? They look like grains of rice, but these are bee eggs. The eggs hatch into larvae, and larvae turn into pupae. Pupae turn into baby bees.

Look carefully as this baby bee emerges from her capped wax cradle. Oh, look at you! All grown up!

The only males in the hive are called drones. You can tell a drone from a worker by their large black eyes. And their job is to mate with other queens so that they can lay more eggs.

Now we come to the good stuff. Honey! Bees make honey by drinking nectar - and here's what they don't teach you in school - by throwing it up again, and again, and again! Here's the story.

When a forager lands on a flower, she drinks a little bit of nectar and stores it in her honey stomach. Now, she may have to visit 1,000 flowers to fill up her honey stomach, but, once she does, she flies back to the hive. Once she's back in the hive, get ready for the icky part!

She throws it up into the mouth of another bee. And that bee throws it up into the mouth of another bee, and then another bee, and another bee, and another bee! And this process may sound gross, but it's actually an incredible talent.

As the nectar moves from one honey stomach to the next, it becomes thicker and loses more and more water until it becomes ... honey!

I love honey! Liquid honey! Honeycomb! Creamed honey! Honey on toast! Honey on biscuits! Honey on chicken nuggets!

Honey on pizza!?

Are you ready for your Ranger Zak fun fact? Well, here it is. Honey is the only food on the planet that never goes bad.

In fact, archaeologists have found honey inside the tombs of ancient Egyptians which means if you found it you could be eating mummy honey!

Bees aren't just important because they make delicious honey for us to eat.

Gavin, why don't you tell the Junior Rangers at home what the world would be like if there were no bees. *There would be a lot less food because about one-third of the food that you put in your mouth is pollinated by bees.*

Think back to all those flowers that one worker bee might visit each day. Each time a bee visits a flower, it moves pollen from one flower to the next.

This process is called pollination, and flowers need it to produce fruits, vegetables, and seeds which help make sure that the plant can grow to the next generation.

Well, Junior Rangers, thanks for showing me around the hive today!

No problem, Ranger.

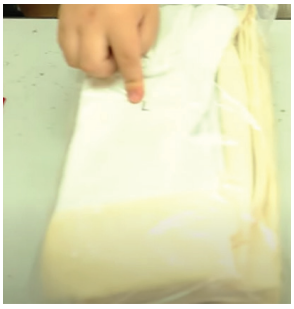
If our Junior Rangers at home wanted to become beekeepers like you, how could they get started?

You could head over to our shop OCB Supplies.

Let's head there now and put together a starter kit.

Hi Junior Rangers, we're back! And we're at OC Beekeeping Supplies in Fullerton, California, and I'm here to show you what you're going to need to become a backyard beekeeper:

a bee suit,



gloves,

a hand tool,

a smoker,

and the actual Beehive.

And before we say goodbye, Gavin and Grady are gonna build us our very first beehive. *Okay, Junior Rangers, I'm gonna teach you how to build a beehive.*

All you need is a bottom ...

a box ...

some frames ...

and a top!

It's that easy!

Hi, Junior Rangers! Welcome back to the ranger station! I sure had a lot of fun learning about bees and beekeeping with Grady and Grayson today.

If you want to try some honey made by the bees that we hung out with, make sure to check out their website at hapahoneyfarm.com. And, you can try some of their blue-ribbon, award-winning honey.

Look at the screenshots and read the narration from
"What You'd See If You Could Walk Into a Beehive."

What You'd See If You Could Walk Into a Beehive

https://youtu.be/clwSy1N9BvQ

Bees first appeared on Earth 130 million years ago,

and they outlived dinos.

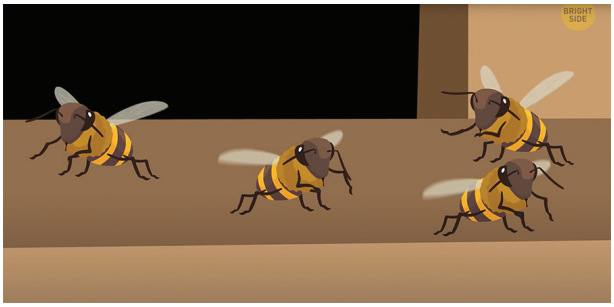
What helped them survive for so long is the incredibly complex structure of their society and teamwork. Each bee has its own role and responsibility.

Some of them build and repair their home.

Some bees protect it.

Others clean the hive and get food.

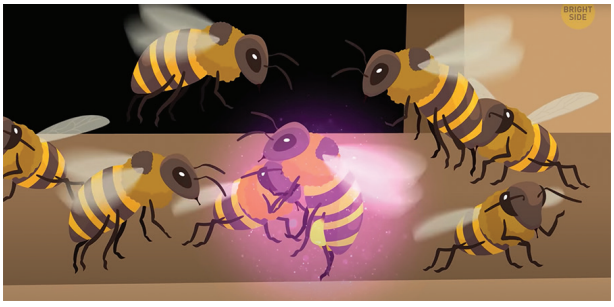
But, what if you could sneak into a hive and figure out how this whole system works? What would you see inside?



For some mysterious reason, it's easy for you to get past the guards; but, if you were a bee from another colony, they wouldn't let you in without a fight. The guard bees look rather intimidating.

They stand on their back four legs at the hive's entrance with their front legs raised in the air. These bees inspect every insect entering the hive with their antennae and front legs.

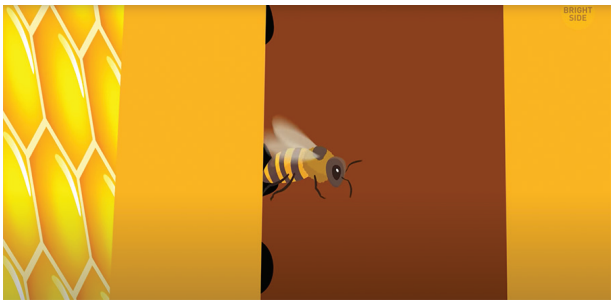
Each hive has its own odor, and the guards can understand if a bee belongs to their colony by smelling it. Only the bees that live in the hive can get inside.



Suddenly you see something strange. One of the guard bees has detected an intruder! An alien bee must have mistakenly tried to enter the wrong hive. But, it's carrying a load of nectar, and the guard lets it in. Apparently, they don't mind accepting free gifts of food even from strangers.

You feel too curious to linger there any longer. The hive has only one entrance. You notice that the walls around it look strange. You take a closer look and understand that it's coated with a thin layer of some substance. It's **propolis** (hardened plant resin produced by bees). It helps fight infections and cures different health problems.

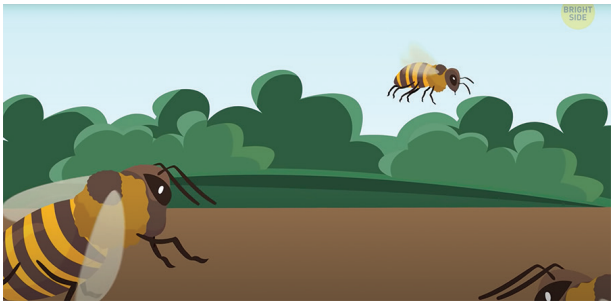
A bit further, you can see countless honeycombs - their densely packed hexagonal cells made of beeswax. Bees use them to store food, pollen, and honey. That's where they keep eggs, larvae, and pupae.



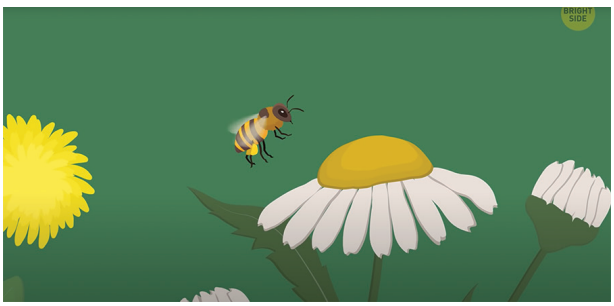
Honeycombs are fixed to the walls of the hive. They stretch from top to bottom and are even attached to the sides. But, you spot narrow passageways along the comb edges. Bees use them to move around the hive. You might also be able to squeeze through one of these tunnels.

After exploring the place, you figure out that bees store honey in the upper part of the comb. Beneath there are cells that contain pollen. Then, there are cells used for keeping eggs with future worker bees. And, at the very bottom, there are drone eggs.

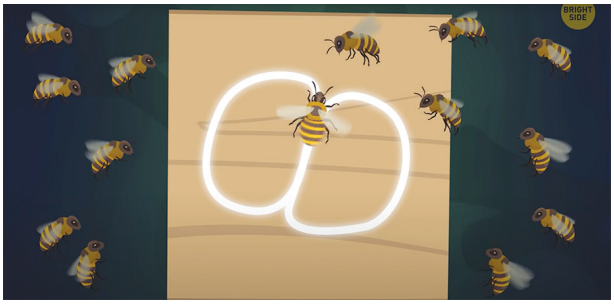
Of course, your ultimate goal is to see the queen bee, but it's not that easy to find her. First, you come across lots of other bees. Most of them are workers. They make up the largest part of the hive's population, and they're all ladies. Each of them has its own task; the most common of them is foraging.



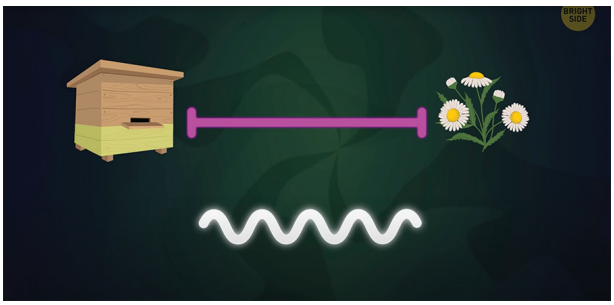
You spot a bee leaving a hive and decide to follow it. The queen can wait a bit. You want to see how bees provide food for the hive. The bee is buzzing ahead of you.



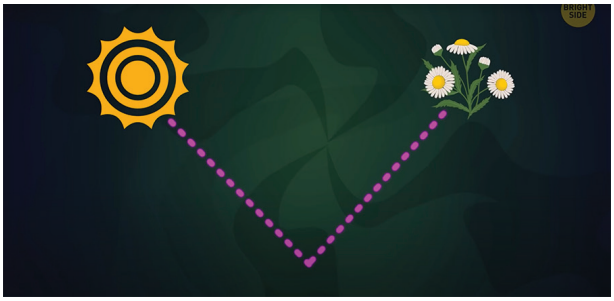
After visiting a couple of flowers, it suddenly starts wiggling while hovering in one place. Ah! That's the famous bee dance! That's how bees communicate. Once a forager finds a perfect supply of nectar, ...



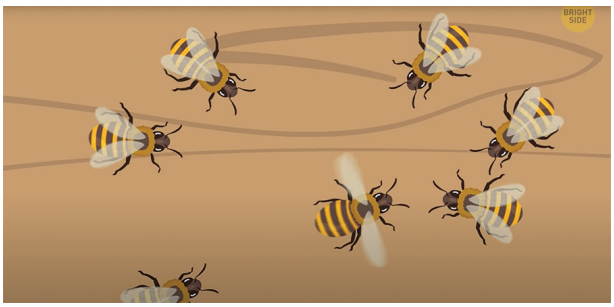
It starts to perform a very precise dance. It consists of a series of straight lines and figure eights. Throughout the dance, the bee is also shaking its wings. How long the dance lasts means how far away from the hive the nectar is.



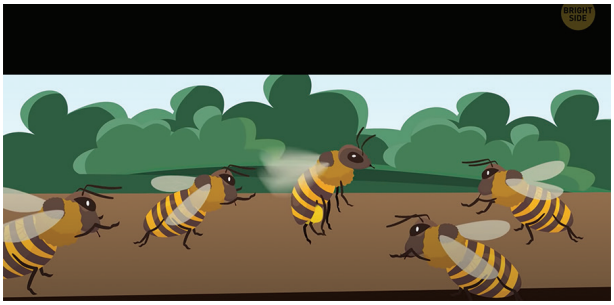
Every 75 milliseconds is another 330 feet to the distance. And, how intense the dance is, depends on the richness of the source of the nectar. The stronger the waggle is, the more nectar the bee has found.



And there's also the angle of the dance. It shows the direction of the nectar in relation to the sun.



Your bee must have found tons of nectar. It's practically vibrating. Suddenly, it starts flying back to the hive. You follow it there. The bee does a shake dance in front of the other worker bees. This is how it tells other bees they need to go foraging right away.



You decide to stay behind and just watch what will happen. Soon the bees return. They've brought back a lot of nectar that needs to be ripened into honey.

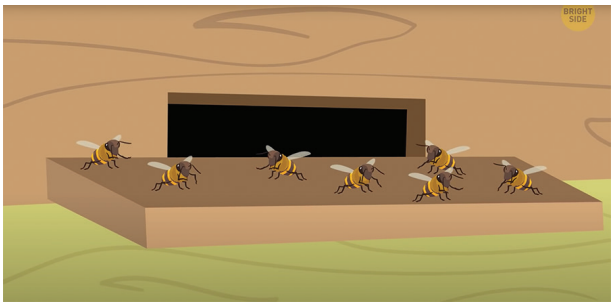
Your bee does a tremble dance this time. It's shaking its legs in a way that makes its body tremble all over. This little dance makes other workers get down to process the nectar.

It's time for you to resume your search. You dive back into the hive and begin to squeeze through small passageways. You come across the cells where worker bees begin their lives as eggs. It takes a bee 21 days to develop from an egg into a full-grown worker.

The first task of this new worker is to clean the cell where it grew.

The cell then becomes a nursery for a new egg, and the bee looks after this egg. Later, it feeds the larva and keeps it warm.

During the next stage of its life, when it's 12 to 20 days old, the bee starts doing chores around the hive. It produces wax, stores pollen and nectar, builds the comb, ...

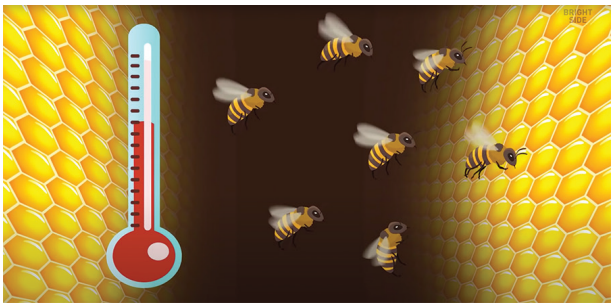


guards the entrance, ...

and so on.

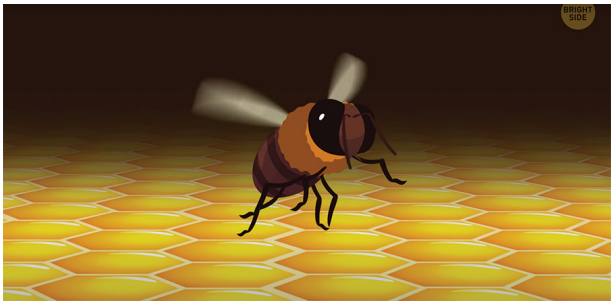
When the bee turns 20 days old, it becomes a forager. It looks for and delivers pollen, nectar, and tree resin to make propolis. The bee also brings water. Bees need it for drinking and cooling the hive.

At one point do you see something that looks like a hospital room? There, worker bees look after those that feel unwell. The doctors bring them different types of honey depending on their infection. If there's no other way, they remove a sick bee from the hive. It helps to prevent the entire colony from getting ill.



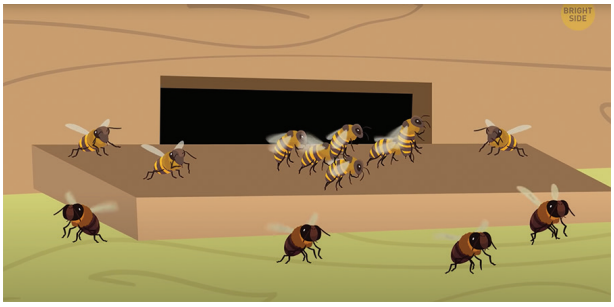
And then there are also temperature control bees. The temperature in the hive is usually around 95 degrees Fahrenheit. It's crucial to keep it this way - not hotter - not colder. Otherwise, the eggs won't hatch. You see a group of bees and instantly understand they're temperature bees! Apparently, the temperature in the hive has dropped, and now the bees are trying to warm it up. They're vibrating in a special way which raises their body temperature, and you can feel the air around you become a bit warmer.

And, if they needed to cool the hive, they would go and gather some water droplets. Then they would bring this water on their backs. Once in the hive, the temperature bees would buzz their wings very fast, making the water evaporate and lowering the temperature.

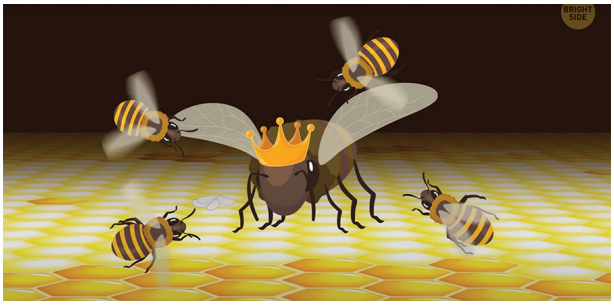


You move further and soon come across a bee you haven't seen before. It has huge eyes, a large body, and no stinger. It's a drone, the only kind of male bee in the hive. Drones don't have any foraging tools either.

Their only purpose is to mate with the queen and care for her. The drone's life isn't too long. For one thing, if this bee manages to mate with the queen, it never survives the process.



And, if there's a food shortage or winter is coming, worker bees usually kick drones out of the hive and don't let them back in. Wow, that's hard!

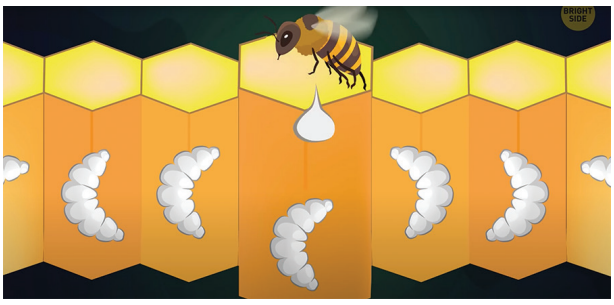


You keep going until you finally notice a nursery. There you spot a bee that is twice the size of a worker bee. Your quest has come to an end. That's the queen. This bee is the most important one for the hive because it's the only bee that can lay eggs.

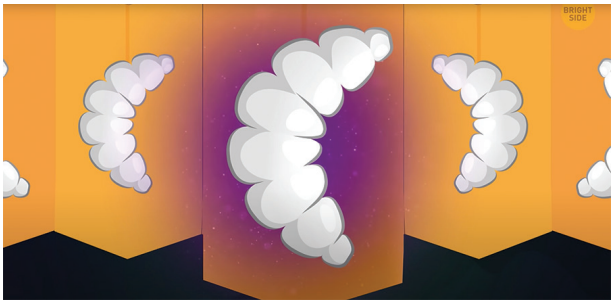
Despite her title, the queen doesn't actually rule, and her brain is smaller than that of a worker bee.

But, she produces special pheromones that influence the mood of the entire hive.

The queen also gives birth to every single bee in the colony.



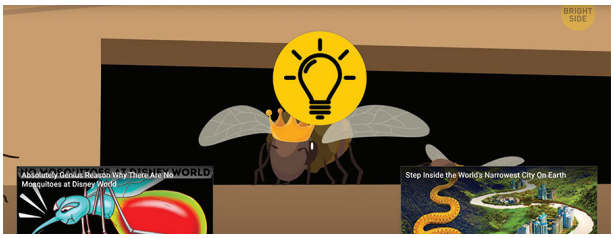
When the queen is still a larva, worker bees feed her royal jelly. That's a goop with super high sugar content.



A larger cell along with such a diet leads to a bigger body and the future queen's ability to emit the pheromones.

When the queen has mated with drones she returns to the hive. Three days later she starts laying eggs and never stops. She works especially hard in the spring, laying one egg every 20 seconds. No wonder that later in the year, the colony already has a population of thirty thousand to sixty thousand bees.

But wait — something strange is happening here! A group of worker bees ... in fact, lots of them (it might be half the colony) ... leave the hive with the queen leading them. It means the colony has become too big. The queen goes outside for the first time since mating, and the whole swarm sets off in search of a new home.



Back in the hive, a new queen hatches from an egg eight days later.

Activity #1: The Difference Between a Worker, Queen, and Drone

Purpose:

The first activity will teach student(s) the difference between a worker, queen, and drone. There are two options to complete this activity. Choose the one that will work best for you.

Directions for Option 1:

1. Use a poster board or a piece of paper and make three columns.
2. At the top of each of the columns, label each column with the words: Worker, Drone, and Queen.
3. Next, use the popsicle sticks and paper to make sticks with labels on them. The labels correspond with each type of bee in step 2. Make one label for each of the words listed below:
    1. Long
    2. No stinger
    3. Guard
    4. Female
    5. Large Eyes
    6. Fertilized Female
    7. Royal Jelly
    8. Stinger (make 2 labels for this word)
    9. Male
    10. Stout
    11. Lays Eggs
    12. Forager
    13. Nurse
4. Now, use a plastic cup or mason jar for each type of bee and place one under each column.
5. Place each popsicle stick in the cup or mason jar associated with the bee that you think it belongs to.
6. Read Introduction to A Bee's Life PowerPoint slides (pages 38 - 43) to check your answers. You can also use the "Bee Labeling Activity Answer Key" on page 43 to check your answers.
7. Glue each popsicle stick into the correct column.
8. Write the definition of each word under or beside the popsicle stick.

Activity #1: Bee Labeling

Directions:

1. Match the words in the Word Bank with the correct Type of Bee.
2. You can write your answers on paper or type them in the document.
3. You can use Introduction to A Bee's Life PowerPoint slides (pages 38 - 43) to check your answers, or you can use the "Bee Labeling Activity Answer Key" (page 43).
4. Update your answers if you matched any incorrectly.
5. Write or type the definition of each word next to it in your document.

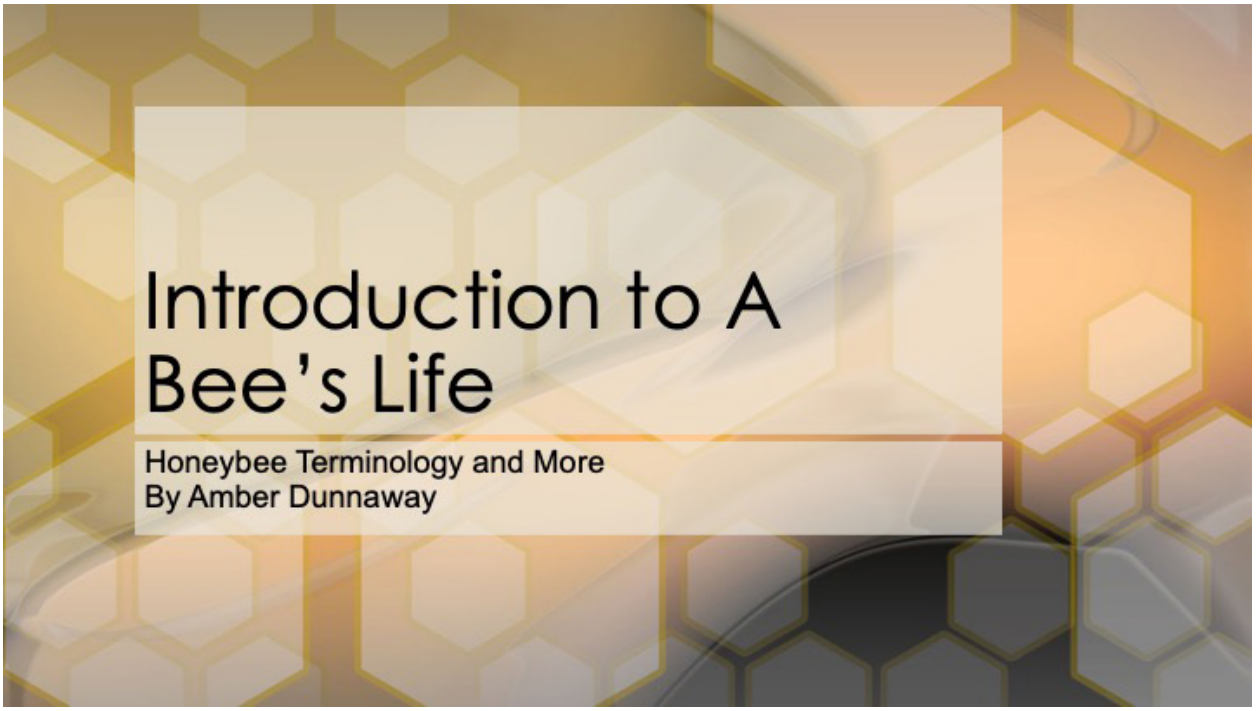
Types of Bees:

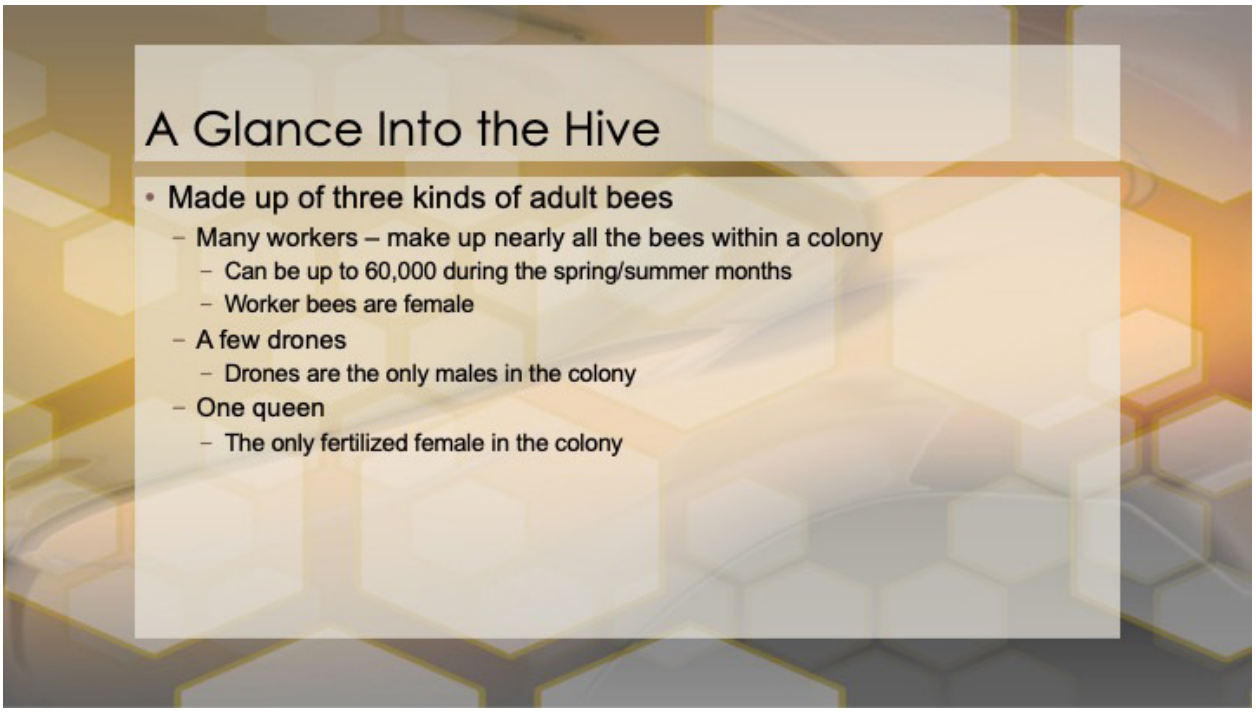
1. Queen
2. Worker
3. Drone

Word Bank

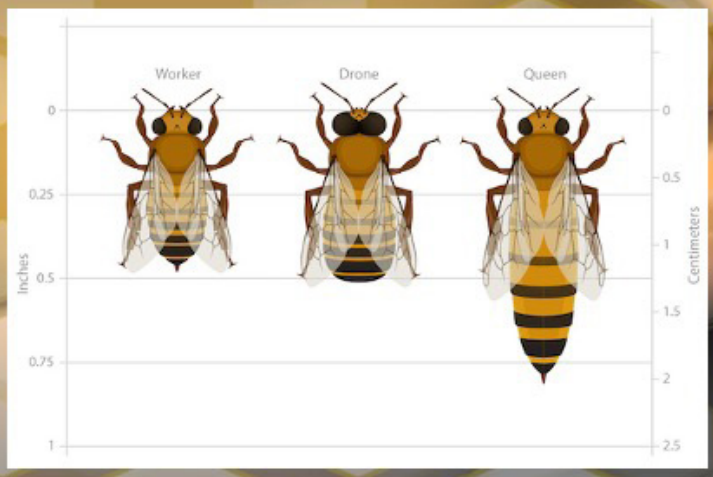
- Long
- No stinger
- Guard
- Female
- Large Eyes
- Fertilized Female
- Royal Jelly
- Stinger (this word goes with 2 of the types of bees)
- Male
- Stout
- Lays Eggs
- Forager
- Nurse

Answer Key on Page 43


Introduction to A Bee's Life
Honeybee Terminology and More
By Amber Dunnaway


A Glance Into the Hive
• Made up of three kinds of adult bees
– Many workers – make up nearly all the bees within a colony
– Can be up to 60,000 during the spring/summer months
– Worker bees are female
– A few drones
– Drones are the only males in the colony
– One queen
– The only fertilized female in the colony

How would you describe each bee?



- Worker
  - Small
  - Stinger
- Drone
  - Stout
  - Large eyes
  - No stinger
- Queen
  - Long abdomen
  - Stinger

Source: Ask a Biologist. *Bee Bonanza: The Story of Honey Bees*. Arizona State University

The Queen and Her Hive

- Lays all the eggs within the colony
- Lays between 1500-2000 eggs a day
- Beekeepers usually will place a paint mark on the top of a queen's thorax for easier sighting
- Lives for several years, usually an average of 2-3 years, can live for 7 years
- To create a queen, worker bees feed her an extra amount of royal jelly
  - Royal jelly is a protein-rich food used to feed a young larva

Photo by Amber Dunnaway

A Drone's Task

- A male honeybee
- Job is to mate with a virgin queen and spread the genes of their colony
- Usually only seen in a hive during spring and summer
- Just a few to several thousand in the hive
- Larger than the worker bee, massive eyes
- No stinger
- Live for about 90 days

Photo by Betsy Reed

Work, work, work...

- Worker bees are female but do not lay eggs
- Perform different tasks as they age
  - Clean
  - Nurse young bees (brood)
  - Attend the queen
  - Make honey or wax
  - Guard the hive
  - Forage for nectar and pollen
- Smallest bee, but make up most of the colony
- Life span is 6 weeks during the spring and summer and four to nine months throughout the winter

Photos by Amber Dunnaway and Betsy Reed

The Many Jobs of a Worker Bee

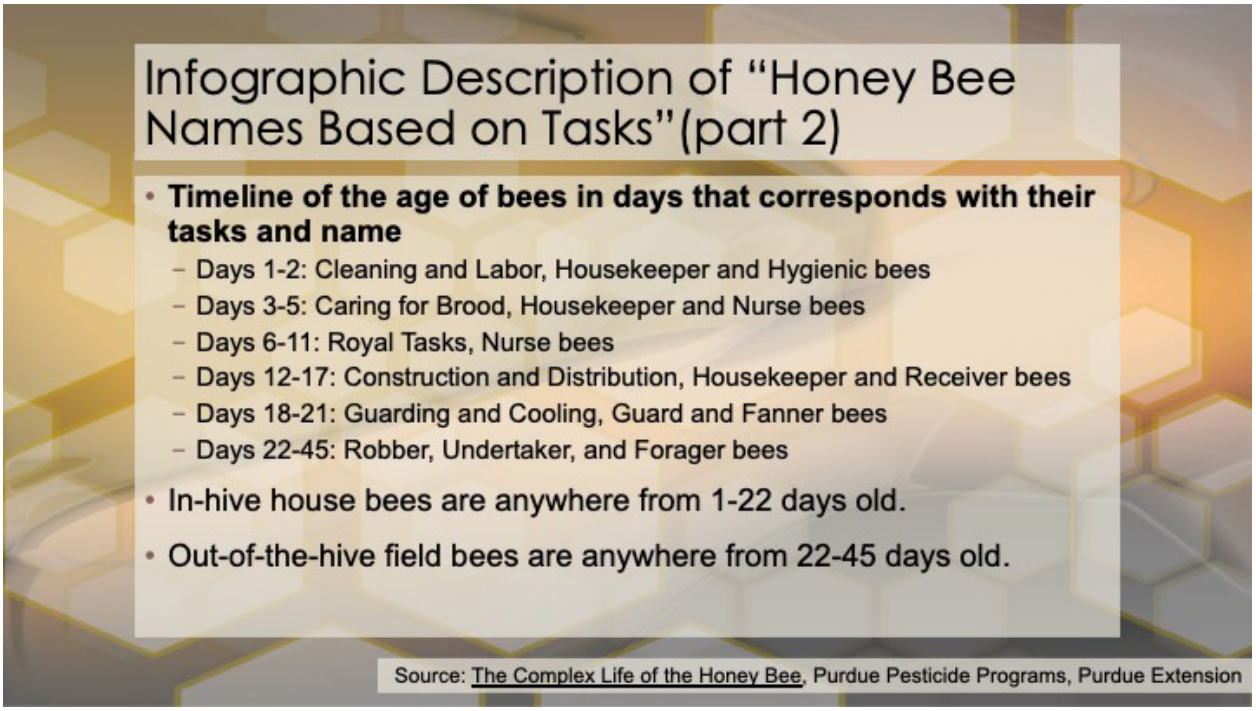
Source: The Complex Life of the Honey Bee, Purdue Pesticide Programs, Purdue Extension

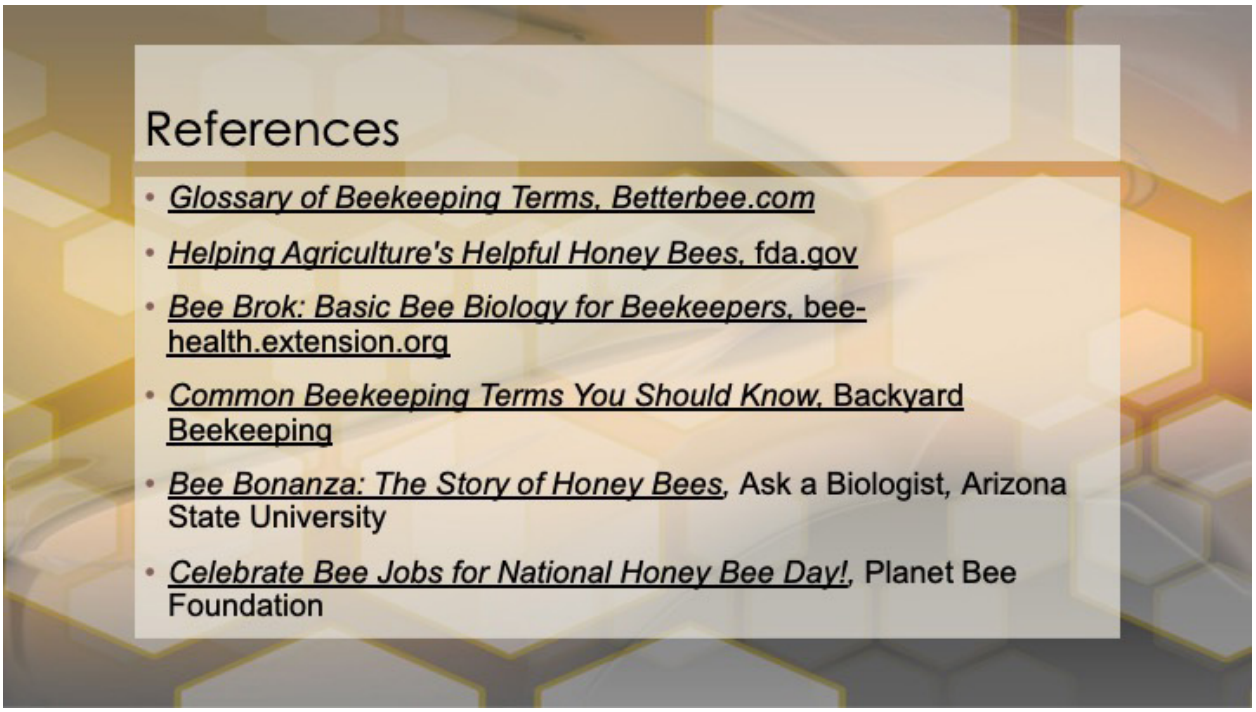
Infographic Description of "Honey Bee Names Based on Tasks" (Part 1)

- **Names of Honey Bees and Their tasks:**
  - **Nurse:** An in-hive bees. Provide older larvae honey and bee bread. They also cap the brood. Feed young larvae and larvae designated to be queens royal jelly.
  - **Housekeeper:** In-hive house and out-of-hive field bees. Polish and clean cells. Work inside the hive is paramount. Provide older larvae honey and bee break. They also cap the brood. Produce wax for building cells and making repairs. They also transport food within the hive.
  - **Guard:** Out-of-hive field bees. Guard the entrance to the hive and ventilate the interior.
  - **Undertaker:** Out-of-hive field bees. Bees are now out in the field collecting pollen, nectar, propolis, and water.

- **Names of Honey Bees and Their tasks:**
  - **Robber:** Out-of-hive field bees. Bees are now out in the field collecting pollen, nectar, propolis, and water.
  - **Fanner:** Out-of-hive field bees. Guard the entrance to the hive and ventilate the interior.
  - **Receiver:** Out-of-hive field bees. Produce wax for building cells and making repairs. They also transport food within the hive.
  - **Hygienic:** In-hive house and out-of-hive field bees. Polish and clean cells. Work inside the hive is paramount.
  - **Forager:** Out-of-hive field bees. Bees are now out in the field collecting pollen, nectar, propolis, and water.

Source: The Complex Life of the Honey Bee, Purdue Pesticide Programs, Purdue Extension


Infographic Description of "Honey Bee Names Based on Tasks"(part 2)
Timeline of the age of bees in days that corresponds with their tasks and name
Days 1-2: Cleaning and Labor, Housekeeper and Hygienic bees
Days 3-5: Caring for Brood, Housekeeper and Nurse bees
Days 6-11: Royal Tasks, Nurse bees
Days 12-17: Construction and Distribution, Housekeeper and Receiver bees
Days 18-21: Guarding and Cooling, Guard and Fanner bees
Days 22-45: Robber, Undertaker, and Forager bees
In-hive house bees are anywhere from 1-22 days old.
Out-of-the-hive field bees are anywhere from 22-45 days old.
Source: The Complex Life of the Honey Bee, Purdue Pesticide Programs, Purdue Extension


References
Glossary of Beekeeping Terms, Betterbee.com
Helping Agriculture's Helpful Honey Bees, fda.gov
Bee Brok: Basic Bee Biology for Beekeepers, bee-health.extension.org
Common Beekeeping Terms You Should Know, Backyard Beekeeping
Bee Bonanza: The Story of Honey Bees, Ask a Biologist, Arizona State University
Celebrate Bee Jobs for National Honey Bee Day!, Planet Bee Foundation

Answer Key for Bee Labeling Activity

Answer Key for Activity #1: Bee Labeling *(from page 37)*

Queen
1. Fertilized Female
2. Lays Eggs
3. Long
4. Stinger
5. Royal Jelly

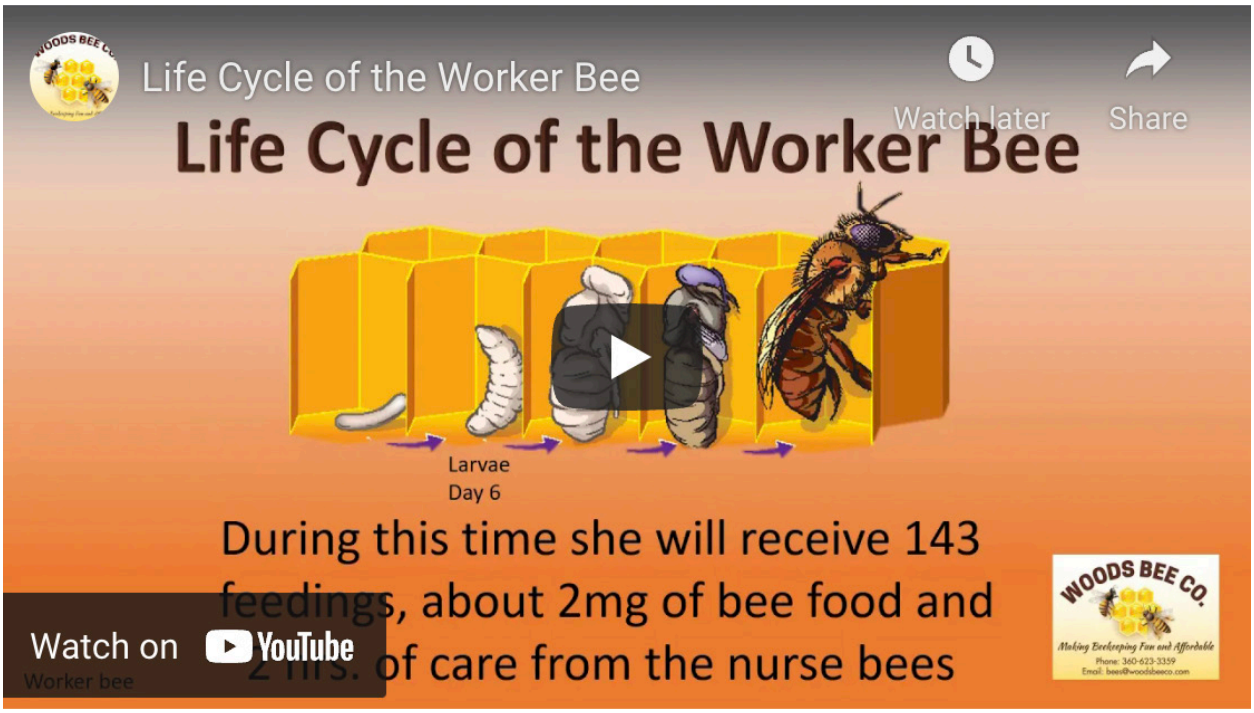
Worker
1. Female
2. Forager
3. Nurse
4. Guard
5. Stinger

Drone
1. Male
2. Large Eyes
3. Stout
4. No stinger

Activity #2: The Life Cycle of Honeybees

Purpose:
The second activity will teach students about the life cycle of honeybees.

Directions:
Look at the screenshots and read the narration from
"Lifecycle of the Worker Bee" (pages 45 - 50).

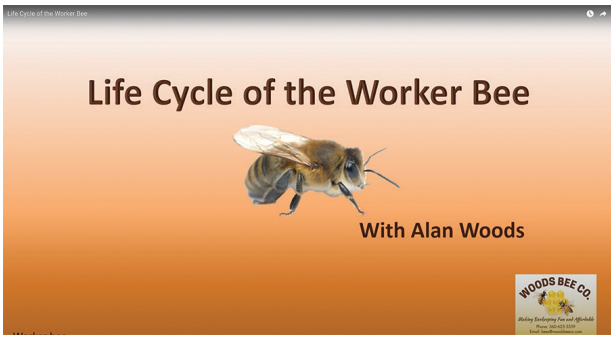


Life Cycle of the Worker Bee

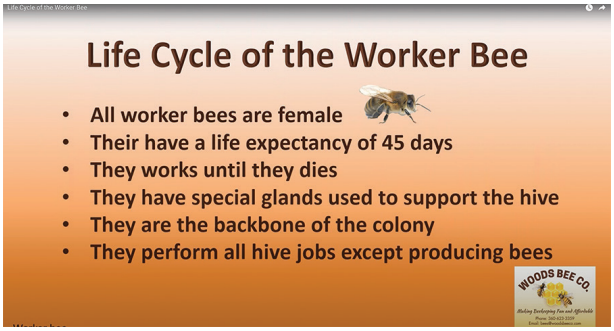
https://youtu.be/SoFGN7G7Afs

Hello, beekeepers! Thank you for joining Woods Bee Co. for another session of "Thinking Out of the Box."

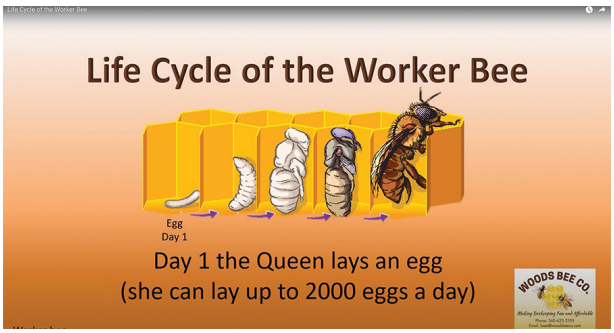
I'm Alan Woods, and today we're gonna look at the Life Cycle of the Worker Bee.



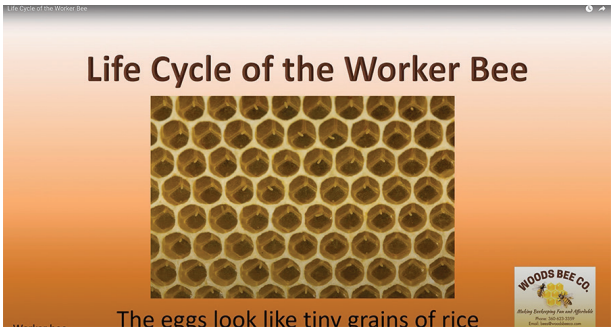
But, before we start, I want to tell you a few interesting facts about the worker bees.



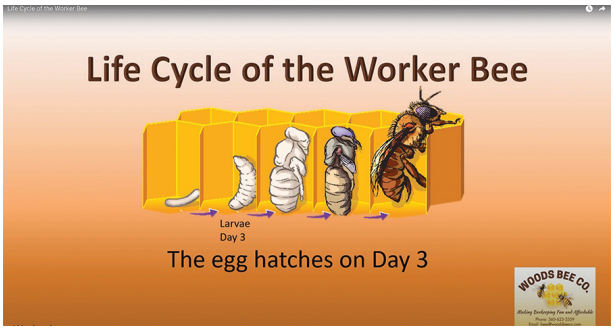
All worker bees are females, and they have a life expectancy of only 45 days. So these hard-working ladies literally work themselves to death. They are equipped with special glands used to do specific jobs and are clearly the backbone of the colony. In fact, they perform every job in a hive except for producing new bees.



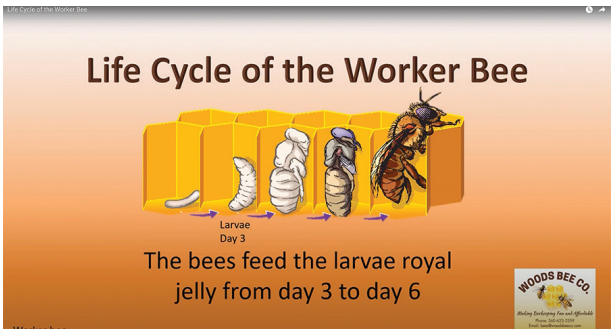
The task of producing new bees is left to a single queen that can lay up to 2,000 eggs a day. In short, the worker bee starts her life as a single fertilized egg.



While the eggs in this picture look like tiny grains of rice, they can be somewhat difficult to see with the naked eye.

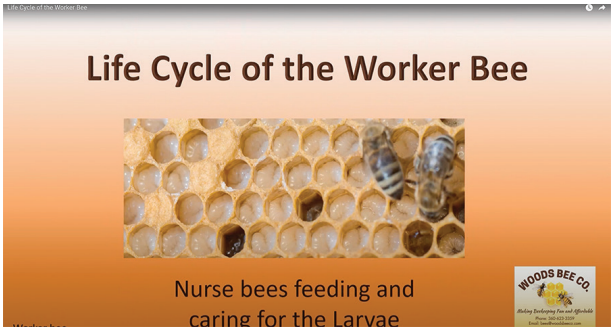


The larva hatches from the egg on Day 3 where she will spend the next 18 days developing into an adult worker bee.



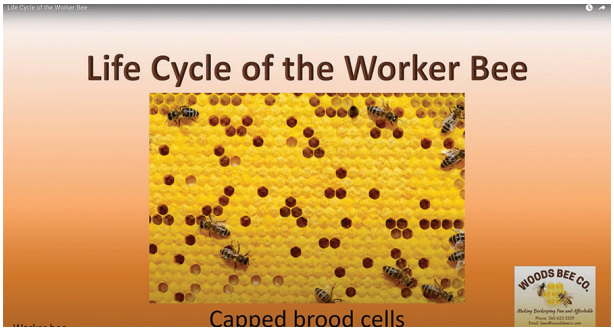
The bees feed the larva royal jelly from Day 3 to Day 6.

During this time she will receive 143 feedings, about 2 milligrams of bee food, and will get about 2 hours of care from the nurse bees.

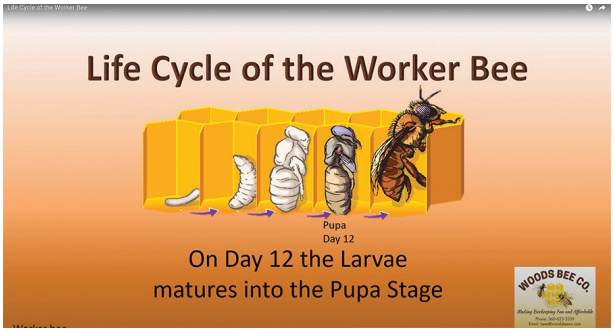


In this picture, nurse bees feed and care for the larvae.

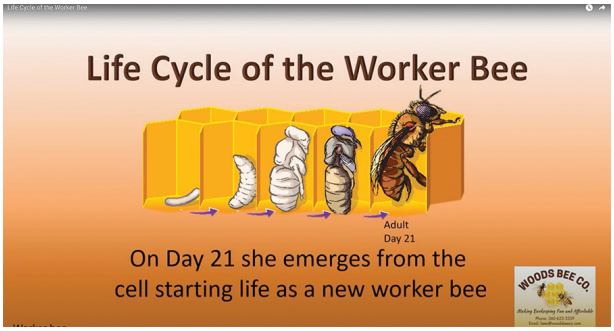
On Day 9, the bees will close the cell.



This is a picture of what the clothed cells look like. We call it **capped brood**.

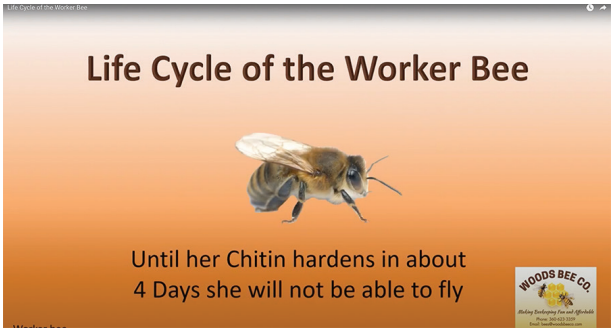


On Day 12, the larva matures into the pupa stage where she will continue to develop until she becomes an adult worker bee.

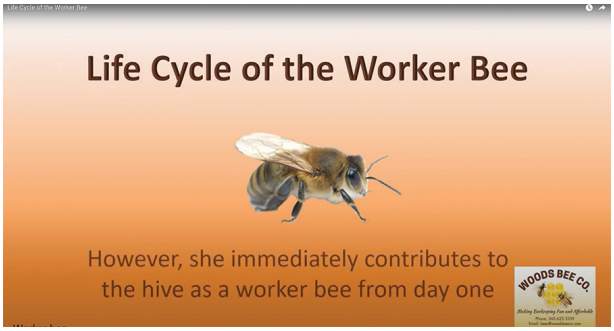


On Day 21, she emerges from the cell, starting life as a new worker bee.

In this picture, a new worker bee emerges from her cell as her sisters welcome her into the world.

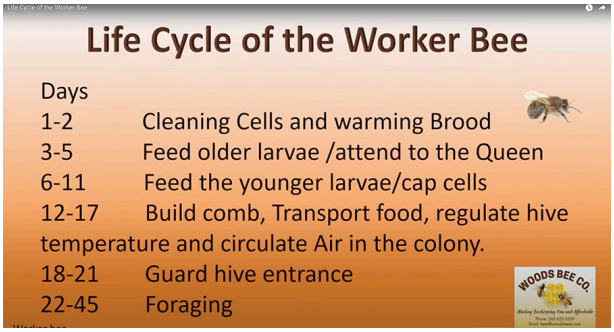


After emerging from the cell, until her chitin hardens in about four days, she will not be able to fly.

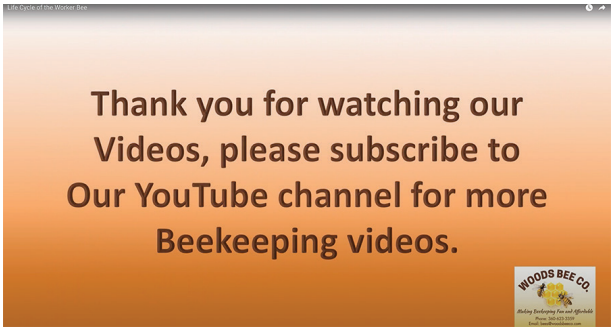


However, she immediately contributes to the hive as a worker bee from day one.

She jumps right in and begins to do what she can.



You may be wondering, why is this information necessary for a beekeeper? Please understand that at each stage of a worker bee's life, she is equipped to perform a certain task. If there is a break in the cycle, these tasks must be performed to ensure that the strength of the colony is maintained. While older bees can perform some of these tasks, their inability to perform them as well could hinder the hive, putting the welfare of the colony at stake. Listed are the jobs and ages that worker bees are equipped to fully perform. We will make another video explaining each of these jobs in more detail.

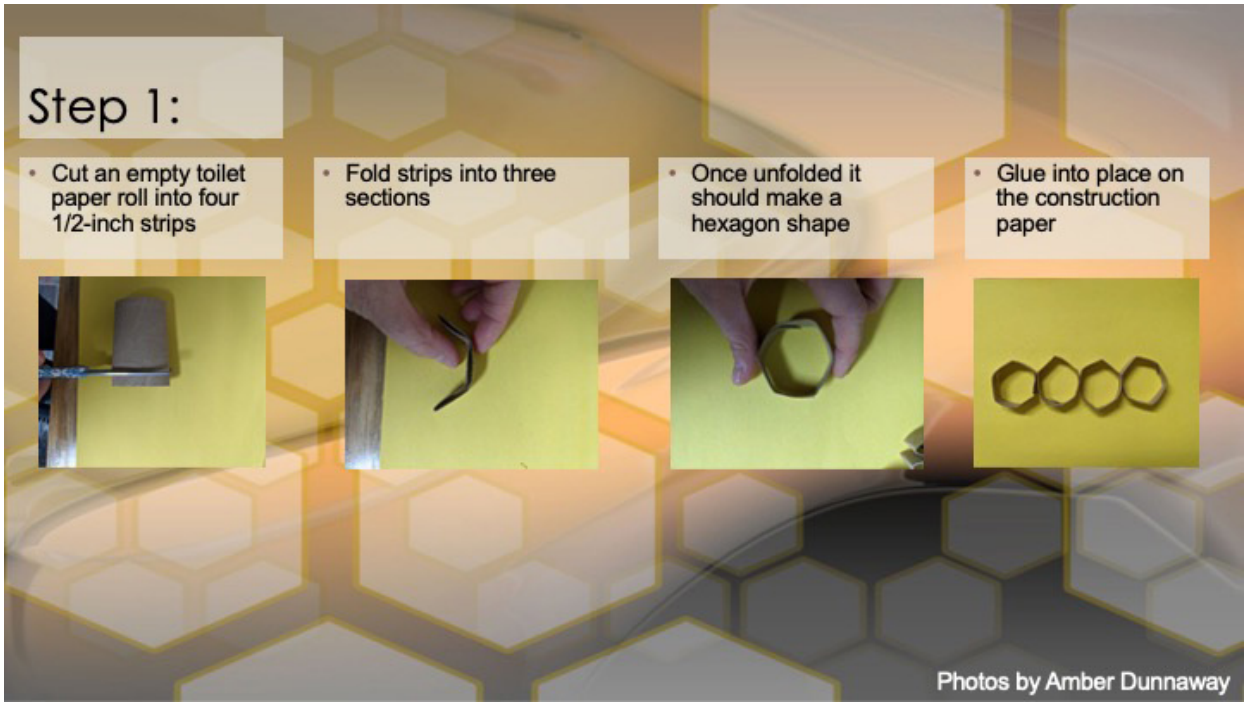


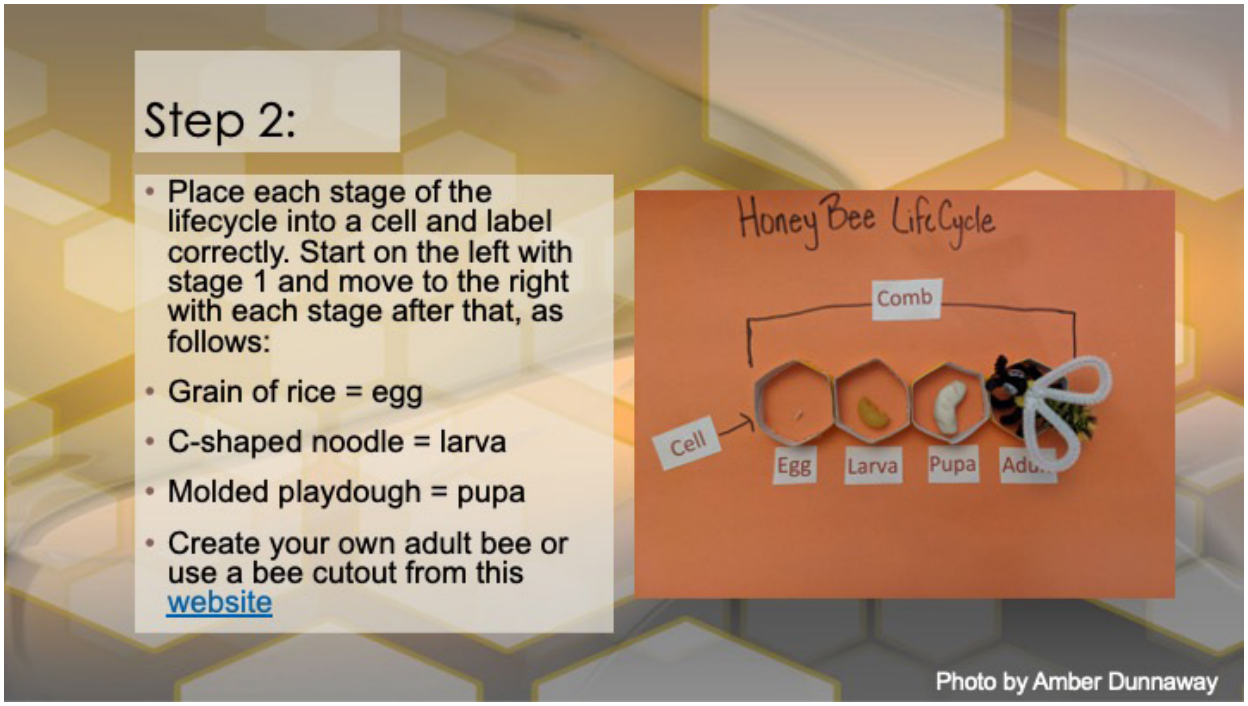
Thank you for watching our videos. Please subscribe to our YouTube channel for more beekeeping videos.

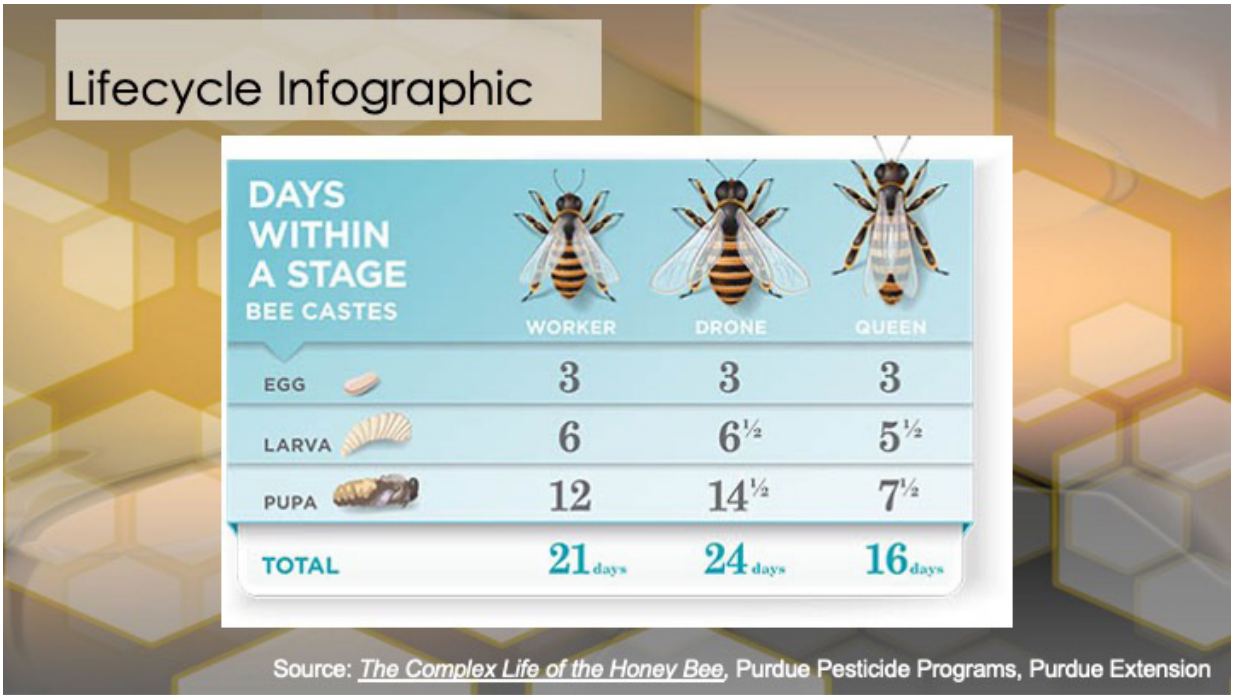
1. For this activity, you need the following materials:
    1. A piece of construction paper
    2. Hexagons made from toilet paper rolls (bee cells)
    3. Rice
    4. Noodles
    5. Modeling dough/playdough
    6. A model honeybee or a printout of a bee so they can model the lifecycle of the honeybee

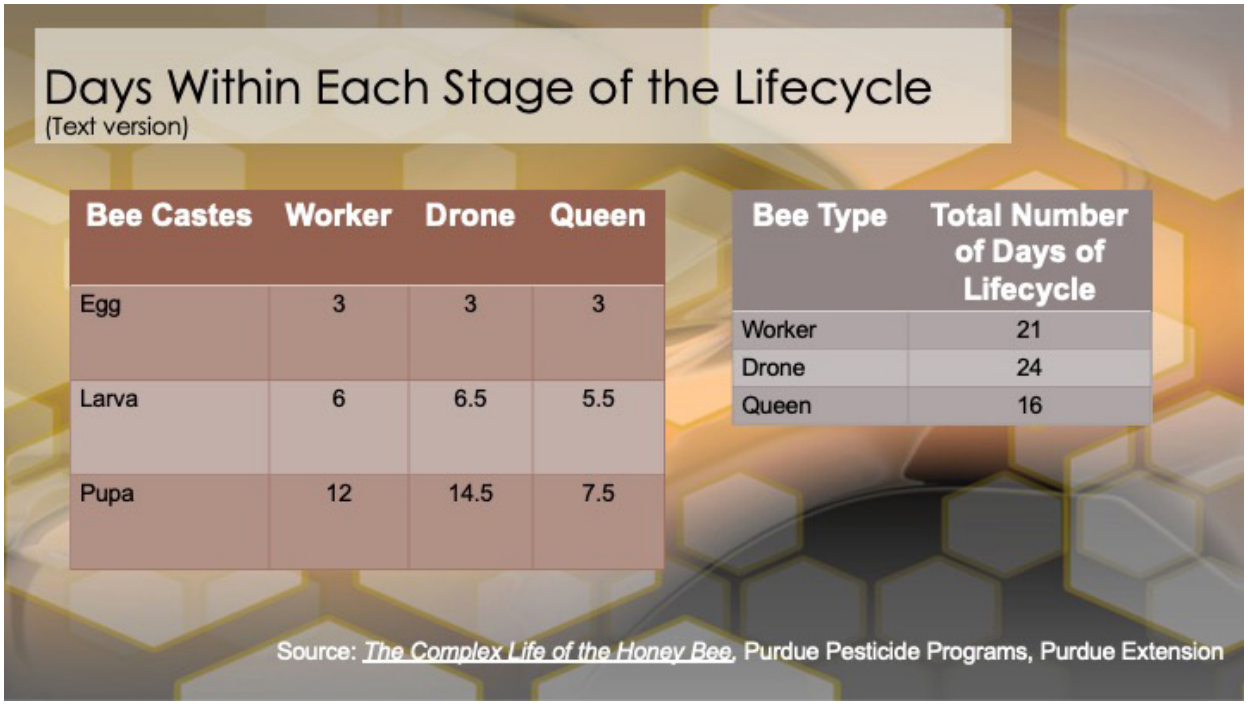
2. Review "Build a Honey Bee Life Cycle Instructions" PowerPoint (pages 51-53) for instructions to this activity.

"Build a Honey Bee Lifecycle Instructions"
PowerPoint


Step 1:
Cut an empty toilet paper roll into four 1/2-inch strips
Fold strips into three sections
Once unfolded it should make a hexagon shape
Glue into place on the construction paper
Photos by Amber Dunnaway


Step 2:
Place each stage of the lifecycle into a cell and label correctly. Start on the left with stage 1 and move to the right with each stage after that, as follows:
Grain of rice = egg
C-shaped noodle = larva
Molded playdough = pupa
Create your own adult bee or use a bee cutout from this website
Honey Bee Life Cycle
Comb
Cell
Egg
Larva
Pupa
Photo by Amber Dunnaway





Bee Castes	Worker	Drone	Queen
Egg	3	3	3
Larva	6	6.5	5.5
Pupa	12	14.5	7.5

Bee Type	Total Number of Days of Lifecycle
Worker	21
Drone	24
Queen	16

Activity #3: Write About Worker Bees

Directions:

- Write one to two paragraphs on a worker bee job of choice.
- Include at which stage of a honeybee's life the job is in.
    - For example, if you choose a nurse bee, then you will need to research and find that once the adult hatches they can be a nurse anytime from day 3-12.
- If you are in a classroom setting, present each job written by each student to the class.
- Articles (from websites) and screenshots with narration from videos (found online) are on pages 54-84. Use these resources to help write about your bee of choice.
    - Honey Bee Jobs in the Hive

○ Honey Bee Jobs in the Hive

Workers

Workers do different jobs based on their age. Some workers will stop at a particular job rather than progressing with their age group, unless hive pressures (such as lack of foragers) pushes them to mature. This is a genetic predisposition based on the DNA of the father. Queen bees hold the sperm of many different drones to allow genetic diversity in the hive, which assures a diverse cast of workers with different skills.

Queen Bee Image Credit: Alex Wild

Worker Honey Bee

Days 1-2: the newly emerged bees work on cleaning the cells around where they emerged so that they cells can be reused for egg laying or food storage.

Days 3-11: now the worker bee becomes a nurse bee, performing a number of different tasks. Nurse bees are the only ones that can digest protein, so they digest brood food (pollen) brought back by foragers and digest it. Then they regurgitate it to feed all other bees in the hive. This is actual bee vomit (unlike honey, which technically goes into the crop, a sort of internal pocket, and does not progress to their proper stomach).

Days 12-17: advanced nurse bees continue their work but can now also produce royal jelly to create queen bees if necessary. If a queen is still present then these bees take over as the main feeders and groomers of the queen.

Days 12-22: these worker bees do a great variety of tasks. They can take nectar from foragers and help store it in a honey cell by fanning and chewing it to lower the water content. They can also help produce wax to create more cells or cap storage or egg cells. They can help spread propolis over the walls of the hive, creating a resin layer on the inside of the hive to act as an immune system against smaller insects and viruses. They can also act as guard bees to defend the front of the hive against predators or work as mortuary bees (my personal favourite). These bees find the dead bodies of others and remove them from the hive.

Days 22-42: this is when workers, on average, become foragers and can finally go out into the world.

After mentioning all of that I will add as a caveat that, as I hinted at before, hive pressures can speed or slow this process as needed. If many foragers die in a terrible rain storm one day, then the resulting lack of food will pressure nurse bees and other workers fewer than 22 days old to mature faster and become foragers. This is true of any job at any part of the growth cycle. This can be deadly, however, since one of the reasons this age dependent work line exists is because it allows the workers more time to mature within the hive (which especially helps their wings and stingers, which must go through keratin hardening). If the bees mature too fast they are more likely to die once outside, then putting more pressure on the remaining bees, and possibly leading to collapse in poor enough conditions.

The information for this post came from the following book:

Winston, Mark. *The Biology of the Honey Bee.* Harvard University Press, April 1991.

Posted in: Uncategorized

- ## Celebrate Bee Jobs for National Honey Bee Day!

National Honey Bee Day is the perfect occasion to explain the many different jobs that honey bees do in the hive! We all know that bees work hard, but what are they actually *doing* in there?!

It may come as a surprise, but honey bees progress through different jobs in the hive (to keep it buzzin'), as they get older and smarter! There are three main castes of honey bees: drone bees, queen bees, and worker bees. All three are essential for the hive to thrive, and they are all very different, each contributing and playing a unique role.

This is a frame of bustling honey bees

Drones are the male bees in the hive and their only purpose or reason to be alive is to mate with a queen (from another hive of course!). They live about 3-6 months if they don't find a queen to mate with, which isn't so bad since they die after they mate! If they fail to mate with a queen and come back to the hive, the worker bees will eventually evict them from the hive when the colony starts to contract for winter, since drone

Celebrate Bee Jobs for National Honey Bee Day!

bees eat more honey than the smaller worker bees do and because they don't help out in the hive at all! The female worker bees that remove the male drones from the hive may seem ruthless, but the lack of contribution and drain on resources puts the hive at risk for making it through the difficult winter. Times are tough in the cold, and those who don't contribute - are out!

Each hive has one queen bee that is responsible for creating new bees. First, she goes on a mating flight where she mates with about 15 different drones. Then she lays eggs every day after that, while worker bees cater to her every need - and do all the other work in the hive too. She lives about 2-5 years and lays about 1500-2000 eggs per day at her peak. Once the queen gets too old, the worker bees will decide to create a new queen.

Do you see the queen? Check out her entourage!

Worker bees make up 99% of the hive and house a multitude of responsibilities, all of which change with their different phases of life. There are about seven different jobs a worker bee will be responsible for in her lifetime, although not all bees do every single job. Worker bees live about 4-6 weeks and do ALL the work in the hive. They work so hard that they work themselves to death!

When a worker bee is firstborn, she cleans her cell and removes any bodily waste left from coming out of the egg, as to prepare the cell for the next egg. This "cleaner" role lasts for the first couple of days as the bees utilize their mouths and front legs to clean. Afterward, they can hold the job of the "undertaker", where they clean out dead bodies or unhealthy bees to prevent disease. Worker bees are incredibly clean creatures since they have so many family members within such small living quarters.

A young worker bee can then become the babysitter of the hive or the "nurse" bee, as they help aid and feed young larvae around 10,000 times a day! After they outgrow their role nursing larvae, some worker bees may become a "queen's attendant". Most of their work attending to the queen merely consists of cleaning her, feeding her, and removing waste that is around her - the queen basically has her own entourage!

Another worker bee job is the "honey maker" bees. They collect the nectar that the matured field bees brought back to the hive, put it into cells, and work hard to transform the nectar into honey.

Some bees might become "wax maker" bees. They use glands in their abdomen to build their honeycomb home or to seal up cells once an egg has been placed inside or once the cell is full of honey!

Once a worker bee has matured enough, they will move from the more simple in-hive jobs to the more difficult jobs outside the hive. Bees can become "guard" bees where they guard the entrance of the hive from foreign intruders, like bears, mice,

This honey maker bee is working hard!

Celebrate Bee Jobs for National Honey Bee Day!

or wasps.

Most of these bees are foragers. Do you see the pollen they have on their legs?

Then, the bee will graduate to the most difficult job at the end of their lives, the "forager" bee, where they collect nectar and pollen to bring back to the hive. When they leave the hive for the first time, they have to familiarize and map out their new surroundings in order to work efficiently and be able to find their way home. For humans, the forager bee should be the most celebrated, as that job is responsible for pollinating more than ⅓ of the food that we eat. Next time you see a bee on a flower, don't forget to say thank you!

The various stages of life and the incredible responsibilities of the worker bee prove how essential they are to their eusocial colony within the hive. Drones and the queen are responsible for creating more bees, while worker bees do pretty much everything else. We are happy to celebrate the hard work of our fuzzy friends (especially worker bees) because without them there would be no honey and much less diversity in our selection at the farmers market or grocery store. Happy National Honey Bee Day!

Sources:

- https://www.perfectbee.com/learn-about-bees/the-science-of-bees/the-types-of-bees
- https://sites.psu.edu/beeseverywhere/2018/02/21/post13/

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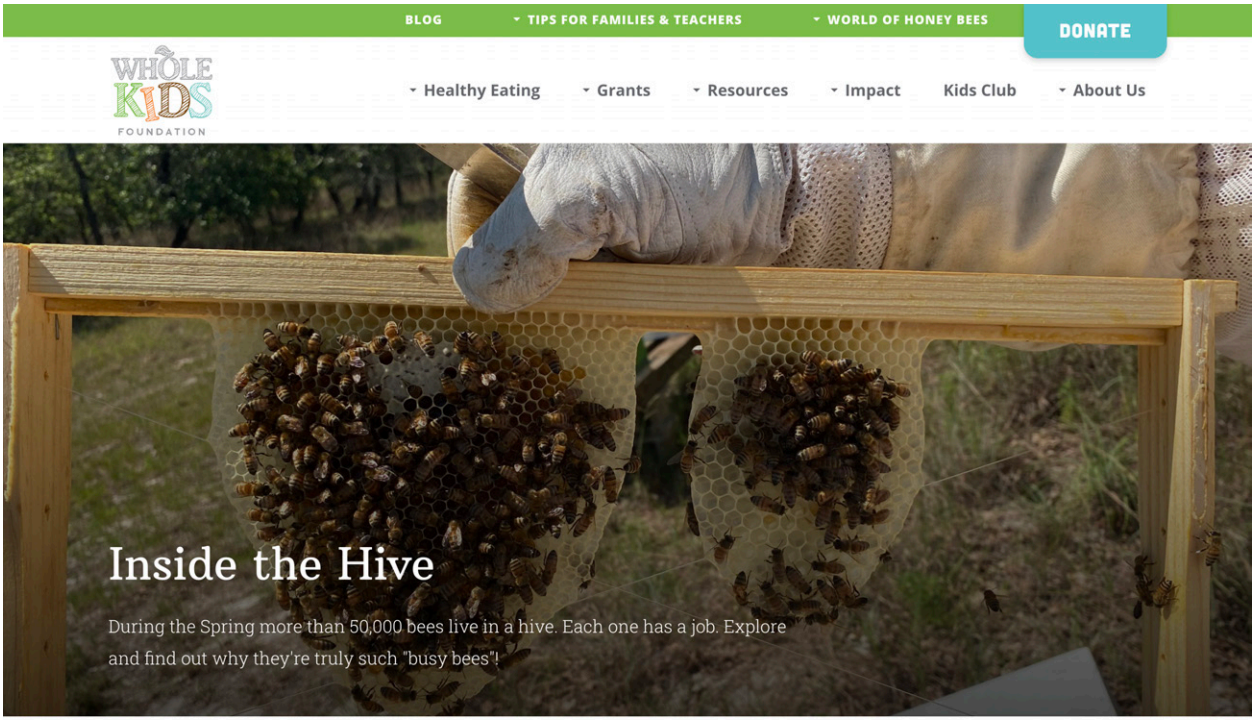
Written by Layla Dargahi and Haley Todd

- **Meet the Honeybees and Learn What They Do**



MEET THE HONEY BEES AND LEARN WHAT THEY DO

Did you know each hive has only one queen, and one male drone bee for every 100 female worker bees?

Meet the Honeybees and Learn What They Do

QUEEN BEES

Truly hive royalty! Queens are selected when they're still eggs. The egg is fed lots of royal jelly, a nutrient-rich gelatinous substance. Queen bees even get specially built cells in the hive to fit their larger size. There's just one queen per hive, and she can lay up to 2,000 fertilized eggs in a single day! Queen bees can live up to 5 years.

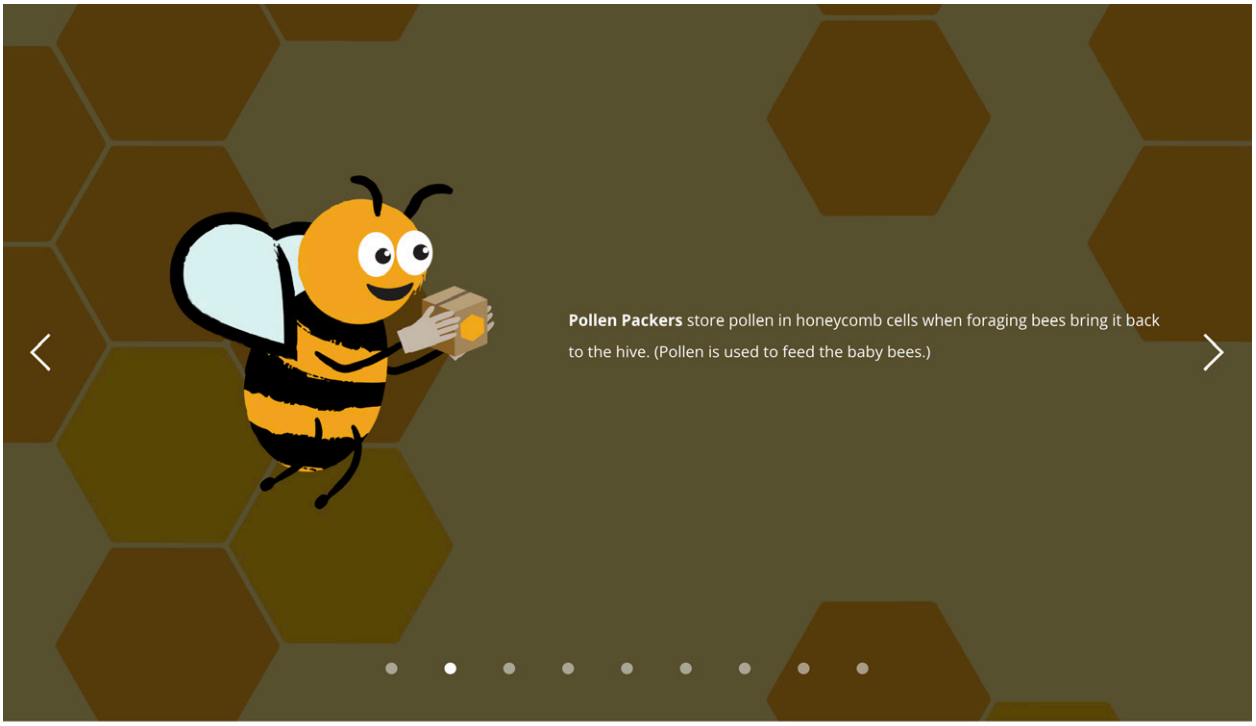
WORKER BEES

Most of the bees in a hive are worker bees, and they are ALL female. They do lots of important jobs to keep the hive running smoothly, from guarding the hive to finding nectar-rich flower patches to making honey. Worker bees usually live to be about six weeks old, and they're busy from the get-go!

DRONES

These are the only male honey bees. There aren't many of them, and they have just one job: to mate with a new queens (in a different hive) so she can lay fertilized eggs, which then develop into baby bees. Drones live about 12 weeks.

- Meet the Honeybees and Learn What They Do



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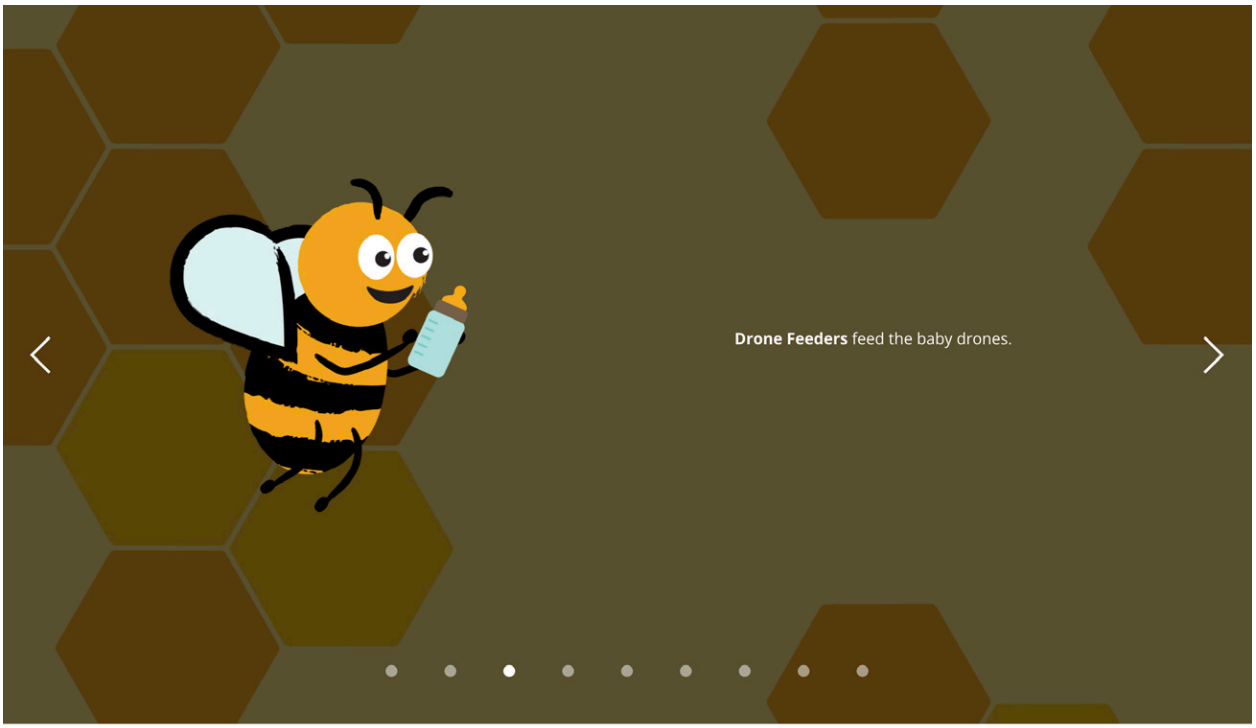

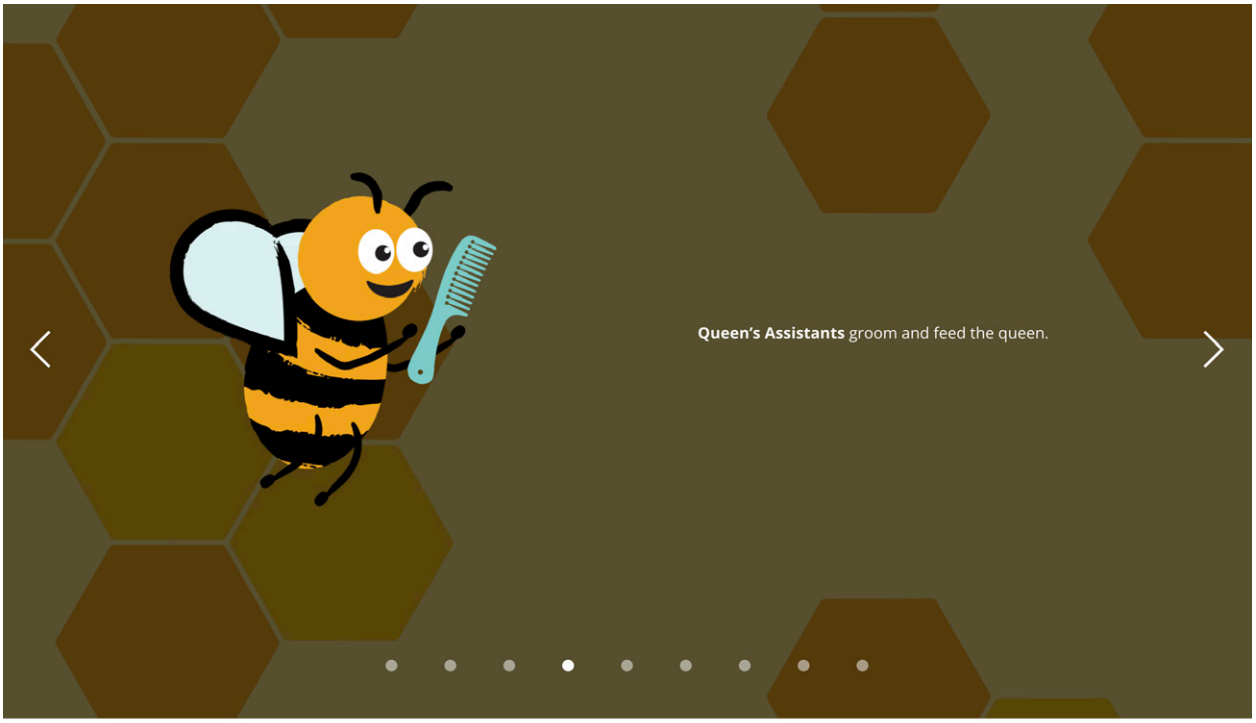

- Meet the Honeybees and Learn What They Do

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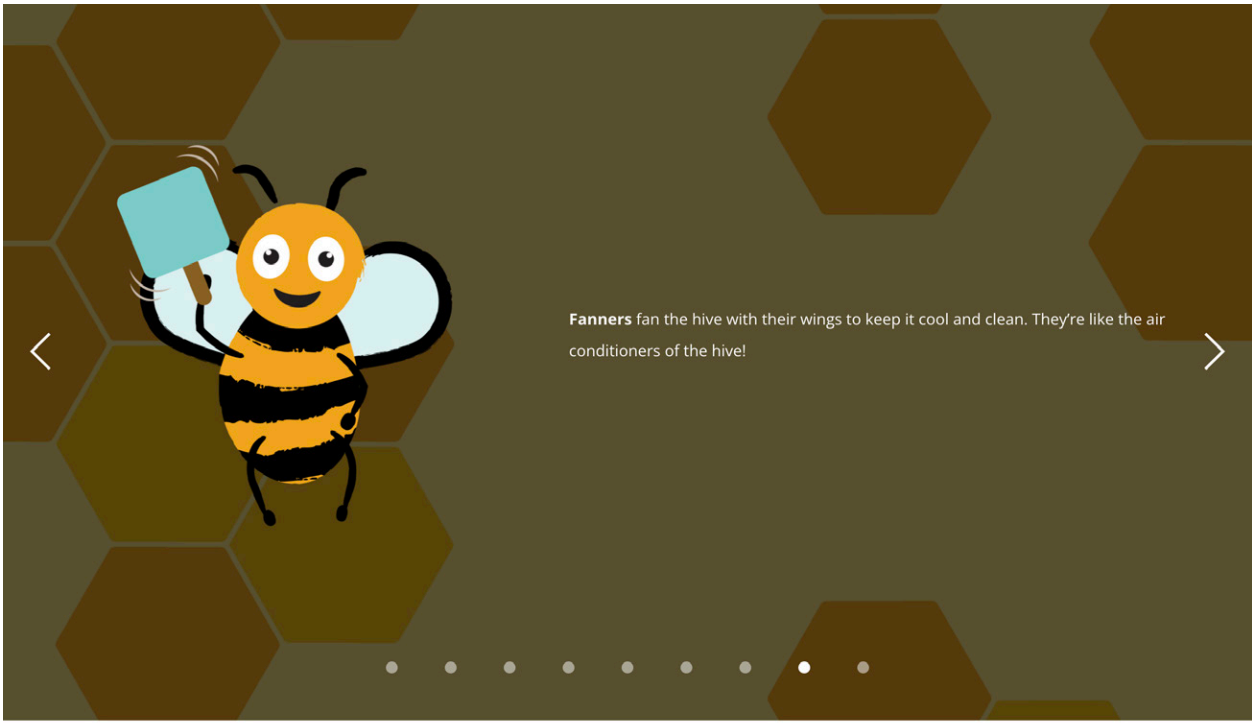


- Meet the Honeybees and Learn What They Do

○ Meet the Honeybees and Learn What They Do

SPOT THE QUEEN

There's only one queen per hive, and whenever she moves, her attendants move with her. When it's time for a new queen, the workers choose a larvae that is just a few days old. They feed that larvae extra royal jelly which allows her reproductive organs to develop. That makes her larger than worker bees.

Queen honeybees don't wear crowns, so how can you tell which one she is? Here are a few ways to spot the queen in a colony.

1. Look for a long, pointed abdomen
2. Look for a bee with a shiny black spot
3. Look for the largest bee

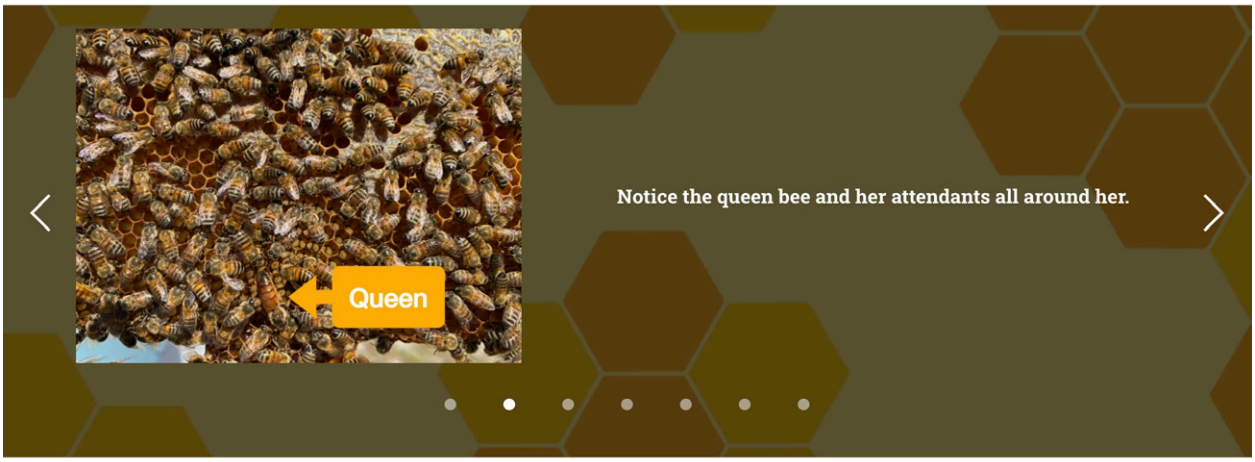
CAN YOU SPOT THE QUEEN?

Click here to see if you found the queen.

- Meet the Honeybees and Learn What They Do

TAKE A DIVE INSIDE THE HIVE

TAKE A DIVE INSIDE THE HIVE



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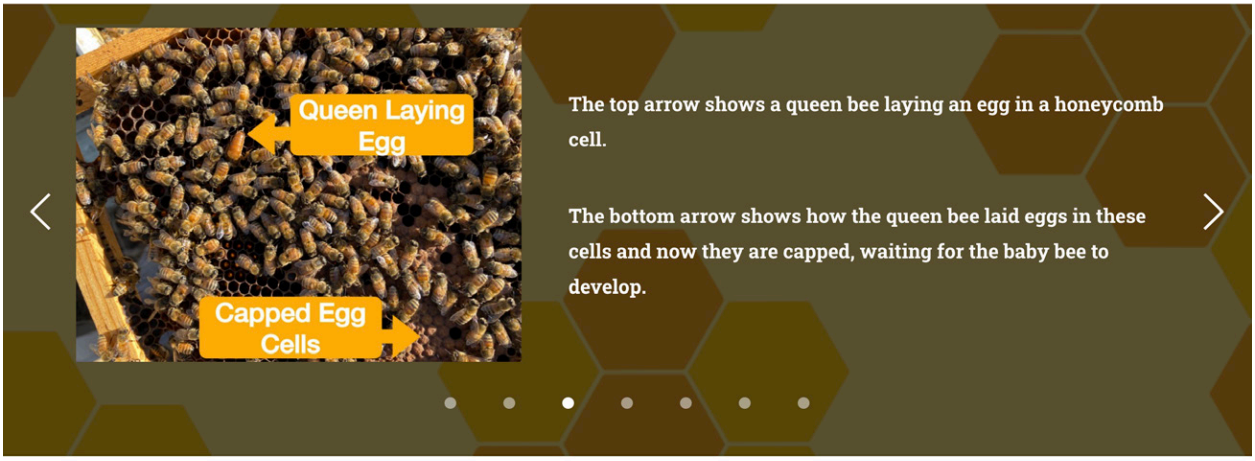

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- Meet the Honeybees and Learn What They Do

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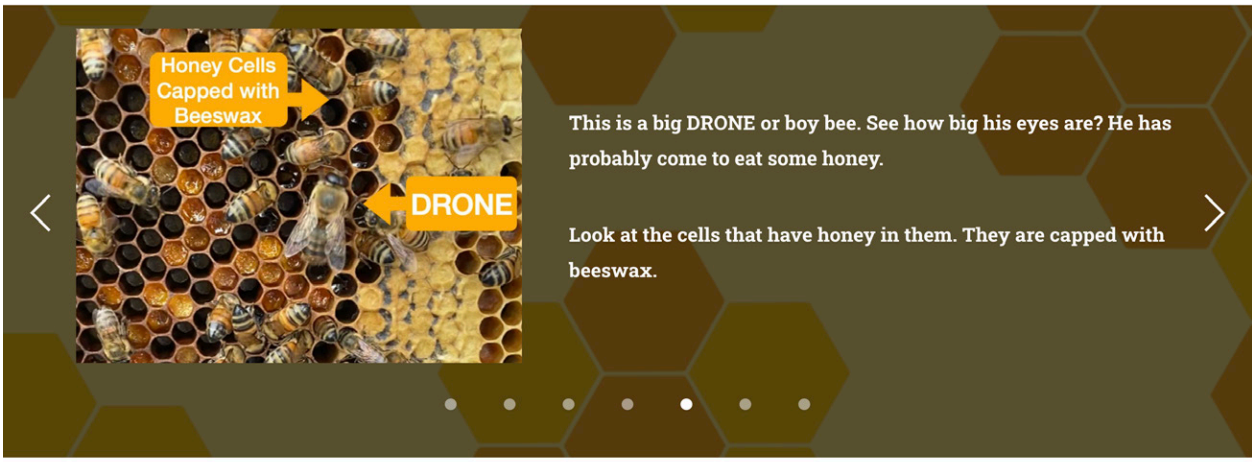


TAKE A DIVE INSIDE THE HIVE

- ## Meet the Honeybees and Learn What They Do

TAKE A DIVE INSIDE THE HIVE

BEEKEEPER TOOLS 101 VIDEO

Bee-hind the Scenes with a Beekeeper and the Tools of the Trade

Bee-Hind the Scenes with our Queen Bee:

Beekeeping Tools 101

https://youtu.be/sivhiBtprJg

Hi, everbody! My name is Nona, and I'm a beekeeper. I'm super excited to be here with you today to tell you a little bit about some of the tools that we use in beekeeping.

Now one of the best ways to do that is with a hive that doesn't have any honeybees in it. And that's what these are. So I'm gonna take my veil off so that we can talk.

Now, it's important to know that honeybees are not aggressive. They do not want to sting you. They're really focused on collecting nectar and pollen from all of the flowers around us. So if they come to you, they're just checking to see if you're a flower.

If you're really still and patient, they'll just fly away when they determine you're not. Since I'm a beekeeper, I'm aware that bees have predators, and one of those is bears. So you might have read that in a storybook, but it's true in real life. So if I were a bear that wanted the honey in this hive, I might come and knock it over and take the lid off. And the bees would come up to defend their hive. That's why I wear the suit. It keeps me safe and it keeps the honeybees really, really safe. Because when I open the hive, they'll come and see if I'm a bear.

Now that we've got that, I want to show you the first tool that we use as a beekeeper. And that's our smoker. Smoke tells bees that there's a forest fire, and that makes them really focus on their hive. They want to protect their honey and everything else inside of it.

You can use lots of different kinds of fuel. We happen to use hay because we have a farm. And sometimes the cows leave a little bit. So I just stuff that in there, and I add some fire.

And this is a bellow. When you squeeze it, it pushes air in and smoke out.

Now I'm ready to open the hive. So I'm just gonna tell these bees I'm coming in, and give them a little puff of smoke.

I might sneak one in the top as I take the lid off. And now they're really focused on what's going on in their hive.

I'm gonna get my hive tool which has a sharp end and a hook. Bees are builders. They build honeycomb, and they make this stuff called **propolis**. I call it "bee glue" because they like their hive to stay nice and tight. So I need my tool to help just wiggle and get these frames apart so that I can get them out and look at what's going on. Sometimes they do a really good job.

This is a frame of a brand new honeycomb. You can see it's nice and white. That means the queen hasn't laid any eggs in it, and they haven't stored any honey in it yet.

This is a frame next to it that is dark. That tells you that the queen has been on this frame and laid lots and lots of baby bees. When a baby is born, there's a dark lining that stays behind in the cell.

Now, it's really important that we put these back in the same order that we got them out in because the queen bee always has a plan and we don't want to interrupt that. So the queen bee is gonna lay her nest in the middle of this hive, and they're gonna store some food on the outer frames.

I'm gonna show you a honey frame. I'm gonna use my tool. I'm going to use the hook end because honey is so tasty, but it's also really heavy. Gotta give me a minute.

You can see that in every cell in this frame, they filled it with honey and then capped that cell with beeswax. Now this honey frame is a little darker than some. First, because it's fall honey. It's from last fall, and the flowers are darker. Also, because thousands and thousands of bees' feet have run across this and depressed the caps on the honeycomb.

If there were lots and lots of bees on this frame, which I can assure you there definitely would be, ...

I could just use this very, very soft brush to gently move them out of the way so that I could see what was happening below.

I'm gonna put this heavy frame back in just like I found it, and tell you a little bit about the box.

This hive has 10 frames in it. Those are the squares that give the honeybees directions on where to build. And it was designed by a man named Mr. Langstroth. So this is called a Langstroth hive.

This box, where the queen lives, is called a **brood box** because it's the brood nest where all the baby bees are. In the springtime, when all of the flowers are blooming, bees can make lots and lots of honey.

We'll add a second box called a **honey super,** and the bees will go up into that box, fill it with honeycomb, store their honey there, and then that's how we'll harvest our honey.

If you were a beekeeper in another country or many, many, years ago you might use something that looks like this.

This is called a **skep.** Now this is a decorative skep. It's not a working skep. If it were, it wouldn't have a bottom. This would be an open cylinder, and the bees would make their honeycomb inside the skep. They would fill them with honey, and then the beekeeper would just simply tip this upside down to check on the health of their hive.

So those are some of the basic tools that we beekeepers use. It's pretty simple. They're super important though, and I'm so glad that you joined us to learn a little bit about beekeeping.

I hope you'll continue to discover the great world of honeybees.

CURIOUS ABOUT WHAT BEES DO IN WINTER?

Learn from Scientific American about how bees warm up during the cold winter months.

What Do Honeybees Do in Winter?

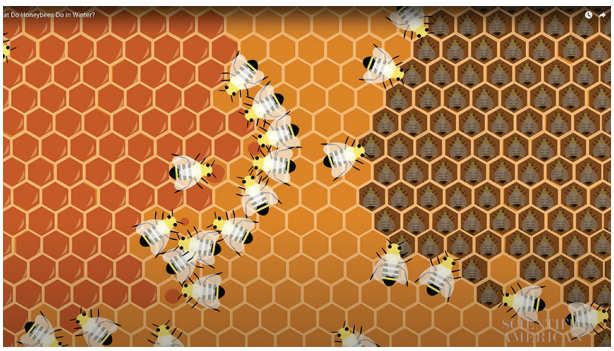
https://youtu.be/aPj0W2eT9PM

When temperatures drop and the days get shorter, ...

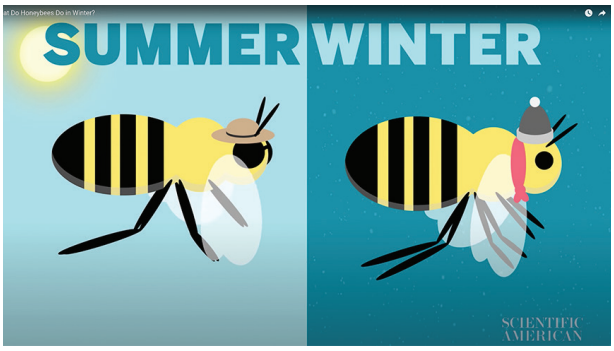
many animals wait out winter by hibernating or migrating to warmer climates.

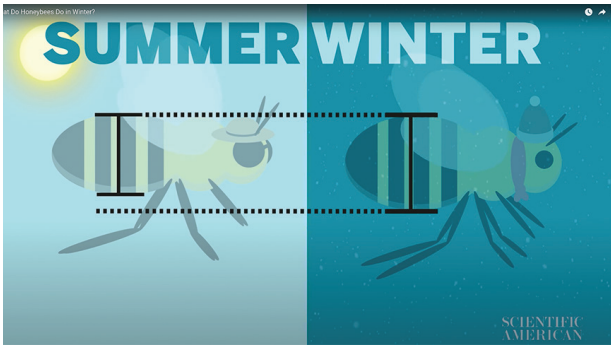
But honey bees do something a little different to stay cozy.

They hug.



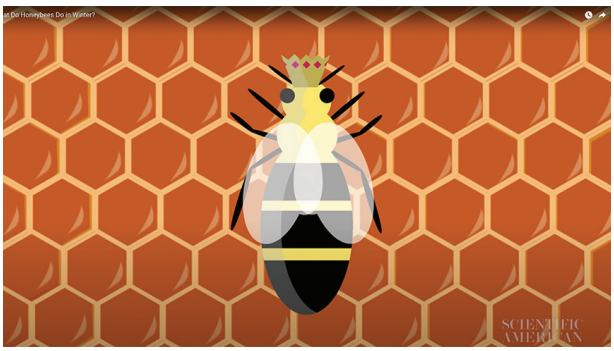
Honeybees start preparing for winter in late summer and fall. Female worker bees stockpile enough honey to keep the hive fed through spring, while also raising their winter replacements.



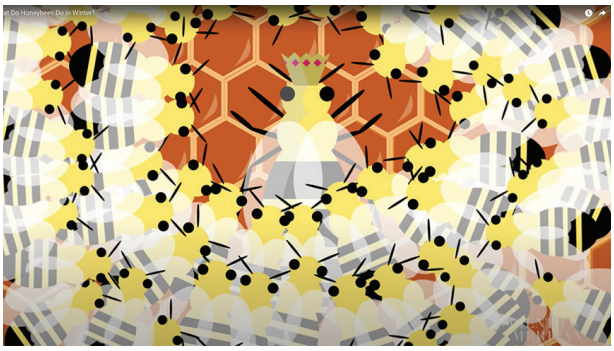


These winter bees have fatter abdomens compared to summer bees, as well as a longer lifespan. Summer bees typically live just four to six weeks, while the winter bees can live four to eight months.

As the temperatures get colder and the hive population shifts to winter bees, workers kick the male drones out of the hive, saving the remaining food for the new winter bees

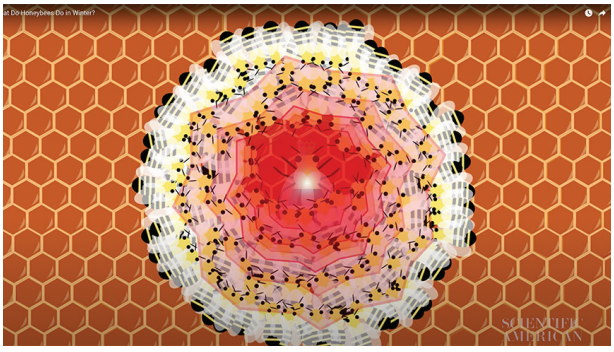


and—most importantly—the queen.



Once the cold hits, winter bees have one very important job: keep the queen warm and fed.

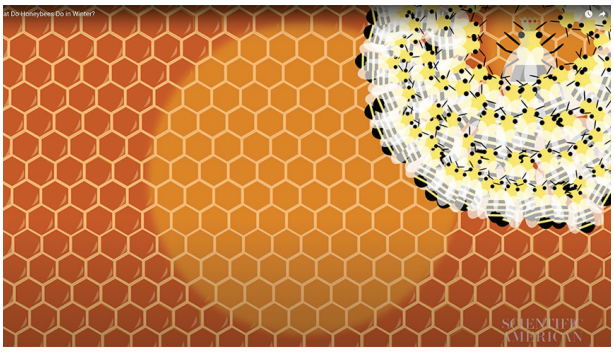
They do this by forming a "winter cluster," which is a very big and very warm group hug.



Bees gather around the queen, fluttering and shivering to generate heat. With the whole colony in on this hug, the queen can get quite toasty.

While the outside of the cluster might be 50 degrees Fahrenheit, ...

the center can reach a scorching 90 degrees.



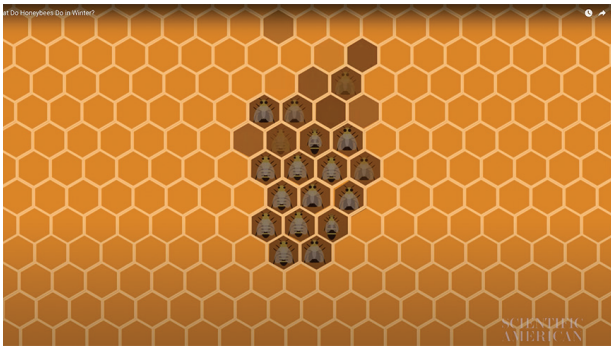
All that fluttering and shivering is work, and work requires food. On warmer days, the hungry honeybee cluster moves through the hive to new stores of honey.

Depending on the conditions, a colony can consume more than 80 pounds of honey before spring, so beekeepers make sure to leave some behind in the fall.

Not all bees hug their way through the cold.

Honey bees in warmer climates may not need these clusters.

And queen bumble bees are often the only bumble bee who survives through the winter, hibernating alone in a safe, warm nesting spot.



Right before spring comes around, the honey bee colony returns to producing summer worker bees.

When temperatures rise, they'll be ready to collect the pollen and nectar they need for the next winter.

Post-Assessment

Take out the KWL chart that you started in the pre-assessment for this unit. Fill out the "What I Learned" column of the KWL chart.

KWL Chart: Organize Your Thoughts!

Write everything you know about honey bees, 5 things you want to know, and 5 things you learned once the lesson is completed.

I KNOW	I WANT TO KNOW	I LEARNED