

WILD at Schools: Bee at Home

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Target Audience: K, 1st and 3rd Grade

Time: 45 minutes to 1 hour

Location: Classroom / area for nest building activity / school yard

Pre-material:

- Book to introduce the role of bees and mason bees in particular: Mason meets a Mason Bee: An Educational Encounter with a Pollinator by Dawn Pape. Good Green Life Publishing (March 16, 2015).
- For 3rd Grade students to introduce bumblebees as a native social bee: The Bumblebee Queen by April Sayre. Charlesbridge (July 1, 2006).

Background Information

Bees are one of our best known groups of insects and probably the most economically important. Their pollination services are required for many fruits, vegetables, seeds and nuts produced in the United States. Most attention and knowledge is focused on European honey bees and bumble bees, but worldwide, there are approximately 20,000 bee species and over 400 bee species in Maryland. Native bees are fascinating insects with unique life histories, behaviors, ecological roles, shapes, colors and sizes. The majority of bee species are **solitary** and ground nesting. About 30% of Maryland bees are considered specialists, gathering pollen from a limited number of flower species, usually in a single genera and occasionally from a single species.

Bees, like butterflies, undergo complete metamorphosis. They begin their life cycle as a tiny, white egg which hatches into a white, worm-like larva. After feeding, the larva develops into a pupa within a cocoon from which a winged adult emerges. In **social** bees, eggs are laid by one female and are cared for by her workers, usually daughters. In **solitary** bees, each female makes her own nest and collects food (pollen mixed with a little nectar) on which to lay eggs.

Bees have many unique body parts each with a specific function:

- **Antennae:** Bees have two antennae located on their head used for smelling (including pheromones, flowers, predators and smoke) and 'hearing'. Membranes on the antennae (and another set on their legs) allow bees to detect vibrations. Social bees communicate with one another using pheromones and rely on their antennae to receive these messages.
- **Compound eyes:** Each eye is made up of hundreds of small eye units called ommatidia (ommatidium, singular). The brain pieces together images made by the ommatidia into a single image (not the compound view shown by 'insect' glasses). Bees can see all color wavelengths except for red including ultraviolet (UV) rays. Many flowers have UV patterns on them that help guide bees to the flower's nectar.

- **Simple eyes:** Bees have 3 simple eyes called ocelli, which sense light and dark and movement and may help bees navigate and keep track of time.
- **Glossa:** A bee’s tongue, called a glossa, is contained within the proboscis with a mop-like labellum at the tip to suck up nectar. Bees with long tongues are adapted to drink from long tubular flowers and are usually specialists.
- **Mouth:** A bee’s mouth contains mandibles, which are tooth-like appendages used to chew pollen, cut leaf pieces or bark and mold wax into shapes.
- **Pollen Basket:** Most bees have stiff hairs designed as pollen collecting structures. Bumble, sweat and honey bees have a corbicula or pollen basket, a polished cavity surrounded by a fringe of hair on the hind legs. Mason and leaf cutting bees have scopa which are stiff hairs on the underside of the abdomen.

This lesson will discuss different types of bees, their physical appearance, anatomy, lifecycle and nesting locations. Mason bees and their nesting habits will be described in detail. Students will then observe bees in the schoolyard to reinforce their understanding of the connection between pollination and fruit production.

Learning Objectives

As a result of this program, students will be able to:

- Describe the anatomy of adult bees.
- Understand the different stages of a bee life cycle.
- Explain the habitat and survival needs of bees.
- Describe some of the diversity of bees, including sweat, mason, bumble and honey bees.
- Know that native bees help flowers.
- Observe bees performing pollination services.

Curriculum Standards and Science & Engineering Practices Addressed

Grade	Standard	Detail	Program Element
K	K-LS1-1	Use observations to describe patterns of what animals need to survive.	Students explore the habitat needs of bees, observing patterns of the similarities and difference between species. Students learn how bees dig nests or construct them from other materials.
	K-ESS2-2	Construct an argument supported by evidence for how animals can change the environment to meet their needs.	
	K-ESS3-1	Use a model to represent relationships in the natural world.	Students build a model of a bee nest and learn how plants supply food in return for pollination services. Students use program information to suggest how people can help bees by improving their habitat.
	K-ESS3-3	Communicate solutions that will reduce the impact of humans on other living things in the local environment.	
1st	1-LS1-2	Determine patterns in behavior of parents and offspring that help offspring survive.	Students learn how bees provide for their young and build safe homes.

	1-LS1.A 1-LS3.B	Different animals use their body parts in different ways to see, hear, grasp objects, protect themselves, move from place to place, and seek, find, and take in food, water and air. Individuals of the same kind of animal are recognizable as similar but can also vary in many ways.	Students explore bee adaptations that help them find flowers and collect pollen. Students observe multiple specimens of the same species.
3rd	3-LS1-1 3-LS2-1 3-LS4-3	Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction and death. Construct an argument that some animals form groups that help members survive. Construct an argument that in a particular habitat some organisms can survive well, some survive less well and some cannot survive at all.	Students produce a model of bee reproduction. Students compare social and solitary bees as alternative survival strategies. Students understand why bees need different habitats to survive.
Engineering and Science Practices		Use information from observations to construct an evidence-based account for natural phenomena. Use a model that represents a concrete event. Conduct simple investigation to describe relationships in the natural world to answer scientific questions.	Students observe bees visiting flowers for evidence that pollen is transported from flower to flower. Students build a physical model of a bee nest. Students look at the food requirements of bees to understand why bees hibernate in the winter.

Key Program Vocabulary:

Abdomen: the posterior (hind) body segment of an insect.

Antenna: a sensory appendage of the head.

Cocoon: a silky case spun by the larvae of many insects for protection in the pupal stage.

Egg: the first stage in the bee life cycle.

Exoskeleton: hard, outer covering of insects.

Habitat: the natural home of a living organism consisting of four elements: food, water, shelter and space.

Larva: the second worm-like stage of the bee life cycle.

Metamorphosis: structural changes that occur through developmental stages. Complete metamorphosis has four stages: egg, larva, pupa and adult.

Native plant: a population of plants within a defined geographic area that exist there without direct or indirect human introduction. For this program, native plant species are those that were present in Maryland before the arrival of Europeans.

Nectar: sugary fluid secreted by plants to encourage pollination.

Pollen: microscopic grains discharged from the male part of a flower that can fertilize the female ovule.

Pollination: the transfer of pollen between plants of the same species.

Pollinator: an animal that passes pollen from male to female flower parts of flowers.

Proboscis: an elongated, sucking mouthpart that is typically tubular and flexible, contains tongue like structure or glossa.

Pupa: the third non-feeding stage in the bee life cycle.

Social: refers to bees that live in a colony and share in the task of raising young.

Solitary: refers to bees in which a female builds her own nest and feeds her own young.

Stigma: female part of a flower that is sticky to capture pollen.

Thorax: the middle body section of an insect where wings and legs are attached.

Equipment / Materials

- 30 Bamboo tube halves for making nests (see Appendix for picture)
- 5 flower models with pom-pom pollen (see Appendix for picture)
- 5 'Puddles and mud' (see Appendix for picture and 'mud' recipe)
- 5 sets of bees in magnifying boxes with enlarged photographs (*Apis mellifera*, *Bombus bimaculatus*, *Agapostemon virescens*, *Xylocopa virginica* and *Osmia taurus*) (Optional)
- 5 sets of bee nest matching cards ([download](#))
- 5 tubs with white beans for eggs (see Appendix for picture)
- 6 magnifying boxes and 25 bee bodies (craft sticks with black felt)
- Felt board and felt bee parts (see Appendix for picture)
- Flip chart and markers (or classroom white board)
- Bee Anatomy Picture Pack ([download](#))
- Bee Picture Pack ([download](#))
- Student assessment worksheets ([download](#))

Before starting program, and if weather and season will allow, determine if there is a safe area at the school suitable for outdoor observation of bees. Check for bee or wasp nests which must be avoided and determine whether any students are known to be allergic. A pollinator garden is an ideal location for study, but dandelions or clover along a sidewalk will often have many feeding bees. If it is possible to include the direct bee observation activity, then cut the KWL and song activity to allow enough time for outdoor exploration.

Gather students initially together in a carpet/story area. Then, have students move to their tables for the group work and to build bee nest model.

INTRODUCTION: 5 minutes - all grade levels

1. Tell students that they are going to learn all about bees today.
2. Draw three columns on the board or chart, label the 1st **KNOW**, the 2nd **WHAT** and the 3rd **LEARNED**.
3. Ask students what they already know about bees and record in the **KNOW** (1st) column, even if incorrect. If needed, provide prompts such as. *What color are bees? Where do they live? What do they eat? What else do you know about them?* During the program, student questions can be added to the 'What I want to know' column.
4. Explain to students the importance of bees:

- a. Bees have a very special job, they **pollinate** flowers and many trees. Pollination means that they carry **pollen** from flower to flower so that plants can grow fruits that contain seeds. The seeds then grow into new plants and trees.
 - b. Plants need bees to help them because they are rooted to the ground and can't walk to another flower to transfer pollen. They make nectar for bees so that bees will visit their flowers.
 - c. Many of the foods we eat are the fruit and seeds of plants that were pollinated by a bee. Prompt students for examples of fruits, vegetables, seeds and nuts. (Examples include: apples, cherries, blueberries, strawberries, watermelon, carrots, peas, beans, cucumbers, sunflower seeds, almonds.). Ask students if they like any of the fruits or vegetables on the list.
5. Explain to students that flowers and lots of our favorite foods need bees, so we are going to learn more about bees and how we can help them.

BEE ANATOMY: 10 minutes - K and 1st grade only

6. Assemble felt board bee (K only) and use [anatomy picture pack](#) to illustrate bee anatomy with enlarged photographs (1st Grade only). Encourage students to compare and contrast the bee's anatomy with their own. For Kindergarten students count body parts using the bee plush and explain that the felt board shows one side of the bee.
 - a. Insects have an **exoskeleton** with no internal bones. Inside they are soft. To grow, they have to molt. They shed their old skin and have a new larger one underneath.
 - b. Insects have 3 body parts –a head, **thorax** and **abdomen**.
 - c. The head includes 2 **compound eyes** which have multiple lenses to help bees find brightly colored flowers. Bees also have 3 extra **simple eyes** which can see light and dark so they can see the position of the sun. These eyes help the bees find their way home. Ask students how many eyes bees have in total.
 - d. Bees have **antennae** which help bees explore the world. The antennae are used to smell, hear, touch and even taste – they act like the bee's nose, ears, fingers and tongue all in one! They smell the scents that flowers make to attract bees.
 - e. Bees drink nectar from flowers. They have a **proboscis** that acts like a straw so they can suck up the liquid nectar; it can be as long as their head.
 - f. The **thorax** has parts that help bees move. Ask students how many legs and wings bees have.
 - g. The **abdomen** is where female bees grow their eggs and have their stinger. Remind students that bees don't want to sting people – they will only do so if they think people are going to hurt them or their nest and many bees can't sting people at all
 - h. Most bees have a special place to carry pollen back to their nest. Stiff hairs hold pollen on their back legs or abdomen. Bees have other hair all over their bodies that pollen will stick to. This pollen might fall off when they visit a different flower and that's how the flower gets pollinated.
7. Have students review the parts of the anatomy by counting down from 6 on their fingers and miming the different body parts.

- 6** ***LEGS (have students wiggle legs and arms)***
- 5** ***EYES (have students point to their eyes)***
- 4** ***WINGS (have students act like they are flapping their 'wings')***
- 3** ***BODY PARTS (+ SIMPLE EYES)***

2 ANTENNAE (+ COMPOUND EYES) (have students hold arms like they have antennae)

1 STINGER (+PROBOSCIS) (have students stick out their tongues).

8. *Optional:* Have children stand and sing to tune of “head, shoulders, knees & toes” and demonstrate body parts as mentioned.

Head, thorax, abdomen, abdomen

Head, thorax abdomen, abdomen.

Six legs, 4 wings and an exoskeleton (or sting, sting)

Head, thorax, abdomen, abdomen

Head, thorax, abdomen, abdomen

Head, thorax abdomen, abdomen.

Big eyes, small size, and two antennae

Head, thorax, abdomen, abdomen

BEE IDENTIFICATION: 10 minutes – 1st and 3rd grade only

9. Have students use their knowledge of bee anatomy to identify bees. Have students work in 5 groups to look at real bees in magnifying boxes and enlarged photographs in picture pack. Ask students to look at each insect and decide as a group if it is a bee. If no real bees are available, have students just look at pictures.
10. Ask students which of these insects they think are bees. If they think it is a bee, students should give a thumbs up, if they think it is another type of insect, they should give a thumbs down. Explain that all of the insects provided are bees. Ask the students if they are surprised to learn that that these are actually all different bees that live in Maryland. Bees can be big or small and lots of different colors.
11. **1st Grade:** Briefly explain the lifestyle (social or solitary) and habitat of each bee species to students using the [bee picture pack](#).
- Number 1 is a honey bee. Explain that these bees are kept by farmers and bee keepers in hives to pollinate their crops and are the only type that make honey. All of the other bees the students just looked at are native bees.
 - Number 2 is a bumble bee. They are a social bee like the honey bee. They live in family groups of a queen and her daughters that help feed the baby bees called **larvae**. Unlike honey bees, bumble bees make their nest in the ground.
 - Number 3 is a green or sweat bee. Each bee digs its own hole in the ground to build its nest. Ask students if they have seen bees going into holes in the ground.
 - Number 4, the big bee, is a carpenter bee. It is called that because it chews its own nest holes in wood and dead trees. It is the largest bee in North America. Most bee species are much smaller, close to the size of a grain of rice (pass out the small bee examples).
 - Number 5 is a mason bee. Mason bees build their nests inside hollow stems in plants, in holes in dead trees or in boxes that people put out for them. They seal the nests with mud they collect which is how mason bees get their name.
12. **Grade 3 only:** Pass out the bee nest cards. Explain they must match the bees to their nest type and see which bees are social and which are solitary.
- Ask students what the difference is between animals that are social and solitary. Make sure they understand that social bees work together as a group like a family where

- everyone shares food. Solitary bees may live close to other bees but don't help feed each other (like neighbors in an apartment block).
- ii. Each group matches the bee to the card showing their nest location. Explain that most native bee species are like the green bees and live in nests in the ground (70% of species).
 - iii. Ask students what are the advantages of living in a group as a social bee. Answers can include: work together to protect nest from a predator, if one of the bees die than the others can care for the larvae (baby bees) so they don't die, just do one job really well (aka specialize).
 - iv. Although the green bees are solitary, they often group their nests together. Ask students why this might be helpful. Explain that predators are less likely to attack their nests in groups.
 - v. What are the disadvantages are of living close to other bees? Answers can include both that it increases competition for food (they might have to fly further to find flowers) and that disease may spread more easily.

BUILD A BEE NEST: 20 minutes - all grade levels

- 13.** Review with students that bees live in places or **HABITATS** where they can find the elements they need to survive: FOOD, WATER, SHELTER (a place to build a nest for their eggs) and SPACE.
- 14.** Ask students if they noticed that bees build their nests in different places. Bees need different habitat for their nests. Many bees dig a hole for their nest in bare soil. Some bees use holes in dead trees. Other bees build their nests with mud like the mason bee.
- 15.** Describe the nest building process of a mason bee using the picture pack with students so they can model the process themselves: Mason bees collect mud and carry it in their mouth to seal a hollow stem. Then, they collect lots of pollen and nectar from flowers and mix them to make a ball, called bee bread, in their nest where they lay an egg. Mason bees have stiff hairs on their abdomen where they carry pollen. After laying the egg, the female bee carefully seals the egg into its own nest chamber using another section of mud and start collecting food for another egg. The bee mother keeps doing this until she fills the tube.
- 16.** Tell students they are going to see what it would be like to be a mason bee as it builds a home for its larvae. Distribute a ½ tube to each student. Explain that students will make a nest of baby bees in these tubes. If they were a real bee, they would crawl into the tube, but as they are too big to fit inside these tubes, we are going to use ½ tubes.
- 17.** Spread out 'puddles' with salt dough 'mud', 'flowers' with pompom 'pollen' and dishes with white bean 'eggs' on each table. Have students follow along with the demonstration as you describe each step.
 - Step 1:** Mud – have students 'fly' and collect a small amount of mud from the puddle and make a wall in their tube.
 - Step 2:** Food – have students fly to flowers and collect pollen to put in their nest to feed their larva. Explain to students that they need to collect 3 pieces of pollen (pompoms) from the flowers to make enough food for each baby bee. Real mason bees have stiff hairs on their abdomens where they can carry their pollen so students can pretend to carry pollen on their stomach.
 - Step 3:** Egg – have students place a white bean to represent an egg on the pollen.

Step 4: Mud – have students collect more mud to seal the nest safely from predators.

Repeat the 4 steps for kindergarten and first grade students at least 2 more times. Encourage 3rd grade students to repeat the process themselves and fill the tube with nests (spread flowers and puddles further apart for older students so they can fly further).

18. Congratulate students on making lots of homes for baby bees and review the bee life cycle using the picture pack.
 - a. The **eggs** will hatch and baby bees called **larva** eat the pollen and nectar. Bee larva look completely different to bees just as caterpillars look different to butterflies. In fact, the larvae look more like white caterpillars. Once they have grown, the larva spins a **cocoon** to keep it safe while it is in a **pupa** where it changes into a bee – this change is called **metamorphosis**.
 - b. The mother mason bees collect pollen and lay their eggs in spring. It takes several weeks for their larvae to grow and turn into bees. The new bees stay safe in their homes all through the fall and winter and emerge next spring to take their turn at collecting pollen. Mason bees visit flowers they can find in the spring especially fruit trees like apple and cherry blossom and dandelions. Mason bees are very good pollinators because they carry lots of pollen on their fuzzy bodies.
 - c. Other types of bees like green bees visit flowers and collect pollen in the summer and fall. Bumble bees are active for a much longer time than other bees and collect food from when flowers first bloom in the spring until they die in late fall.
 - d. Have students help put back ‘mud’, ‘pollen’ and ‘eggs’ into containers.

***3rd Grade extension:** Explain that social bees like bumble bees emerge in early spring and start their nest and keep laying eggs all summer into the fall because they have their daughters help collect food (by the fall their might be 400 bumble bees in the same nest). Solitary bee species emerge from their winter shelter at different times of year so they can take advantage of different flowers. They have just a few weeks to lay all their eggs to produce next year’s bees.*

CONCLUSION: 5 minutes - all grade levels

19. Return to the KWL chart. Ask the students if we need to change /add to any of the facts in the **KNOW** column. Ask if there are things they learned about bees to add to the what we **LEARNED** column.
20. Now that students know what a bee needs to survive, ask the students what we can do to help bees. Suggestions should include improving their habitat by planting flowers, making bare soil and mud available for bees and adding bee homes. Older students may also know that chemicals that people spray to kill bugs can also harm bees.
21. Ask students if they think their schoolyard is a good habitat for bees, does it have all the things they need? Explain that you are leaving a packet of black-eyed Susan seeds (the state flower) that the class can plant to help bees.

OPTIONAL OUTDOOR EXPLORATION: 15 minutes - all grade levels

22. Take students to an outdoor area to observe wild pollinators like bees. Encourage students to calmly observe bees carrying out pollination. Points to direct student observation:
- Remind students that bees don't want to sting people – they sting only if they think you are going to hurt them or their larvae, and some bees can't sting at all. As long as students don't try to stroke a bee or get too close to their nest, they can safely watch a bee on a flower or fly past. The worst thing to do when you see a bee is to start waving your hands wildly because it might think you are trying to hit it.
 - Look for different bee species.
 - Try to see pollen – is it covering the bee or is pollen being carried in a pollen basket?
 - Are some flowers more popular than others for bees to visit? Do these flowers have a scent?
 - How long do bees tend to stay at each flower before they move on?
 - Do bees visit all of the flowers on each plant before they travel to another plant?
 - If fruit or large seed heads (such as daffodils/tulips) are present, open one to show students ovules within or point out visible seeds such as dandelion clocks.
23. Use magnifying boxes to capture bees (bumble bees are usually easiest) that are busy feeding so students can safely observe them. Use a 'bee body' (craft stick with black felt) to show how bees get covered in pollen by visiting flowers. If you put the craft stick inside the flower head, pollen should be visible on the black felt. This can be seen most easily with larger flowers such as daffodils.

Student Assessment

Students complete worksheets:

- K and 1st Grade: Bee Anatomy & Bee and Me Worksheet.
- 1st Grade: Mason Bee's Lifecycle Worksheet.
- 3rd Grade: Bee Lifecycles, Social and Solitary Bees.
- All Grades: Mason Bee Quiz.

Follow-Up Activities

Provide:

- Maryland Bee Identification Sheet
<http://dnr.maryland.gov/wildlife/Documents/CommonBees.pdf>
- How Can We Help Bees at School? Sheet ([download](#))

Extra information

Answers to common questions:

Q: Do all bees sting?

A: No, only the females have a stinger and some native bees are too small to sting people (or for you to notice). Honey bee workers do sting and then die.

Q: What is the bee's stinger made of so it can push through the skin?

A: The stinger is made of chitin (it's tough like our finger nails), a special kind of substance that makes up most of insects' outsides. Chitin can be hard or soft and flexible. In the case of the bee, it is very hard and extremely effective!

Q. How fast can bees fly?

A: 12 to 20 mph.

Q. Do bees sleep?

A: No, but they will rest in their nest and sometimes inside flowers.

Q How many bees does it take to weigh as much as 1 M&M

A: 10 honey bee sized bees.

Q Were bees on Earth at the same time as the Dinosaurs?

A: No. Bees have been around about 30 million years (much longer than humans) and coevolved with flowers.

Q Where do bees carry their nectar?

A: They have a special 'honey stomach' – fun kid fact = honey is regurgitated nectar, but it is stored in a special honey sac and unchanged from the nectar form.

Q What is the difference between bees and wasps?

A: Generally bees are hairy and wasps are smooth. Most bees are herbivores (eat pollen and nectar) while most wasps are carnivores as larva (eating other insects) but eat nectar as adults. There are 4 types of social wasps (yellow jackets, paper wasps, European hornets and bald-faced hornets) that will aggressively defend their nests giving wasps a bad reputation. However most of the 1200+ species of wasps in Maryland are solitary and not aggressive. Most are parasitic and many are tiny.



Larry Hogan, Governor

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Jeannie Haddaway-Riccio, Secretary

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Example of halved bamboo tubes



Example of 'flower' with pom-pom pollen, bean 'eggs', and 'puddle with mud'



Example of felt bee board



Example of assembled 'nest tube'

Long lasting salt dough 'mud' recipe

Ingredients

- 1 Cup Flour
- 1 Cup Water
- 1/4 Cup Salt
- 1 tablespoon Vegetable Oil
- 2 teaspoons Cream of Tarter
- Food Coloring (4 drops)
- Sauce Pan and Wooden Spoon

Directions (Cook all ingredients over stove)

1. Pour all ingredients (order does not matter) into sauce pan.
2. Stir until everything is mixed well.
3. Once the mixture is mostly clump free, heat over medium heat.
4. Continue stirring. After a few minutes, it will start to clump up.
5. Stir until one big clump is formed and remove from heat.
6. Knead by hand.
7. Store in sealed container