

Educator Resource Guide



Part 1: To Bee or Not to Bee

Bees (and their mimics)
as pollinators

Developed by:

*Michael Dawson, Nicole Miller-Struttman, James
Faupel, Jennifer Gauble and Cheyenne Davis*



To Bee or Not to Bee

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Background Information

**"To Bee or Not to Bee" is intended to be used as the first lesson of the Shutterbee Activity Series, but if used individually, special instruction should be given to summarize the importance of pollinators to students afterward, and to lend background and value to the activity.*

Most plants need pollination to reproduce. Pollination occurs when pollen is taken from the male part of a flower and moved to the female part of a flower. An animal that carries the pollen from one plant's flower to the next is called a pollinator. Pollinators play an intricate role in natural ecosystems by helping plant populations consistently reproduce, a role that we rely on heavily for continuing our worldwide supply of food, as well as many of our other plant-based resources, such as medicine, clothing, building materials, etc. Research shows that around 1/3 of our global food supply is reliant on animal pollination, and 80% of plants in the world rely on pollination by living beings, which is called BIOTIC pollination. Pollination by non-living factors, such as by wind or water, is called ABIOTIC pollination.

In this lesson, students will learn about the effects of pollination on our sources of food. Since so much of that pollination is done by animals, it is vital that we also learn about the different types of pollinators and understand how we can best support them. Some of the most familiar insect pollinators to us in our landscapes are bees, flies and wasps. These three important pollinators can unfortunately be hard to tell apart from each other. This first lesson of the Shutterbee Activity Series will help make it easier to differentiate bees, flies and wasps.

Bees, specifically, are some of the world's best animal pollinators. Many people will only know of a handful of types of bees prior to this series of activities, but there are over 20,000 species of bees worldwide, 4,000 in the U.S., and over 400 in Missouri! Bees are the perfect candidates for the focus of this fun series of Shutterbee activities, thanks to the special services they provide to both plants and us.



Lesson Summary and Learning Goals

This lesson consists of two related activities. During the first, *Pollinator Buffet*, students construct a meal by selecting among ingredients. They then use a key to figure out which ingredients require pollination and which bees pollinate them. During the second activity, *Build a Bee*, students work in teams to construct a bee and two insects that are often confused for bees: flies and wasps. In doing so, they compare and contrast the attributes of the three groups.

Lesson length: 50 minutes

Note on Bee Declines: Humans have a major impact on wild bee populations all around the world. Habitat destruction, careless invasive species introductions, and harmful chemical use on lawns and crops, are just a few of the many ways that we negatively impact bees. While these activities do not directly address bee declines, here are a few recommendations for how humans can positively impact bees. Remove invasive exotic plants and provide native plants for them to have access to food resources, provide chemical free areas for them to thrive and be healthy in, and allow for areas to act as nesting sites. Nesting sites can vary by species, such as bare patches of soil and sand, standing dead plant stems, and holes in old wooden logs and snags. You can also help by joining citizen science research groups like SHUTTERBEE and collecting bee data!!

Learning Goals

This lesson introduces students to the following topics:

- The importance of pollinators in food production
- The differences among three common flower visitors (bees, flies and wasps)
- Bee diversity in Missouri



Learning Standards

6-8 Science Missouri Learning Standards: Grade Level Expectations

Life Sciences 1: From Molecules to Organisms

Concept B: Growth and Development of Organisms (6-8.LS1.1.) Construct an explanation for how characteristic animal behaviors as well as specialized plant structures affect the probability of successful reproduction of animals and plants respectively.

Life Sciences 2: Ecosystems: Interactions, Energy, and Dynamics

Concept A: Interdependent relationships in Ecosystems (6-8.LS2.1) Analyze and interpret data to provide evidence for the effects of resource availability on individual organisms and populations of organisms in an ecosystem.

North American Association of Environmental Education Guidelines for Excellence Grades 5-8

Strand 1: Questioning, Analysis and Interpretation

A. Questioning: Learners are able to develop, focus, and explain questions that help them learn about the environment and do environmental investigations.

F. Working with models and simulations: Learners understand many of the uses and limitations of models

Strand 2: Environmental Processes and Systems

B. Earth's living systems: Learners describe how living things, including humans, are dependent on their environment and are adapted to live in particular ecosystems under specific environmental conditions. They describe major interactions among organisms and populations of organisms and explain the importance of biodiversity to ecosystem health. They describe how humans affect and are affected by the biosphere.



Supply List and Lesson Set-up

Supply List

Pollinator Buffet Activity

- ☐ Paper
- ☐ Lamination supplies (optional)
- ☐ One tray per student or pair of students (plastic or metal; optional)
- ☐ Magnets with adhesive (optional)

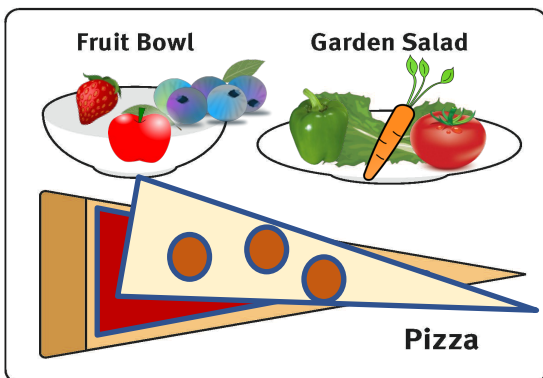
Build a Bee (& its Mimics) Activity

- ☐ Air dry modeling clay, such as Model Magic (1 package or 1 marble-sized ball of white per student; one with color per group)
- ☐ Pipe cleaners (optional)
- ☐ Small wooden dowls or toothpicks (1 per student; optional)
- ☐ Cork coasters or foam blocks (1 per student; optional)

Lesson Set-up

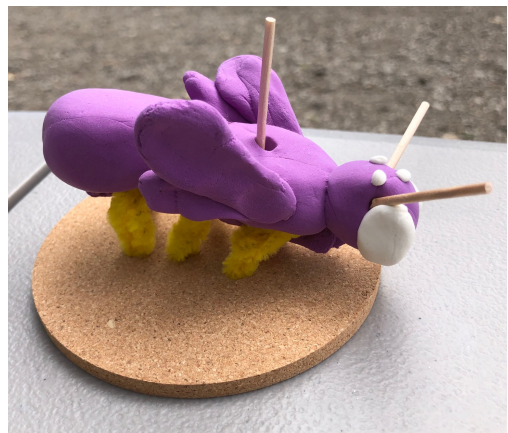
This lesson includes two activities. The first, Pollinator Buffet, has the students create and then deconstruct a meal to demonstrate the importance of pollinators in our everyday lives. During the second activity, Build a Bee, the students learn the differences among bees and their mimics by building models with clay.

Activity 1: Pollinator Buffet. The activity starts with the students assembling a meal out of paper cut outs and a lunch tray. They then use a key to identify which insects visit which plants. The assessment asks the students to make connections between bee diversity and the quality of their meals.



Activity 2: Build a Bee (and its Mimics).

After a short presentation describing how bees, flies and wasps differ, students work in teams of 3 to build one model for each type of insect. They then share how their model demonstrates the key traits.

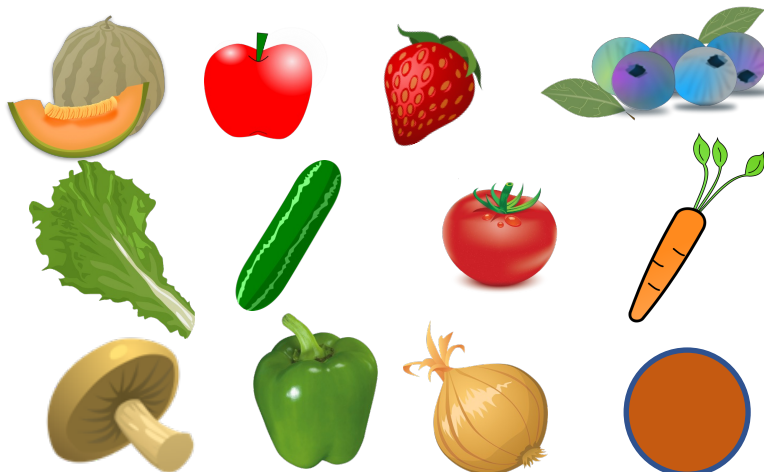
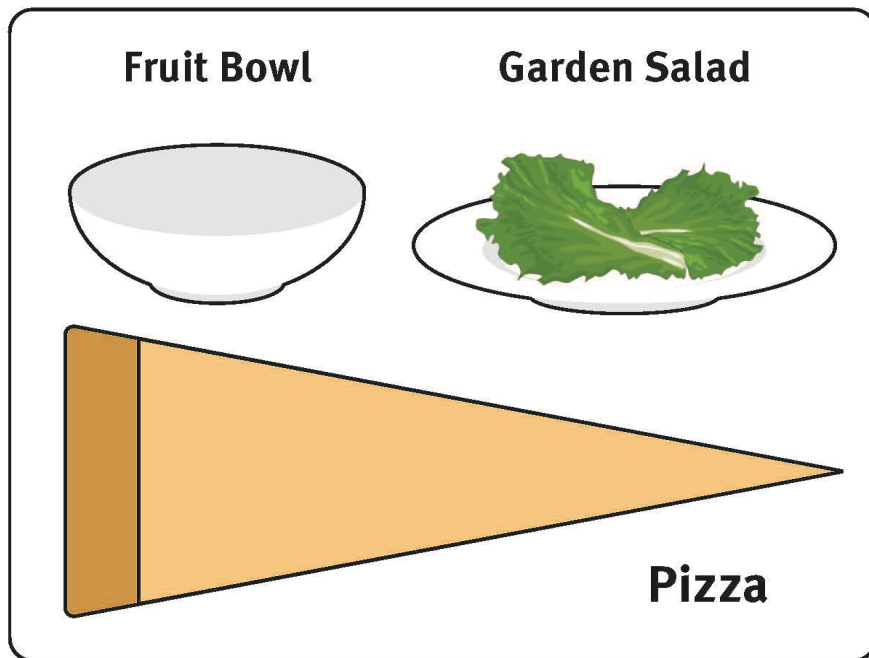




Pollinator Buffet Activity

In this activity, students will choose among available ingredients to create a meal with a slice of pizza, a vegetable salad, and a fruit salad. No prior instruction is necessary. Provide each student or pair of students with a separate food tray with the ingredients and allow them to create their meal.

*** All pieces below are available in printable format in the "Part 1_To Bee or Not to Bee_To Print" file**





Pollinator Buffet Activity

Continued

Once they have created their meal, hand out the key (right).

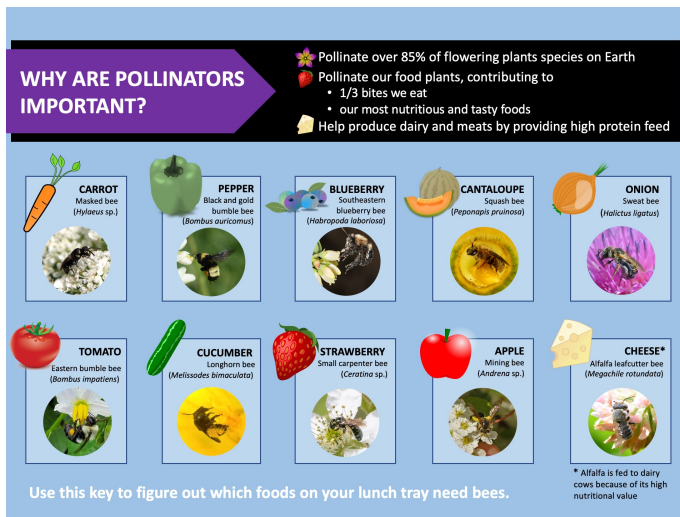
Select one fruit and its pollinator, and briefly discuss the relationship with your students. Then, have the students remove the foods pollinated by that bee from their meal.

For example, if your students picked apples, ask them what would happen to their plate if the mining bee, the pollinator of apples, were to go extinct. Then, have them remove that fruit from their plate.

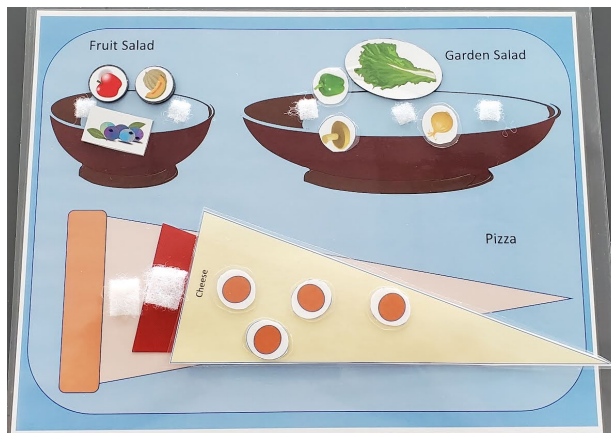
The connection between pollinators and cheese production is a bit more challenging. After you have removed a few of the more straight-forward examples, tell the students that the alfalfa leafcutter bee has gone extinct and that affects cheese production! Dairy cows eat alfalfa, which is high in protein, and that increases cow milk production. Without alfalfa, the cows produce much less milk and therefore less cheese.

Repeat for each ingredient until only crust, pepperoni, mushrooms and lettuce are left.

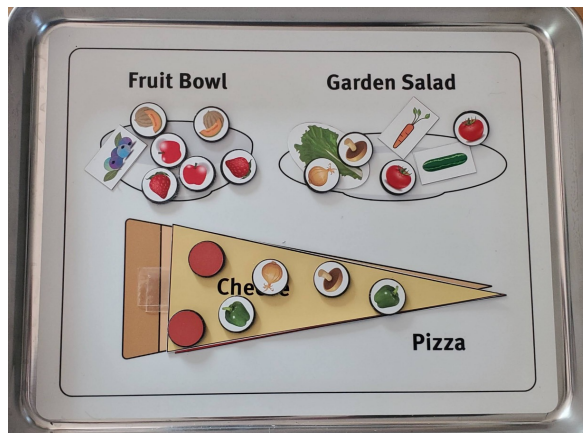
(For more advanced students, let them identify which bees are responsible for their foods on their own.)



Example Laminated Set-up



Example Magnetic Set-up





Assessment of Student Learning

Final wrap-up questions for discussion

Ask students to look at their new meal and ask,

- Does your meal look as **delicious** as it once did? Does your meal look as **nutritious** as it once did?
- How does the diversity of bees matter for your meal?
- What might it mean for you if pollinators are lost?











Optional Extension

For more advanced students or as an extension, have students choose a bee to learn more about and share one piece of natural history about it, using the information on the opposite side of the key. For each species, there is a short description of what the bee looks like, where it nests or another biological fact that may be of interest.

MORE ABOUT YOUR POLLINATORS

There are more than 24,000 types of bee in the world.
Missouri alone has over **450** species!

Bees come in all colors (including blue, green, & red) and sizes, from smaller than an eyelash to longer than a quarter
Most bees nest in the ground & are solitary (no workers or queens)

 <p>MASKED BEE (<i>Hylaeus</i> sp.)</p> <p>Small, mostly black, bees with unique white or yellow face markings that look like superhero masks</p> <p>Carry pollen in a special "tummy" and pull it back up to feed their young.</p> <p>Make cellophane-like material to keep water and pests out.</p>	 <p>BLACK & GOLD BUMBLE BEE (<i>Bombus auricomus</i>)</p> <p>One of our largest local bumble bees.</p> <p>Like other bumble bees, ...are social with annual colonies started each spring by new queens.</p> <p>...shiver to raise their body temperature and forage in cooler temperatures than other bees</p>	 <p>SOUTHEASTERN BLUEBERRY BEE (<i>Habropoda laboriosa</i>)</p> <p>Solitary bee that nests in the ground.</p> <p>Only collects pollen from blueberry flowers.</p> <p>Blueberries need buzz pollination to release pollen. Only blueberry and bumble bees can pollinate them.</p>	 <p>SQUASH BEE (<i>Peponapis pruinosa</i>)</p> <p>Solitary bee that nests in the ground.</p> <p>Only collects pollen from squashes and melons, so they are active before sunrise when they blossoms open.</p> <p>Male squash bees sleep inside flowers at night, often in groups.</p>	 <p>SWEAT BEE (<i>Halictus ligatus</i>)</p> <p>One of the most common bees found in our region</p> <p>Has a large range, found from the Arctic Circle to Venezuela, South America.</p> <p>Can be social or solitary, depending on the environment.</p>
 <p>EASTERN BUMBLE BEE (<i>Bombus impatiens</i>)</p> <p>One of the most common bumble bees of the eastern United States.</p> <p>Bumble bees are one of the few types of bees that can "buzz pollinate" to release pollen from tomatoes and their relatives. Honey bees cannot buzz pollinate.</p>	 <p>TWO-SPOTTED LONGHORN BEE (<i>Melissodes bimaculata</i>)</p> <p>They get their name from the extra long antennae of the males.</p> <p>The females have long hairs on their legs for carrying pollen.</p> <p>Nests in burrows dug into the ground by the female.</p>	 <p>SMALL CARPENTER BEE (<i>Ceratina</i> sp.)</p> <p>Small solitary bees that are often dark, iridescent blue-green.</p> <p>Females nest in the broken or cut stems of various wildflowers and shrubs from which they chew out the soft centers.</p>	 <p>MINING BEE (<i>Andrena</i> sp.)</p> <p>Have unique "eyebrows", dense hairs that run along their large, compound eye.</p> <p>Abundant during the spring, making them great pollinators of fruits peaches and apples.</p> <p>Solitary bees that nest in the ground.</p>	 <p>LEAFCUTTER BEE (<i>Megachile</i> sp.)</p> <p>Carries pollen on the underside of its belly (abdomen), not on its legs like other bees.</p> <p>Cut circular sections of leaves or flower petals to line their nest.</p> <p>Build their solitary nests in cavities of rotting wood or hollow stems.</p>



Build a Bee (& its Mimics) Activity

In this activity, the students will learn the distinguishing characteristics of bees and their wasp and fly mimics by building them out of clay. Transition from previous Pollinator Buffet Activity by asking the students how many types of bees they think there are (from this exercise, they have had exposure to at least 10).

Then, using the paired images in the slides (example shown to the right), ask the students which one is a bee. They often share their reasoning for choosing one over another, which is great for revealing their prior knowledge and misconceptions about bees. However, it is a trick question! They are ALL bees. The point is to demonstrate that bees come in many different shapes and sizes. By the fourth pair of images, some students may have picked up on the false dichotomy.

The next few slides provide more images to help the students visualize how many types of bees there are in North America, Missouri, and St. Louis. We estimate that there are roughly 4000 species of bees in North America. Over 450 of those species live in Missouri and over 200 live in St. Louis! In other words, despite accounting for less than 1% of land area in North America, Missouri hosts over 10% of the bee species found in North America!

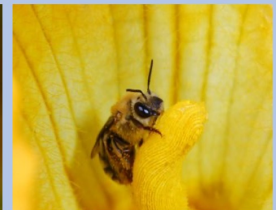
In the slide to the right, each group of images includes 50 different species. Repeating that 9 times provides a visual representation of 450 different species found in Missouri (though to be clear, the images repeat).

1) Which of the following is a picture of a bee?

1



2



In North America there are **4,000** species of bees, 50 of these are Bumble Bees



Missouri is home to around 450 species of native bees



Build a Bee (& its Mimics) Activity Continued

Transition to the next part of this lesson by emphasizing that many insects are pollinators. However, bees do much of the “heavy lifting” because they intentionally collect pollen (they feed it to their young). They are herbivores! They only eat from plants their whole lives, and their bodies reflect that. They are usually very hairy! Those hairs help them collect and hold on to pollen as they fly back to their nests. However, there are lots of insects that *look* like bees. We call them mimics, and they can trick even the biggest bee enthusiast. How do we know when we have a bee, a fly or a wasp?

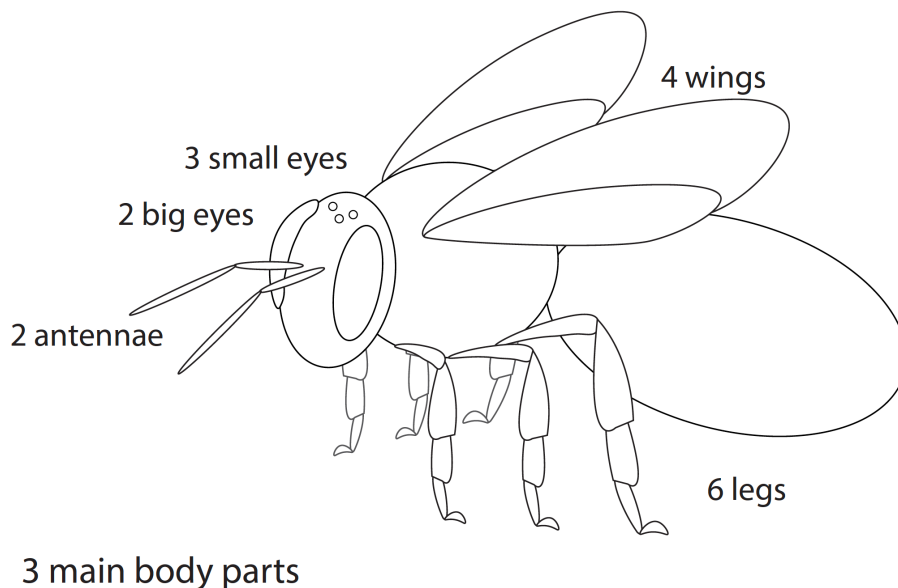
Depending on your students’ prior knowledge, either draw a diagram of the basic parts of an insect body or ask them the following:

How many body parts does an insect have? (3)

How many legs? (6)

How many antennae? (2)

A diagram of a simplified bee body is below for your reference. We do not recommend that you share this with the students at this stage, however. For your information, bees and wasps have 4 wings and 5 eyes (2 large ones on the sides of their head and three smaller ones on top). Flies have only 2 wings and 2 eyes. The next set of slides provides images demonstrating how bees, flies and wasps differ.





Build a Bee (& its Mimics) Activity Continued

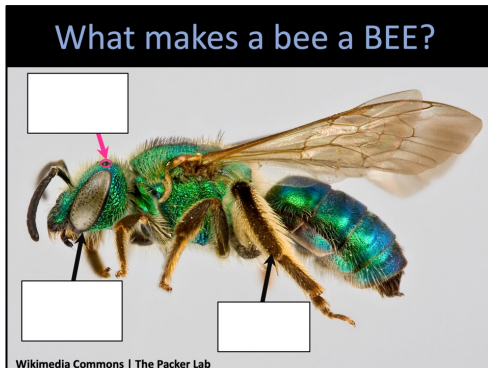
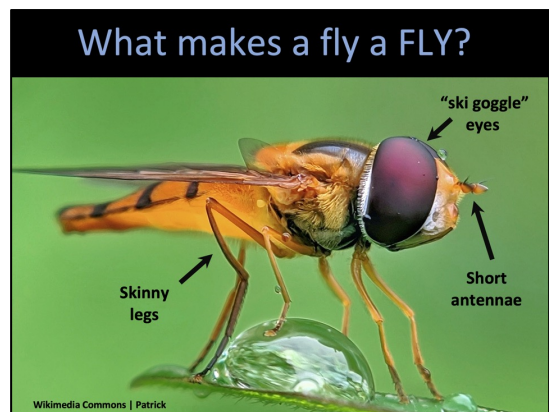
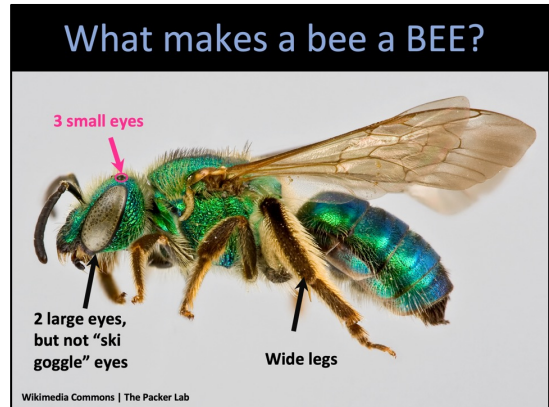
Using the next set of slides, point out the key characteristics that are different between bees, flies and wasps.

Bees have long antennae (relative to their fly mimics), 4 wings, 5 eyes (2 are large, but not as massive as those of flies), wide legs (which are often carrying pollen), and a pinched waist (though not as narrow as that of wasps).

Fly mimics have short antennae, 2 wings, 2 huge eyes that take up most of the face), skinny legs, and a wide waist.

Wasps look a lot like bees (they are very closely related; bees are essentially just herbivorous wasps). They have 4 wings and 5 eyes. However, they have skinny legs and a very narrow waist.

Once you have reviewed the differences, have the students break into groups of 3 and fill out the **Table of Traits** to help them process all of the information (a completed version is on the next page). It will also serve as a reference for the next part of the activity. It may also be helpful to have the students reference the unlabeled versions of the slides.





Build a Bee (& its Mimics) Activity Continued

Table of Traits

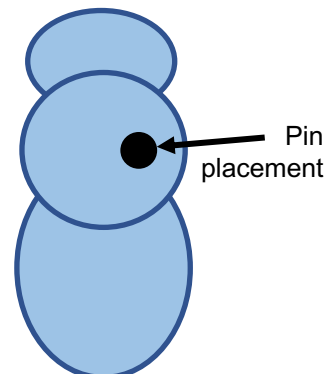
	BEE	WASP	FLY
EYES	5, no ski goggle	5, no ski goggle	2 ski google
ANTENNA	long	long	short
WAIST	pinched	very narrow	wide
LEGS	wide, hairy	narrow, hairless	narrow, hairless
HAIRS	on legs or belly	few	variable
WINGS	two pairs	two pairs	one pair

Hand out supplies to each group: 1 packet or marble-size ball of white modeling clay, such as Model Magic, for each student and 1 packet or marble-sized ball of colored clay to highlight any key traits, if they wish.

***Optional:** give each student 8 short (2-inch) pieces of pipe cleaner to help with the construction of the legs and antennae.

Each student in the group will build one of the insects. As the students work, they can use the table of traits and the help of their teammates as they construct their insect. Conversations among the students regarding the differences in the traits often occur as they are working.

***Optional:** Once the students have finished building their bee models, you can have them use a small dowel and piece of styrofoam or a cork coaster to “mount” their insect the way a scientist would. When pinning insects, we put a pin through the thorax, just to the left or right of the center. This allows us to see the center of the thorax, which can be important for identification purposes.

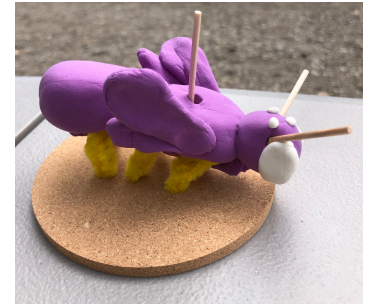




Assessment of Student Learning

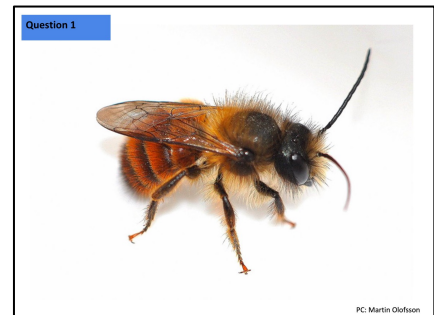
Example of Student Work and Mounting Options

The final products can be taken home, if desired, and they will vary in accuracy. However, the point is not for the models to be perfect, but to help the student process the differences among the groups.



Informal Quiz

The last 12 slides provide a means to test students' ability to identify a bee, fly and wasp. For each of the following photos, have the use their fingers to select whether it is a bee (1), fly (2), or wasp (3). Share the results and have them share why they chose their answer. Highlight the traits that are diagnostic and those that might have thrown them off.



Final wrap-up questions for discussion

Break the students into 3 groups and have each group share out one of the following:

1. Have the students use their model insects to describe what makes bees different from their mimics.
2. What structures of bees' bodies help make them good pollinators?
3. Imagine a world without bees: what would you be able to eat? Alternative: have the students draw or act out the relationship between pollinators and our food.

Optional Extension

What other foods that you love to eat are affected by pollinators? (Imagine a world without chocolate!)



Supply Descriptions

Pollinator Buffet

Printable Pages printed in color, if possible, on printer paper

12 food trays



*Optional supplies

Magnets with adhesive



Metallic cookie trays



Lamination materials



Supply Descriptions

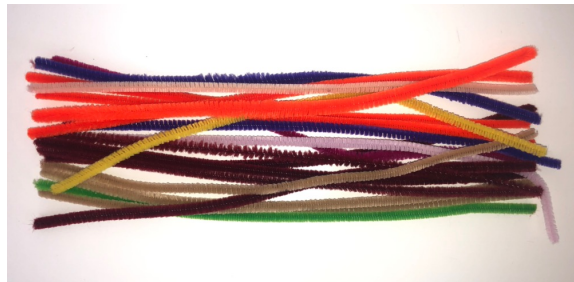
Build a Bee

Air dry modeling clay, such as Model Magic (1 package or 1 marble-sized ball of white per student; one with color per group)



*Optional supplies

Pipe cleaners



Small wooden
dowls or
toothpicks



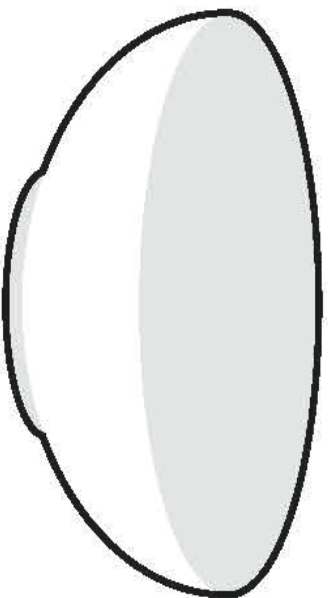
Cork coasters or
foam blocks



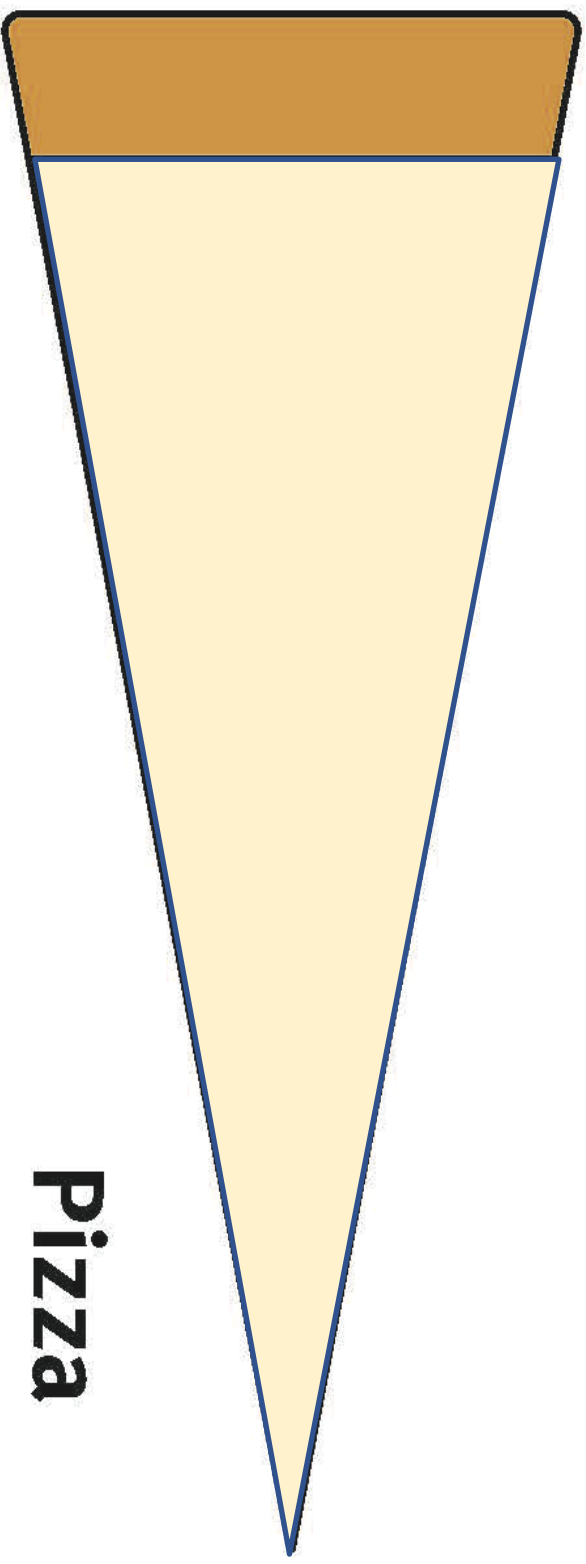
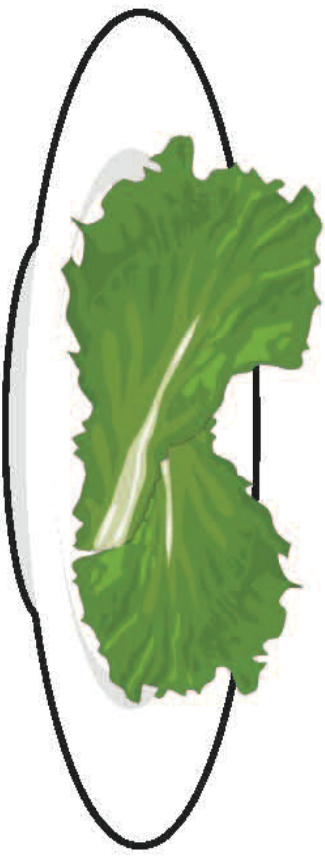
Pollinator Buffet

- Food tray
- Ingredients
- Pollinator Key

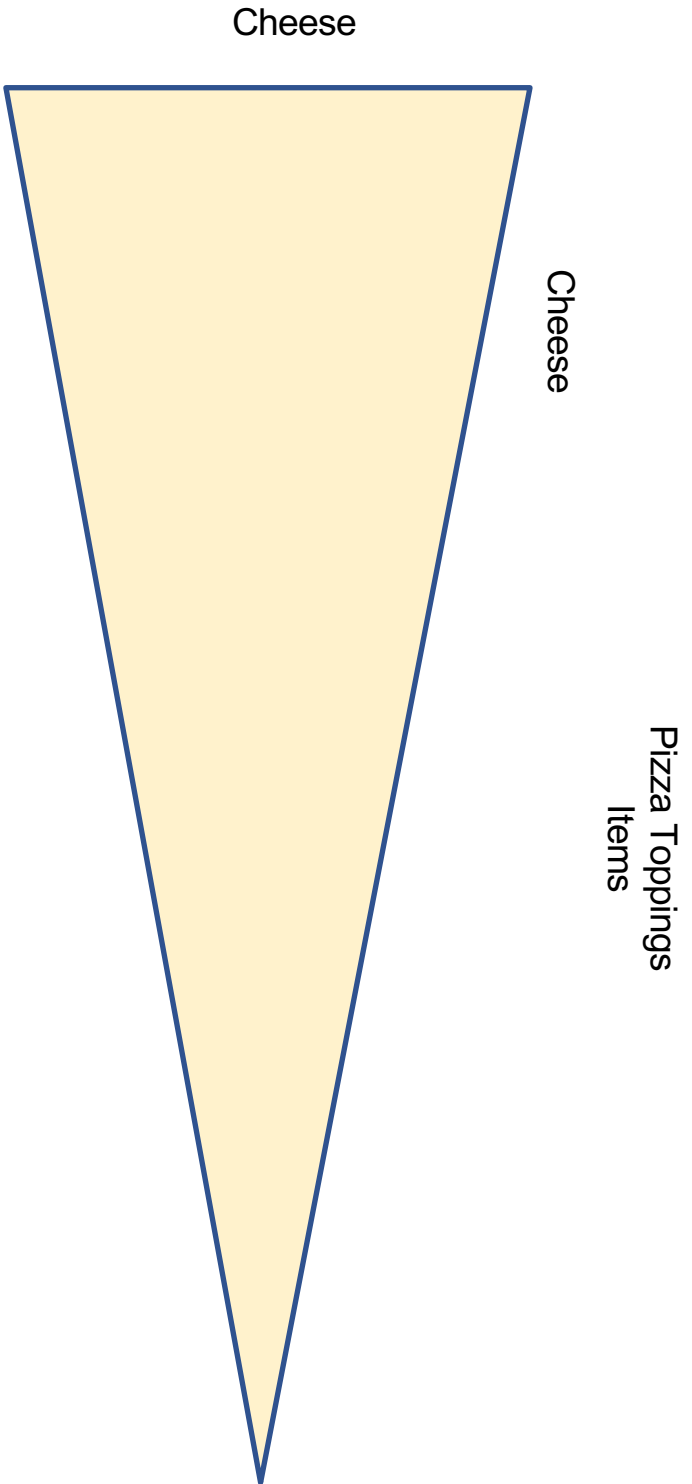
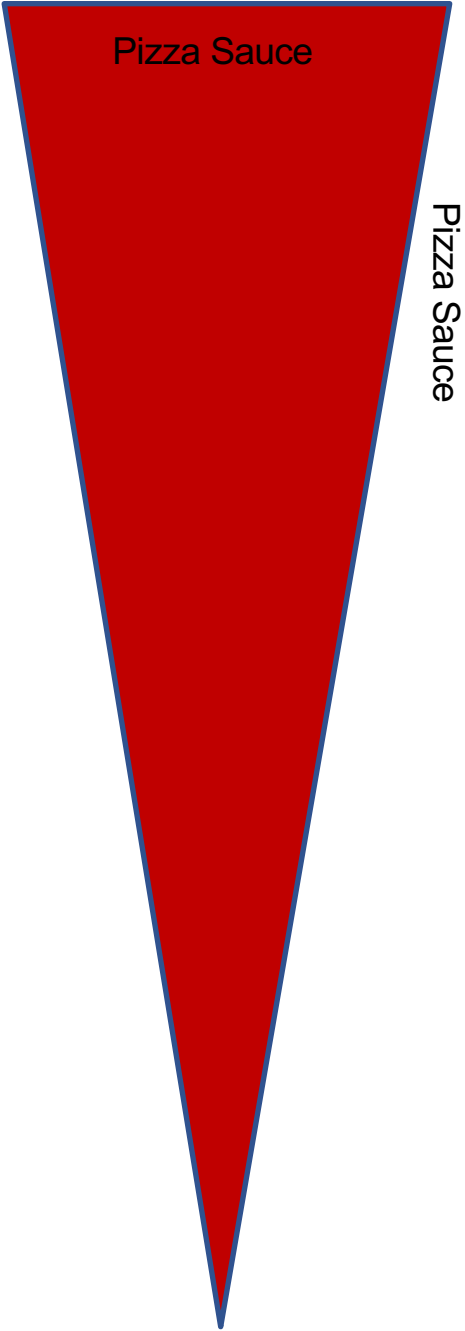
Fruit Bowl



Garden Salad



Pizza



Pizza Topping Items

Fruit Bowl Items

Salad Items



WHY ARE POLLINATORS IMPORTANT?



Pollinate over 85% of flowering plants species on Earth



Pollinate our food plants, contributing to

- 1/3 of the bites we eat
- our most nutritious and tasty foods



Help produce dairy and meats by providing high protein feed



CARROT
Masked bee
(*Hylaeus* sp.)



PEPPER
Black and gold
bumble bee
(*Bombus auricomus*)



BLUEBERRY
Southeastern
blueberry bee
(*Habropoda laboriosa*)



CANTALOUPE
Squash bee
(*Peponapis pruinosa*)



ONION
Sweet bee
(*Holictus ligatus*)



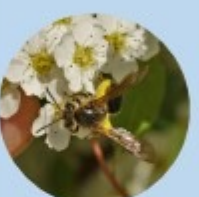
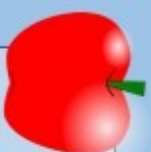
TOMATO
Eastern bumble bee
(*Bombus impatiens*)



CUCUMBER
Longhorn bee
(*Melissodes bimaculata*)



STRAWBERRY
Small carpenter bee
(*Ceratina* sp.)



APPLE
Mining bee
(*Andrena* sp.)



CHEESE
Alfalfa leafcutter bee
(*Megachile rotundata*)

Use this key to figure out which foods on your lunch tray need bees.

MORE ABOUT YOUR POLLINATORS



There are more than 24,000 types of bee in the world.

Missouri alone has over **450** species!



Bees come in all colors (including blue, green, and red) and sizes, from smaller than an eyelash to longer than a quarter Most bees nest in the ground & are solitary (no workers or queens)



MASKED BEE

(*Hyalaes* sp.)

Small, mostly black, bees with unique white or yellow face markings that look like superhero masks
Carry pollen in a special "tummy" and pull it back up to feed their young.
Make cellophane-like material to keep water and pests out.



BLACK & GOLD BUMBLE BEE

(*Bombus auricomus*)

One of our largest local bumble bees.
Like other bumble bees, ...are social with annual colonies started each spring by new queens.
...shiver to raise their body temperature and forage in cooler temperatures than other bees



SOUTHEASTERN BLUEBERRY BEE

(*Habropoda laboriosa*)

Solitary bee that nests in the ground.
Only collects pollen from blueberry flowers.
Blueberries need buzz pollination to release pollen. Only blueberry and bumble bees can pollinate them.



SQUASH BEE

(*Pepanopsis pruinosa*)

Solitary bee that nests in the ground.
Only collects pollen from squashes and melons, so they are active before sunrise when the blossoms open.
Male squash bees sleep inside flowers at night, often in groups.



SWEAT BEE

(*Holictus ligatus*)

One of the most common bees found in our region
Has a large range, found from the Arctic Circle to Venezuela, South America.
Can be social or solitary, depending on the environment.



EASTERN BUMBLE BEE

(*Bombus impatiens*)

One of the most common bumble bees of the eastern United States.
Bumble bees are one of the few types of bees that can "buzz pollinate" to release pollen from tomatoes and their relatives. Honey bees cannot buzz pollinate.



TWO-SPOTTED LONGHORN BEE

(*Melissodes bimaculata*)

They get their name from the extra long antennae of the males
The females have long hairs on their legs for carrying pollen.
Nests in burrows dug into the ground by the female.



SMALL CARPENTER BEE

(*Ceratina* sp.)

Small solitary bees that are often dark, iridescent blue-green.
Females nest in the broken or cut stems of various wildflowers and shrubs from which they chew out the soft centers.



MINING BEE

(*Andrena* sp.)

Have unique "eyebrows", dense hairs that run along their large, compound eye.
Abundant during the spring, making them great pollinators of fruits, including peaches and apples.
Solitary bees that nest in the ground.



LEAFCUTTER BEE

(*Megachile* sp.)

Carries pollen on the underside of its belly (abdomen), not on its legs like other bees.
Cut circular sections of leaves or flower petals to line their nest.
Build their solitary nests in cavities of rotting wood or hollow stems.



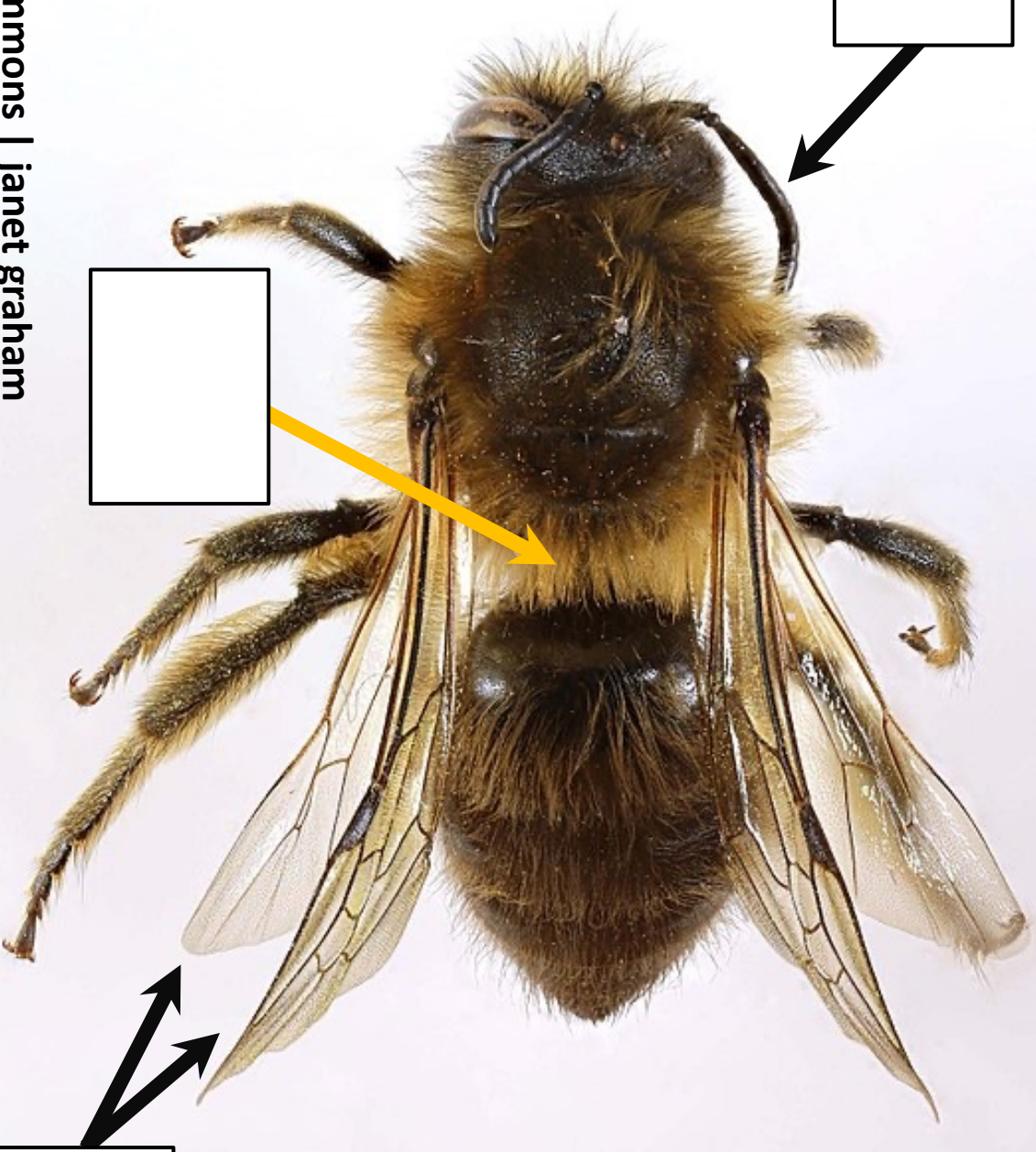
Build a Bee (and its mimics)

- Table of Traits (blank)
- Unlabeled images of
bee, fly and wasp

Table of Traits

	BEE	WASP	FLY
EYES			
ANTENNA			
WAIST			
LEGS			
HAIRS			
WINGS			

What makes a bee a BEE?



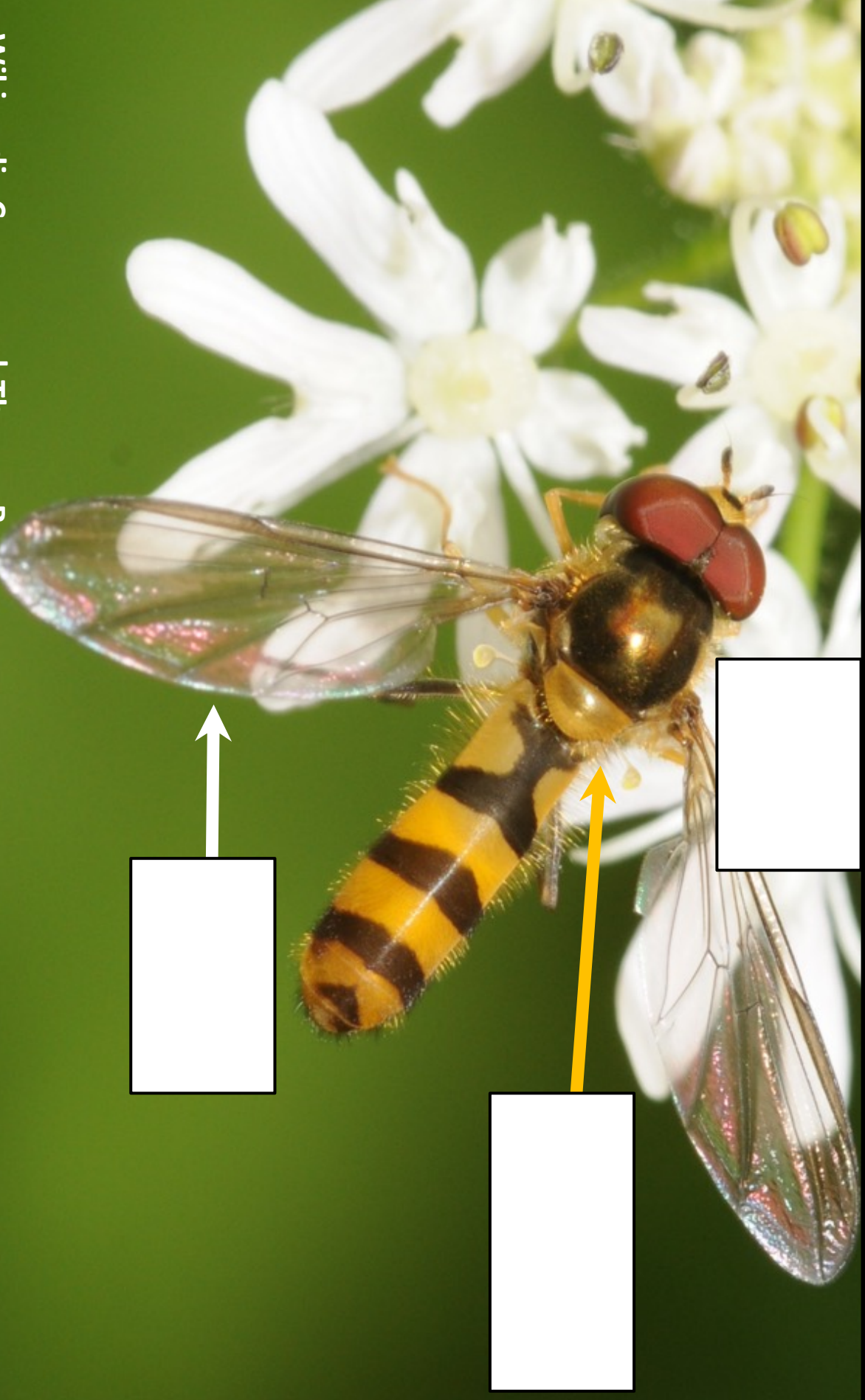
What makes a bee a BEE?



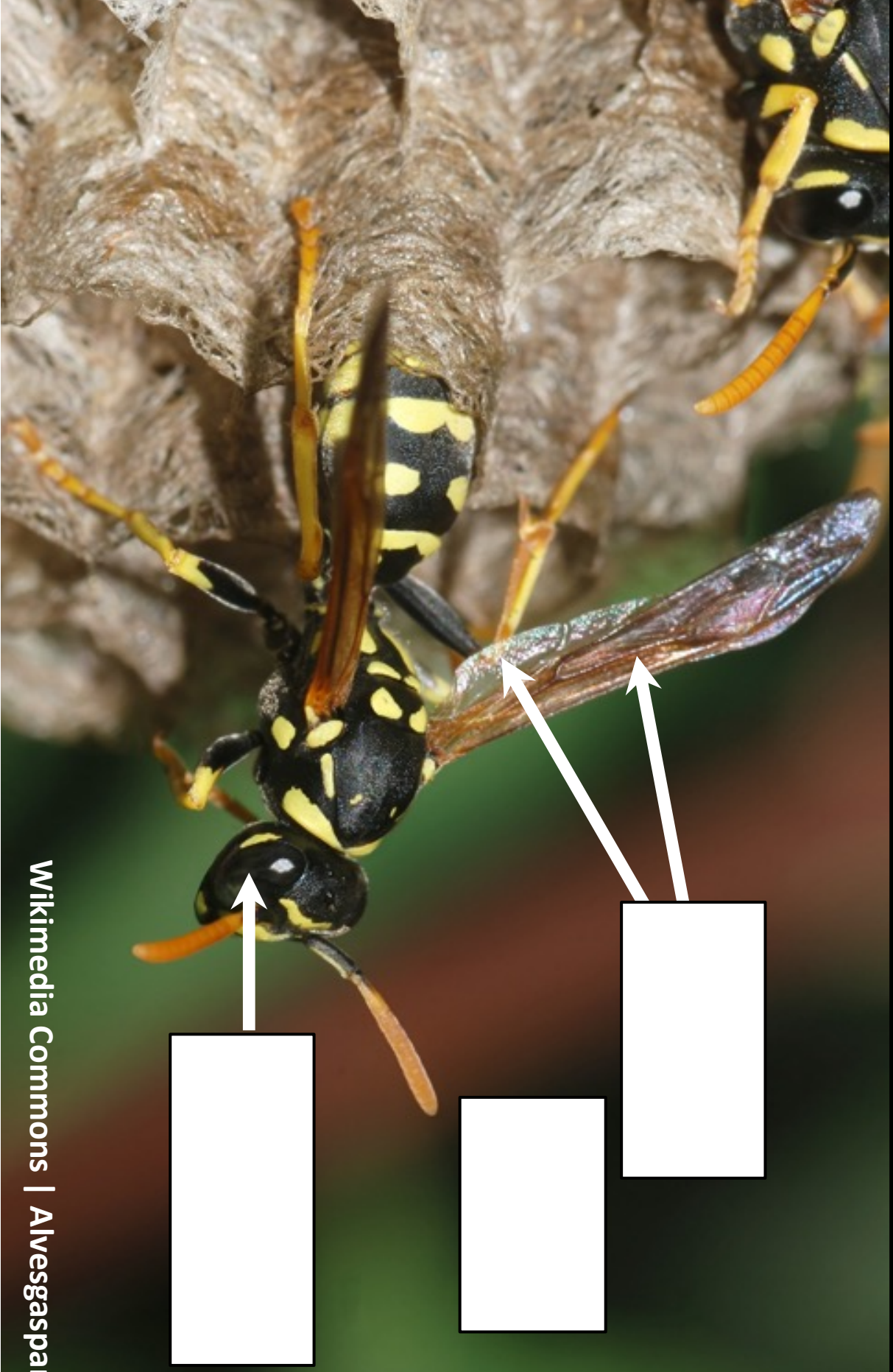
What makes a fly a FLY?



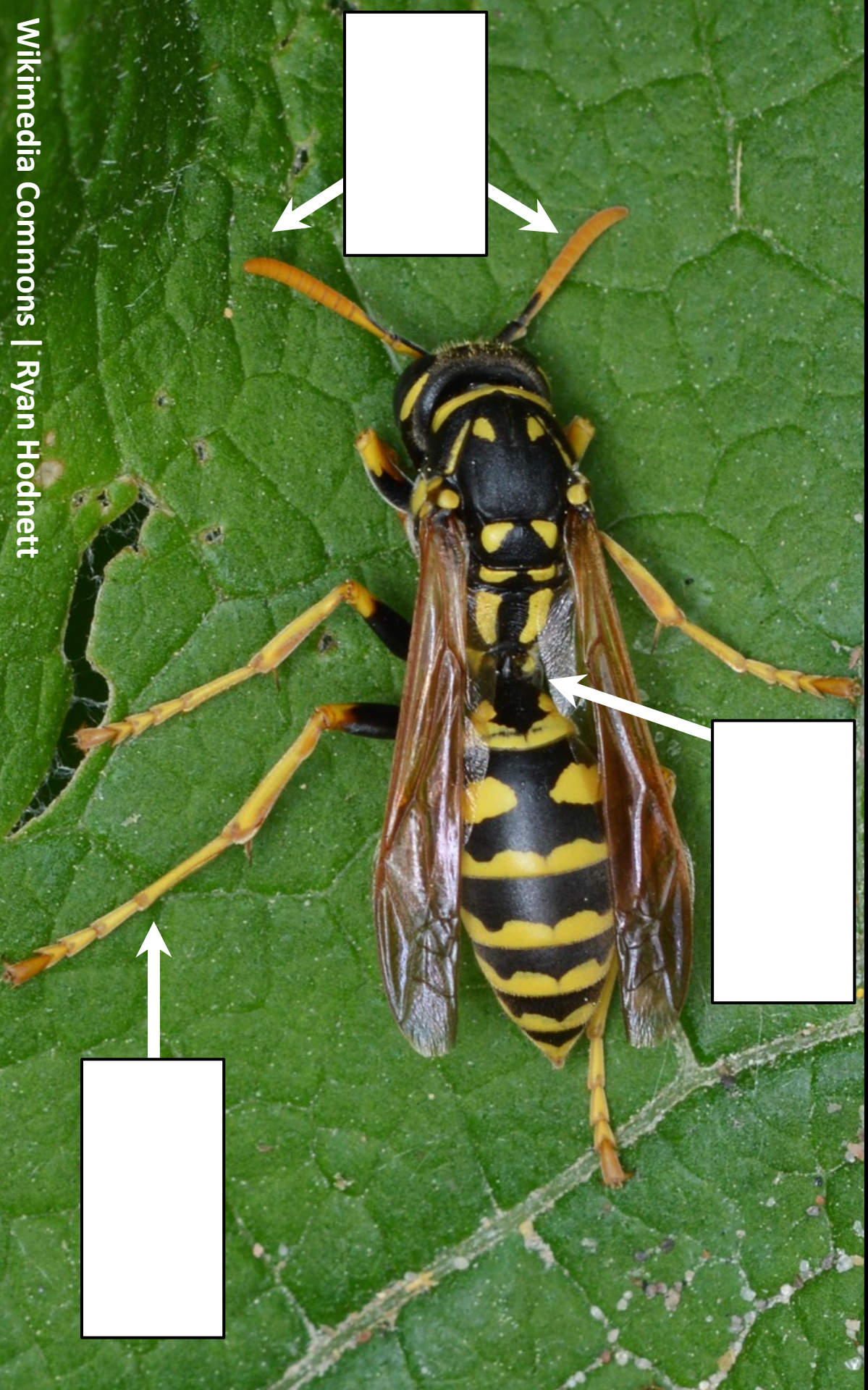
What makes a fly a FLY?



What makes a wasp a *WASP*?



What makes a wasp a WASP?



Thank you for joining!!!

