



STEMsational Ag:
The Virtual Farm
MIDDLE TENNESSEE STATE UNIVERSITY

Module 10: Feed the Bees
UNIT 2: BEE LIFE
Grades 9 - 12



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STEMsational Ag—The Virtual Farm

Welcome to Module 10 Unit 2: Bee Life



Introduction:

Read the PowerPoint slides of "A Bee's Life" (pages 3 - 10) to build a basic understanding of beekeeping terminology and the honeybee lifecycle.



A Bee's Life" Grades 9-12

PowerPoint

A Bee's Life

Introduction to a honeybee lifecycle, jobs, and basic terminology

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

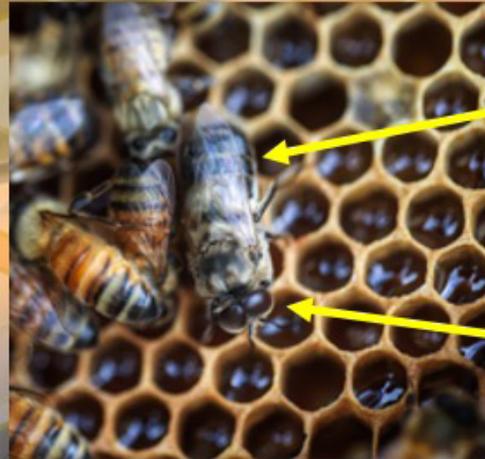


Photo by Amber Dunnaway



A Few Drones

- 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



Stouter body than worker bees

Large eyes

Photo credit: Betsy Reed

Many Worker Bees

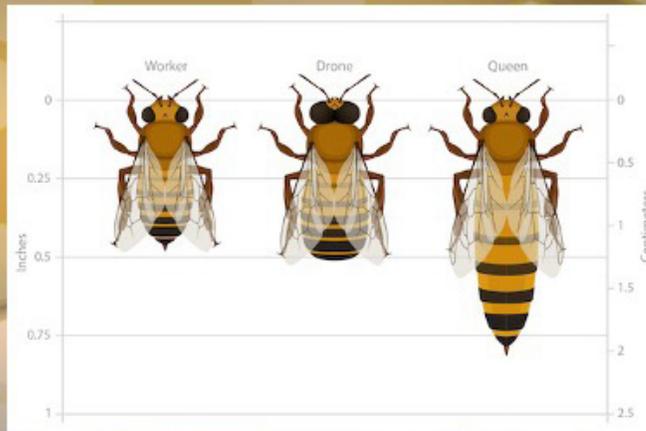
- Worker bees are female but do not lay eggs
- Perform different tasks as they age
 - Clean
 - Nurse young bees (brood)
 - Attend the queen
 - Make honey or wax
 - Guard the hive
 - Forage for nectar and pollen
- Smallest bee, but make up most of the colony
- Life span is 6 weeks during the spring and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



Photos by (top to bottom) Amber Dunnaway and Betsy Reed



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

Lifecycle Infographic

DAYS WITHIN A STAGE BEE CASTES			
	WORKER	DRONE	QUEEN
EGG	3	3	3
LARVA	6	6½	5½
PUPA	12	14½	7½
TOTAL	21 days	24 days	16 days

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



Days Within Each Stage of the Lifecycle

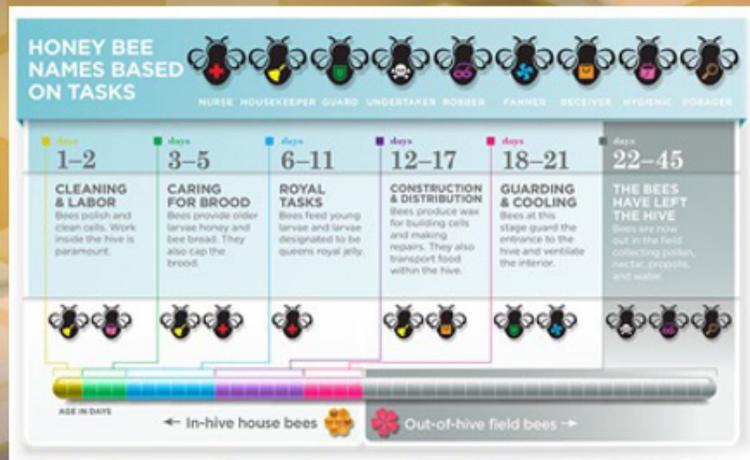
(Text version)

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

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

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 bread. 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



Worker Bee Days 1-2, 3-11, and 12-17

- 1-2 days:
 - Clean the cells around where they emerged so they can be reused for brood and honey storage
 - Utilize their mouths and front legs to clean
- 3-11 days:
 - Nurse bees digest protein to feed the brood
- 12-17 days:
 - Advanced nurse bees produce royal jelly to create queens if necessary



Photo credit: Betsy Reed

Days 12-22 and 22-42

- 12-22 days:
 - Store nectar
 - Produce wax
 - Spread propolis
 - Guard the hive from predators
 - Mortuary bees – remove dead bees from the hive
- 22-42 days:
 - Foraging for nectar and pollen



Photo credit: Amber Dunnaway



Hive Pressures

- Can speed or slow the process of a honeybee progressing to the next job
- Can be deadly when worker bees are forced to mature before they are ready
- Honeybees stay in the hive as long as they do for a reason
 - Wings and stingers must fully form
 - If this doesn't happen, foragers will likely die outside
 - Can lead to the whole colony's death



Photo credit: Amber Dunnaway

Examples of Hive Pressures and stressors

- Climate change
 - Heavy rains/storms
 - Cold snaps and long periods of drought
- Pathogens
 - Viruses – deformed wing virus
 - Parasites – varroa mite
 - Bacteria – American and European foulbrood
- Pesticides
 - Reduce larval survival
 - Alter forage behavior
 - Shorten lifespan of adult bees
- Nutrition
 - Limited availability of plants
 - Reduced floral diversity



Photo credit: Amber Dunnaway



References

- *The NAPPC Honey Bee Health Task Force*, Pollinator Partnership
- *Viruses, bacteria and fungi are microbial pathogens that bug bees*, College of Agricultural Sciences, Penn State University
- *Bee Bonanza: The Story of Honey Bees*, Ask a Biologist, Arizona State University
- *The Complex Life of the Honey Bee*, Purdue Pesticide Programs, Purdue Extension
- *Stung by climate change: drought-weakened bee colonies shrink U.S. honey crop, threaten almonds*, Reuters.com
- *Honey Bee Jobs in the Hive*, The World's Best Pollinators, Penn State University
- *Celebrate Bee Jobs for National Honey Bee Day!*, Planet Bee Foundation
- *Worker Honey Bees Have Different Jobs According to Their Age*, Beekeeping Basics



Pre-Assessment:

Getting to Know a Honey Bee Activity

Directions: Write the answers to the questions below to see how much you know about honeybees! Set the paper aside. You will refer back to it later in the lesson.

1. Who takes care of honeybees?
2. What is a honeybee?
3. What is a queen?
4. What is a drone?
5. What is a worker
6. What products do honeybees create?
7. When do honeybees make honey?
8. When are you most likely to see a honeybee swarm?
9. Where do honeybees live?
10. Where do bees find the ingredients to make honey?
11. Where did honeybees originate?
12. Why are honeybees important to humans?
13. Why are bees dying?
14. How much honey can a single honeybee make in its lifetime?
15. How many times can a honeybee sting?
16. How many honeybees are in a hive?

Purpose:

The student will learn the life cycle of a honeybee and evaluate the stressors that can disrupt a colony's overall well-being.

Student Learning Outcomes for the Unit:

- Students will gain a basic knowledge of honeybee lifecycle terminology.
- Students will explore the different jobs honeybees perform.
- Students will create a presentation demonstrating their understanding of stressors inside and outside of a hive that can lead to colony losses.



National Agricultural Literacy Outcomes:

Agriculture and the Environment, Theme 1

T1. 9-12

E. Evaluate the potential impacts of climate change on agriculture.

Plants and Animals for Food, Fiber & Energy, Theme 2

T2. 9-12

A. Compare and contrast the differences between nature's plant and animal lifecycles with agricultural systems (e.g., producers manage the lifecycle of plants and animals to produce a product for consumption).

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
- **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.)



Vocabulary:

- **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



Choose One of the Activity Options

Learn About Bee Keepers

Option 1

Invite a local beekeeper to your classroom or video call a local beekeeper to talk to the student(s) about beekeeping and maybe even show you inside a hive! Ask the beekeeper the challenges they face every day and what they find most rewarding about being a beekeeper.

Option 2

If you do not have access to a beekeeper, look at the screenshots and read the narration from "Fighting for Survival: A Bee's Life (pages 15-41) to discover what beekeeping looks like on a daily basis!





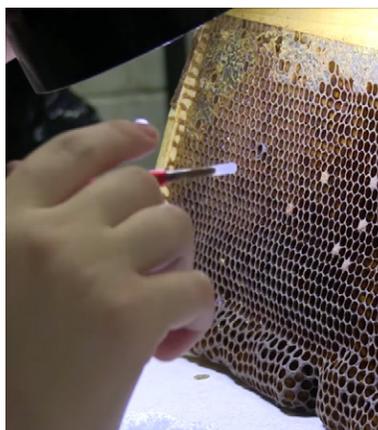
Fighting For Survival: A Bee's Life

Also available online at: www.youtube.com/watch?v=MI2mDXSdXa4



Hey! I'm Amber Dunaway.

I'm a student at Tennessee Tech University in Cookeville, Tennessee, and this summer I received a grant to do honeybee research.



Part of our grant was to raise Queens. And what we did is... we grafted cells to produce Queens that are - or Queens that have - high quality genetics, so that they would be resistant to the varroa mite.



Also, part of my grant was to make a documentary to send out to high schools around Tennessee so that students could get a deeper knowledge of honeybees and how important they are to our daily lives and to our agriculture in the United States today.



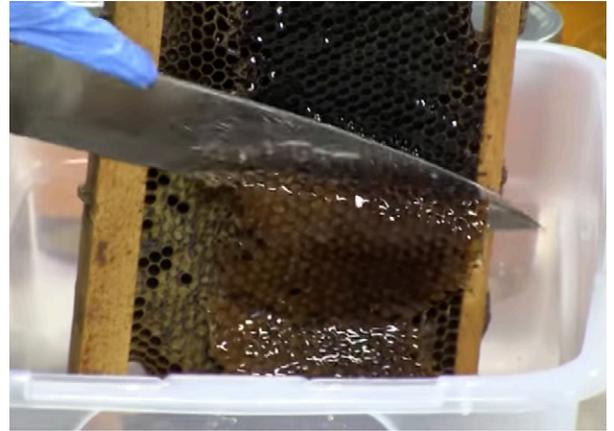
Honey bees, the great foragers of the earth, are essential to the production of agricultural crops in the United States.



This insect is responsible for pollinating around 80% of all fruits vegetables and seed crops in the United States today.



Honeybees are primarily associated with the production of honey.



This thick golden liquid provides the bees with high energy food to constantly feed new generations of honeybees.



Forager bees fly out of the hive and travel miles to collect pollen and nectar.

The honey bee finds the nectar and stores it in her honey stomach.



When she returns to their colony the honey bee will deposit the nectar into storage cells where it will be worked and reworked by the bees until the sugar content is high enough to be preserved as honey.



Then it is capped with beeswax and stored for later use.



Most beekeepers will collect a portion for human use.



This is a frame of honey and it's fully capped and to get the honey to come out ...



We have to cut it off (the capped part).



Alright, now I'm going to insert this into the honey extractor.



Alright, I'm putting the last of our frames of honey in, and we are ready to extract honey.



Okay, now we're going to turn this up so it'll sling all the honey out of all the frames. And we'll turn it up to about medium speed, and we won't turn it any higher or else the comb will start falling out.

Okay, so now I'm going to let the honey flow out, and we'll put it through three different filters to get it completely cleaned.



The home of the honeybee is called a colony. The colony is run by a caste system.



There are three castes: many workers, a few drones, and one queen. Each caste has a special job to perform.



The drone, stouter than the others, will mate with the Queen. This is his primary job. Once the mating has taken place, the drone will die.



The worker bees make up the body of the hive. They are constantly raising young. They perform numerous duties such as cleaning the hive, feeding the brood, caring for the queen, making orientation flights, comb building, ventilating the hive, filling comb with pollen, water, nectar, or honey, and guarding the hive.



I got my first beehives (bee colonies) when I was a freshman in high school.



At that time in Upper East Tennessee they still were keeping bees in what they call gums (hollow trees). And a neighbor of mine gave me two swarms in gums; and I kept them through college and then they died out.



And I got some more and then life got in the way. I finished college, went to Louisiana, lost my bees. My daddy-in-law had kept them for me for a while, but then I lost them, and I didn't get started back until about eight to ten years ago.



I got a faculty grant to do a little bee genetic study.

I'd been hearing all about the loss of the honeybees, and at that time about 80% of the feral colonies in the United States were gone.



And having an interest in genetics, and being a student of genetics, I got to thinking about trying to develop locally adaptive queens that were resistant to the mites and diseases that are facing honeybees right now



Through that grant, we got six colonies for Tennessee Tech. Tech's never been without at least one since that time, though we've lost down to one, a time or two.



When I was 15, I became interested. My grandfather had always had bees, and I went to him. He just actually lived next door, and I told him I was interested in getting into the honeybees.



He helped me catch some swarms at that time, and we actually hand-built my hives. And I got started and I've been in it ever since.



In this yard here (what I've mostly got here) is the full-size colonies you see. They're what we refer to as production colonies.



The smaller colonies, like this one right here behind me, actually contains my breeder queen. And that's what we used to graft from.



The main part of my business is queen rearing, and we graft and raise queens for sale throughout the country.



When I joined the agriculture program at my high school, my Ag teacher taught us a lesson about honeybees...



And ever since then I have been absolutely fascinated by everything about them and wanted to pursue just learning more about them...



And just kind of becoming a honeybee scientist and being an expert about them.

That is my goal.



You will only find one queen in a hive. It might be hard to find her among all the buzzing. Her long abdomen sets her apart.



Some beekeepers mark their queens making it easier to find her.



The queen's job is to mate and lay eggs. A queen can lay from 1,500 to 2,000 eggs a day. They can live three to five years, but many do not live for more than one season.



The queen is the mother of the colony. Her pheromones are kindly the glue that holds the whole colony together. Without that, they're in disarray.



The queen, though - people think that she makes all the decisions - and she doesn't. Worker bees build the cells either in worker size, queen size, or drone size.



The queen then measures it with her antennas when she goes in the cell, and she knows whether to lay, you know, a drone, a fertilized egg, or a non-fertilized egg.



But still, it's her pheromone that keeps everybody working together and coordinating things. The workers actually make more of the decisions than the queens do.



First, I wanted to raise my own queens. I wanted to artificially inseminate my own queens. Mike Haney and I went to the queen rearing school in Michigan and the gentlemen that taught it said, "Before you start it (artificially inseminating queens) you need a genetic package that's worth artificially inseminating."



So then I started stepping back. Here's what we need to do...

We need to select queens from colonies or select eggs from queens of colonies that have survived over long periods of time.



Obviously they're well adapted to the region. Obviously they must be resistant to the disease and parasite problem, because they've survived. And so that's what we've been trying to do is take those queens from long-established colonies and produce more of those genetics putting them in other colonies.



Honeybees must gather pollen and nectar for their survival, however, while they do this they are also providing humans with a great service: pollination of our crops. Pollination is the fertilization of a flowering plant. Without honeybees crop yields would greatly decline and some crops, such as the almond tree that depend entirely on honeybee pollination, would become extinct.



The importance of the honeybee...

A lot of people, especially young kids when I go and do talks for them at school and stuff, I'll ask them what's the most important thing that honey bees do.



Of course, the first answer of all of them is, "Honey, honey." Well, we all enjoy honey, but that is not the most important thing we get from the honey bee...



Pollination is by far the most important thing the honey bee does for us as humans, by going from flower to flower and pollinating the crops. For example, apples can be up to 10% larger just from being pollinated by honeybees.



The thing about honeybees, that makes them more important than all the other insects that do some of the pollination...

Bees are crop specific



And what I mean is when they start working a crop and say, let's just use squash for example. A farmer rents hives to pollinate his squash. When bees start working a crop, they will work that crop entirely until it's gone. They won't work anything else. Then at that time when it plays out, they'll move to something else - whatever it might be - apples. But, they will only work one source until it's gone.



And then, honeybee colonies during the summer will be at a population around sixty thousand. There's no other insect that contains a colony with that number. So you can tell that that's an enormous work force to do the pollination.



I feel like the most important thing that everyone should know about honeybees is how they are so responsible for pollination of our crops in America. Without honeybees, we would not be able to eat the food we do, and the food would not be as nutritious for us as it is today.



As honeybees have been transported around the world, they have been exposed to diseases, parasites, and chemicals that have led to the death of many colonies throughout the world.



This is a serious world event and continues to be a challenge to the survival of honeybee colonies and to the beekeeper.



The varroa mite is a parasite that is the number one plague affecting colonies. The mite is suspected of being the carrier of many of the other viral diseases that plague honeybees.



Beekeepers should do a mite count on their colonies at least twice a year and treat to keep the mite population down within the colony.



The small hive beetle is another pest you will commonly see within a colony. These beetles do little damage, but do present stress in the colony. And, they can destroy frames of honeycomb in the larval stage.



As we talked about, the honeybees main importance is pollination and in the last few years with mites and chemicals, our honeybees have been devastated.



As a matter of fact, at least 95% to 98% of our wild feral colonies are gone. So the only thing remaining is what apiarists are keeping at their homes and on their farms.



One thing that greatly affects the colonies today is pesticides and mites.



One of the two biggest ones are the hive beetle. You'll often see the hive beetle as soon as you open any colony. It just is an annoyance to the colonies and it can make the colonies really weak.



Then the other big one is called the varroa mite and it starts growing in the egg cells that the queen lays.



So from the larva stage, it is affecting the honeybees and it is one of the biggest carriers of tons of diseases. So it has a huge impact on the colonies.



The worker bees and the queen bee are females, but the workers are not reproductively developed.



The honeybee colonies produce new queen bees by feeding the larvae more of a special feed called royal jelly. Honeybees can be induced to produce new queens by manipulation of the colony.



Beekeepers can take advantage of this behavior of honeybees to produce more queens that are more resistant to the varroa mites and other diseases and pest problems.



RidgeTopApiaries.com

RidgeTop Apiaries is located in Middle Tennessee in the hills of the Cumberland Plateau.



Here we will learn about the importance of rearing queens with high quality genetics.



What we're raising here is VSH bees and what that stands for is varroa sensitive hygienic. The varroa mite - it hit our part of the country in the early '80s and at that time our bees had no resistance.



European bees did have resistance and the USDA acquired some of their genetics and have been breeding these queens out of Baton Rouge down at the USDA Bee Lab.



They've now got those VSH queens distributed to people that produce inseminated queens, and we purchase them as bee breeders from those people.



We are grafting from those breeder queens to produce queens that will sense the varroa mite underneath the capped brood; and those bees use their hygienic behavior to chew that larva out and remove it from the hive.



And because the varroa mite breeds and reproduces underneath the capped brood, they (the VSH queens) remove that and thus it reduces your mite load on your colonies.



The varroa destructor (the mite that I'm talking about) is still to this day the number one enemy of our honeybees. It's still what's devastating the colonies. We're running about a 30% loss through winters because of it.



My interest in queen rearing is totally genetic. We've got the problem - a primary problem, I think - with the diseases and the varroa mite, because the varroa mite is probably carrying many of the viral diseases that are killing bees.



So not only do we have that mite hanging off the back of hundreds of bees which are going to impair their function and eventually kill them, we have that mite introducing into that colony viruses that are probably (that may be) related to some of these other factors like colony collapse disorder.



So here's what I think we have to do to be successful at this... We need bees that are resistant to the varroa mite, maybe resistant to some of the other diseases, but that are also adapted to Middle Tennessee (or if you're in another area in the South, or the West, or the North) because species develop a natural adaptation to their environment.



So we need to produce queens that are adapted to the Upper Cumberland region of Middle Tennessee (or the Upper Cumberland region at least) that are also resistant to the the varroa mite disease.



Scientists throughout the country are trying to develop ways to increase the population of honeybee colonies and ensure their survival and success through genetics, evaluation of pesticide toxicity levels, disease and parasite control, and other environmental and behavioral factors.



One of the things that the average person or homeowner can do, especially if they own a little piece of property - instead of keeping it mowed and pristine and pretty like a golf course - would be to let it grow up in wildflowers and give the bees something to work on to make their life less stressful.



Be careful in just your home gardens with using some of the pesticides. Sevendust is especially deadly. If you've got to use something, use some of the organic compounds - (Captain Jack's and some of those that are liquid sprays). Avoid the dust (Sevendust). The bees pack that back to the colony (in their pollen baskets), and then it wipes out the whole colony.



So being aware of the chemicals you use around your home that are deadly to honeybees is something that would be very helpful. Spraying fruit trees and stuff - spray them late in the evening after the honeybees have quit working - that's very helpful.



The biggest thing that probably affects our bees is pesticides and people using them irresponsibly. They just spray them everywhere and don't think about what they're doing to honeybees - and also what they're doing to us.



But, that really affects the honeybees. It confuses their senses. So, they go back to their hive, and they just are all confused. And, it weakens their immune system and causes the colony to feel great losses.



You can go to the internet and you can find plants that are bee friendly. Just because it flowers doesn't necessarily mean it's a good nectar producer. And so, I would encourage urban areas and suburbs to plant flowers and shrubs that are bee friendly, and it'll depend on what area you're in.



This is a hard thing to say as an agriculturalist, but we have really hurt to bee population by herbicide use and by keeping weeds down.



I'm not suggesting that people need to leave weeds in their cultivated crops; I am suggesting it doesn't hurt anything in fence rows, along the edges of your pasture, and along the edges of your field.



I'll give you an example. Perilla mint is toxic to cattle, but they will hardly eat it unless they don't have anything else to eat. Perilla mint is a pretty good bee feed. It produces pretty good nectar. It blooms a little later than this. So I would encourage farmers to leave areas just like you leave bird sanctuaries and rabbit sanctuaries. I would encourage farmers to leave areas that are bee friendly.



If we don't do something to turn this around like Europe has done...



with the vanishing of the honeybees... this country is going to see a dramatic drop in our food sources to the point - I mean - we could actually see some starvation.



So we've got to do something to benefit these honeybees if we expect to keep eating.



Honeybee Project

- Students choose your option to complete this project:
 - Create a presentation (PowerPoint, science poster, Google Slides, etc.)
 - Or write a five-paragraph essay
- The topic:
 - You have just spent time learning all about honeybees and their lifecycle. A queen bee lays an egg, it hatches and begins to develop, it emerges into the hive as an adult. If it is a drone, it will not do much besides mate with queen bees. If it emerges as a queen, she will lay eggs for the rest of her life. If it emerges as a worker bee, she will proceed to complete different tasks as she matures. There are many stressors inside and outside of the colony that can disrupt any part of a honeybee's life.
 - Think of or research a stressor found inside or outside of the colony that could disrupt the lifecycle of a bee. It could be any of the following: climate change (i.e. cold snaps, heavy rains/storms, etc.), viruses and diseases (i.e. varroa mite), pesticides, etc. Research how the stressor specifically disrupts any part of the honeybee lifecycle and the changes the hive must make to compensate.
 - Write a paragraph or create a slide that addresses the impact of bee colony losses have on the world food supply.
- Share your project!
 - Share your project with your class (if you are in a classroom environment) or share it with your friends and family to show them what you learned about honeybees.



Post-Assessment

Directions: Answer the questions below to see how much you learned about honeybees! After you write your Post-Assessment answers, compare them to what you wrote for the Pre-Assessment. Do your answers match?

1. Who takes care of honeybees?
2. What is a honeybee?
3. What is a queen?
4. What is a drone?
5. What is a worker
6. What products do honeybees create?
7. When do honeybees make honey?
8. When are you most likely to see a honeybee swarm?
9. Where do honeybees live?
10. Where do bees find the ingredients to make honey?
11. Where did honeybees originate?
12. Why are honeybees important to humans?
13. Why are bees dying?
14. How much honey can a single honeybee make in its lifetime?
15. How many times can a honeybee sting?
16. How many honeybees are in a hive?

Answer Key is on page 52



Optional Activity for Hands on Learning: Make an Interactive Hive

- The activity will consist of exploring an interactive hive.
- This can be done in a classroom environment or as an individual learner.
- Study and view the "Creating a DIY Interactive Honeybee Display" Power-Point on pages 44-51 for directions on how to create the hive and to access examples of the finished product.
- Even if you do not have all the materials to make the hive, study the slides to learn more about bee hives, various types of bees, and bee roles in the hive!

"Build a Honey Bee Lifecycle Instructions" PowerPoint

Creating an Interactive Honeybee Display



Project Created by Amber Dunnaway



Materials Need:

- 1-Poster board, any color
- 10-Empty toilet paper or 5-paper towel rolls cut into ½ inch pieces folded three times to create a hexagon shape
- 2-Grains of rice (represents eggs)
- 2-Macaroni noodles or a noodle that is C-shaped (represents larva)
- 1-Small container of white play dough or modeling clay (model into a pupa)
- 1 package-Orange and yellow pompoms or yellow and orange pipe cleaners
- 1-Clear glue bottle
- 1-Felt bee, toy bee, honeybee cutout (adult honeybee to complete the lifecycle)
- Cut out of one queen bee, multiple worker bees cut-outs, a few drone bees cut-outs
 1. You can find honeybee cutouts used in the course on this website from [Arizona State University, "Bee Bonanza: The Story of Honey Bees."](#)
 2. Optional: You can purchase a "[Lifecycle of the Honey](#)" set on Amazon
- 5-8 Clothes pins for worker bees
- 1-Bottle of orange or yellow food coloring (only use 2 drops)

Steps to Make the Hive

Parts 1, 2, and 3



Steps to Make the Hive (Part 1)

- Take empty paper towel or toilet paper rolls and cut them into $\frac{1}{2}$ inch strips. Fold each strip into three sections to create a hexagon shape.
- Glue the hexagons together into multiple rows and columns to create honeycomb.
- Add the lifecycle into the cells:
 - Grains of rice will represent eggs
 - C-shaped dry pasta noodles represents a young larva
 - Construct the pupa from modeling clay or play dough
 - Complete the life cycle with an adult bee (use a plastic bee, create one from art supplies, or use a cutout)

Steps to Make the Hive (Part 2)

- Next, add honey in the hive.
 - Mix clear liquid Elmer's glue with yellow or orange food coloring to display "honey".
- Use yellow and orange pom poms to represent pollen. Stuff a bunch of pom poms into a hexagon (cell).
- Add cutouts of a queen bee, drone bees, and worker bees around the hive doing each job.
 - Place the queen near the eggs.
 - Place drones near the queen or outside the honeycomb.
 - Worker bees can be placed everywhere around the hive doing jobs like tending to the young, bringing in pollen, making honey, cleaning, etc.



Steps to Make the Hive (Part 3)

- Finish the interactive hive by placing labels on the hive.
 - Labels should include:
 - The comb
 - Cell
 - Egg
 - Larva
 - Pupa
 - Adult
 - Queen
 - Worker
 - Drone
 - Honey
 - Pollen
 - Propolis (explain to students that propolis is the "glue" that holds the hive together)
 - Pollen basket

The Complete Hive





The Complete Hive Description (Part 1)

- This is an aerial view of a frame of a honeycomb, as if a bee keeper pulled it out of the hive.
- The first thing that a bee keeper would look for in a honeycomb is the life cycle of a worker bee, which is on the left side of the honeycomb.
- The life cycle stages are:
 - Eggs, represented by a grain of rice. When a bee keeper sees these, they know the queen bee is alive and well.
 - Larva, represented by a dry c-shaped pasta noodle.
 - Pupa, represented by white modeling clay or play dough. In this stage, the honeybee starts developing eyes and wings.
 - Adult. It will hatch out of the cell, represented by the hexagon. It hatches as a full-size, adult honeybee.

The Complete Hive Description (Part 2)

- Now, the middle of the hive will be described.
- Honey is represented in a cell by combining clear Elmer's glue and drops of food coloring (either yellow or orange).
- Worker bees store and make honey in cells.



The Complete Hive Description (Part 3)

- Outside of the hive, in bottom right corner, there is a worker bee carrying pollen to the hive. The small yellow pom poms represent the pollen, which is on its legs and called the pollen basket (part of the bee's body).
- The cells that are full with yellow and orange pom poms, represent grains of pollen. Pollen is a protein source and is used as their food to survive. Pollen is also used in the pollination process with flowers.
- Propolis, is gathered by honeybees from sap and resin from pine trees. Bees use it to glue everything in the hive. It's very sticky! The glue used in the display represents propolis.

The Complete Hive Description (Part 4)

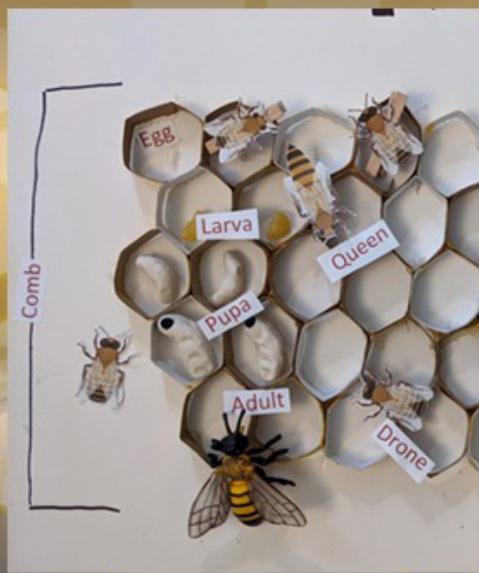
- The various types of bees are in certain locations in the hive as follows:
 - Queen: Has a longer abdomen and is next to the eggs in the life cycle. Her main job is to lay eggs in the hive to ensure the future generation of her hive lives on.
 - Drones: Have a more "stout" body. They do not have stingers. They surround the queen and their main job is to mate with the queen to ensure she has fertilized eggs.
 - Learn about Worker Bees on the next slide.



The Complete Hive Description (Part 5)

• Workers:

- The body of the hive is full of worker bees. There can be 60,000-80,000 worker bees in a hive.
- They are in many places in the hive, which is why the worker cut outs are attached to clothes pins. Feel free to move them around the hive!
- First, you will see worker bees around the life cycle area, near larva and eggs. They feed and take care of bees in the life cycle stages so that they can grow and hatch into adults. For this reason, they are called "nurse bees" because they take care of the young.
- There is also a worker bee close to the queen bee. They take care of her by cleaning the queen and bringing her food.
- There is also a worker bee on a cell with honey. The worker bee makes honey from nectar.
- Lastly, there is a worker bee outside of the hive bringing in pollen and a worker bee making bee bread, their food source. They do it all!



Bee Lifecycle





Answer Key from page 43

Getting To Know a Honeybee Answer Key

Check your answers to the Activity using this Answer Key.

1. Who takes care of honeybees?
 - a. Answer: Beekeepers, also called apiarists, are caretakers to honeybees.
2. What is a honeybee?
 - a. Answer: A honeybee is a social insect that collects nectar to produce honey.
3. What is a queen?
 - a. Answer: A queen bee is the single egg laying female in a honeybee colony.
4. What is a drone?
 - a. Answer: A drone bee is a male honeybee. Its job is to mate with the queen.
5. What is a worker?
 - a. Answer: A worker bee is female. Worker bees make up the body of the colony. Worker bees conduct many jobs within the hive to keep it running smoothly.
6. What products do honeybees create?
 - a. Answer: Honey, bee bread, wax, propolis.
7. When do honeybees make honey?
 - a. Answer: They usually begin making honey during the spring.
8. When are you most likely to see a honeybee swarm?
 - a. Answer: Usually, late spring.
9. Where do honeybees live?
 - a. Answer: Honeybees typically live in a hive. Wild honeybees can live in trees and many different holes and crevices that will protect them from predators.
10. Where do bees find the ingredients to make honey?
 - a. Answer: They collect nectar from flowers to create honey.
11. Where did honeybees originate?
 - a. Answer: Europe, Africa, and the Middle East. Honeybees are not native to North America.
12. Why are honeybees important to humans?
 - a. Answer: Simply put, honeybees and many other bees, are important because they pollinate our food crops. Honeybees pollinate apples, melons, cranberries, pumpkins, squash, broccoli, and almonds, to name a few.
13. Why are bees dying?
 - a. Answer: Parasites, pathogens, pesticides, poor nutrition, and habitat loss.
14. How much honey can a single honeybee make in its lifetime?
 - a. Answer: A single worker bee will produce 1/12th of a teaspoon of honey in its lifetime.
15. How many times can a honeybee sting?
 - a. Answer: Just once and then it will die.
16. How many honeybees are in a hive?
 - a. Answer: Anywhere from 20,000-80,000 bees.