



## CORRESPONDING LESSONS

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Dear Educator,

Thank you for welcoming the fascinating topics of pollination and the plant-pollinator relationships that make it possible into your classroom!

This activity guide is designed to help educators facilitate exploration of the *Pollinator Playground* exhibition in a way that complements classroom curriculum. Activities in this guide are divided into two parts including 1) an anticipatory warm up and 2) suggested tasks to be completed during exploration.

Additionally, each on-site activity corresponds with a standards-aligned, classroom-based lesson plan that can be completed before or after visiting *Pollinator Playground*, at the discretion of individual educators.

Some **key content** objectives covered by this exhibition include:

- Plant and animal life cycles
- Mutualistic relationships
- Animal adaptations
- Environmental and human threats to plants and animals

### **A note on facilitating your field trip:**

*Pollinator Playground* is a hands-on, minds-on, immersive experience with lots of full-body activities as well as question-and-answer challenges.

For best engagement and enjoyment, **we recommend:**

- ✿ Planning these visits to last **45-60 minutes**
- ✿ Preparing students with **expectations** ahead of time
- ✿ Letting students **explore in partners or small groups**, with a chaperone if possible.
- ✿ **Keeping hands free** by not requiring students to carry pencils and paper into the exhibit, or ask chaperones to help with this instead.
- ✿ **Debrief the experience** after exploration with the suggested discussion questions.
- ✿ Completing a **corresponding lesson plan** before or after your visit

As teachers ourselves, we know how needs vary from student to student and from class to class. We encourage making adjustments to these lessons and activities and/or adding your own creative flair. We would love to hear what worked for your kids! Send your questions or feedback to: [education@minotaurmazes.com](mailto:education@minotaurmazes.com).

Again, we appreciate your joining us in exploring the world of pollinators. You and your students are in for an a-MAZE-ing pollination experience!

Enjoy!

Leah Ritz

Educator

[education@minotaurmazes.com](mailto:education@minotaurmazes.com)

# Backyard Phenology

## Content Connections:

Life Science - Plant and animal behaviors and interactions

Science & Engineering Practices - Observation, data collection and reporting

**Grades:** K-12th

**Time:** 1-2 hours

**Objective:** In this lesson, students will observe and record seasonal weather, plants and wildlife in the familiar surroundings of their schoolyard. Through observation and data collection students will increase their awareness of nature.

## Materials:

- Plant field guides and/or specimens
- Drawing paper
- Note taking paper
- Pencils
- Graph paper

## Background:

A naturalist is a scientist who specializes in studying nature. Naturalists make notes and drawings to help them record and track their observations of the natural world. Phenology is an account of seasonal changes and the effects on plants and animals in a given location and the biological effects of those changes. Naturalists often make phenological studies to look at changes in the natural world over time.

This lesson includes an optional extension to participate in a Community Science project. Community Science, or Citizen Science, is the collection and analysis of data relating to the natural world by members of the general public, typically as part of a collaborative project with professional scientists.

## Procedure:

1. Introduce the activity by asking students what they already know about pollination and why it is important. Share with students that there are over 200,000 types of pollinators in the world and in this activity we are going to go outside to make seasonal observations, or a phenology study, of some of our local pollinators.
2. Prepare students to go outside.

- a. Learn plant identification specific to your area. Use a field guide and, if possible, examples of picked plant specimens to help students learn about what they are likely to see outside. Provide students with a list and pictures of different types of pollinators they may see. A list for younger students may be shorter and less specific (i.e. bee, butterfly, moth, etc.) while a list for older students may be longer and more specific (i.e. Honey Bee, Monarch, Cabbage White Moth, etc.).
  - b. Conduct a short naturalist drawing activity. Students should independently choose one field guide illustration or a plant specimen and draw it to the best of their ability. They should make notes about the drawing for later reference including size, color, shape, smell, etc. Give students 10-15 minutes to draw and make notes. Then ask them to trade with a partner. Partners should compare the drawing with the specimens and try to identify what's in the drawing.
  - c. If using a data collection sheet during the outdoor observation portion of this activity, have students practice with it.
3. Go outside and make some observations! Find a place on the school playground, in a neighborhood park, outside your building, or on a field trip to a natural area.
4. Instruct students to spend 10-20 minutes observing a flower or group of flowers. Have them note types, numbers, and characteristics of pollinators that visit their flowers. The details of observations will vary with grade level (see below for examples of data to be collected by each level)
  - a. K-5 - Students should be expected to draw and/or describe pollinators using a provided list of adjectives (colors, textures, sizes), count the number of flowers in a given area, and count the different types of pollinators.
  - b. 6th-12th - Students should be expected to document common names and/or scientific names of the pollinators and carefully describe plant interactions encountered. Students can also note the kinds of flowers pollinated, whether or not more than one type of pollinator visited a specific flower, and conclude if those flowers had special characteristics (scent, certain color, size, etc.).
5. Return inside and process the data. Create a class chart of what was observed. Elementary students can record this information on a bar graph to help visualize types of pollinators observed and numbers of flowers. Discuss the data and identify the most common type of pollinator and flower. Discuss whether or not they think they would observe more or less

pollinators if there were more or less flowers. Older students may create graphs using data collected. Use this opportunity to discuss the difference between quantitative and qualitative data and how the observations (qualitative data) can be used to support the quantitative observations.

6. Debrief the experience by having students infer as to why a certain pollinator prefers a particular plant. Students may need to make observations and do further research when getting back to the classroom.

### **Extension:**

- People all over the world are collecting data on pollinators in their yards, gardens, schools and parks. If you'd like to get involved in a bigger phenology tracking opportunity, provide your data to a Community Science project. You can find many Community Science projects online and log your data from anywhere. The Great Sunflower Project is a general pollinator data reporting website. States and counties may also have their own community science project website. <https://www.greatsunflower.org/quickguide>
- Other Community Science projects can be found through the Xerces Society for Invertebrate Conservation: <https://xerces.org/community-science>

### **References:**

- Tallgrass Prairie Observation lesson from the National Park Service: <https://www.nps.gov/common/uploads/teachers/lessonplans/Pollinators%20Lesson%20plan4.pdf>

# Candy Camouflage

## Content Connections:

Life Science - Animal adaptations, specifically mimicry as a survival adaptation

**Grades:** 3rd-8th

**Time:** 30 minutes

**Objective:** Students will use candy to model a predator-prey relationship that demonstrates the advantage of mimicry for animal survival.

## Materials:

- Skittles
- M&Ms
- Mike and Ikes
- Bowls
- Paper plates or napkins
- Stop Watch
- *Look Alikes* images, pictures of animals that display mimicry
- Hand sanitizer

**Background:** Mimicry is one of several anti-predatory devices found in nature, in which one species, called the mimic, resembles the color, form and/or behavior of a model species. In so doing, the mimic acquires some survival advantage. There are two basic forms of mimicry. In Batesian mimicry, the mimic (palatable) resembles the other species (unpalatable) and only the mimic benefits. In Mullerian mimicry, both species are unpalatable and both benefit.

Mimicry, as opposed to camouflage and warning coloration, is specifically the resemblance between two organisms. Camouflage is specifically the ability an organism has to be unnoticed by its predators (or prey) by copying some environmental traits or by developing a disruptive coloration that allows it to hide.

## Prep:

1. Prepare enough materials for one small bowl or plate for each student or one large sheet pan for each group of five

2. Fill the bowl part way with a mix of Skittles and M&Ms, or two different types of candy that resemble each other closely. Ratios of candies to be mixed vary from round to round of game play and is described in the directions for each round of activity.
3. Cover the bowl with a paper plate or napkin so students can't see it ahead of time.

### **Procedure:**

1. Pass out bowls or sheet pans and explain that students are not to look in the bowl until they are told to do so. Have students clean their hands with hand sanitizer.
2. Explain that they are predators and their prey are hidden inside the bowl among other things that they are not allowed to eat. For the sake of the game, they are to be considered poisonous!
3. Instruct the students that they will have 5 seconds to gather one type of candy (Skittles) from the bowl but MUST leave the other type (see below for additional details). At the end of 5 seconds, they must have 10 pieces of "prey" to live. Explain that each type of "poison" candy will be deducted from the prey candy.
4. Have all the students remove the cover at the same time from the individual bowls or the sheet pan for five seconds and allow students to gather candy.
5. After time is up, count the number of prey candy and poison candy that they have, deduct the poison from the prey and see how much they got. (Optional: They can eat what they have hunted.) If the poison candy is higher than the number of prey candy, then they have perished.
6. Debrief the activity after each round (See below for round details). Have the students reflect and share responses to the following questions: How easy was it to find prey candy? Were some colors of candy easier to find? How easy was it to avoid the poison candy? Did you live or die?
7. Repeat activity following the Rounds outlined below. To prep, fill bowls ahead of time to correspond with each round.
8. After all rounds have been completed, explain to students that the Skittles displayed mimicry of M&Ms. Mimicry is a common occurrence in the natural world. Mimics adopt traits of non-palatable species that help them avoid predation.
9. Ask the students if they can think of any examples of this behavior. Then show students example images of animals that display mimicry and ask

them what the model species might be for the mimics and what are the advantages of their mimicking adaptations.

### **Round 1:**

Fill the bowl with an even mix of Skittles and M&Ms. Students are trying to pick out Skittles from a bowl of M&Ms and Skittles. Follow debrief as outlined in general instructions. This scenario represents a time when prey are plentiful but well blended in with their environment.

### **Round 2:**

Fill the bowl with  $\frac{2}{3}$  M&Ms and  $\frac{1}{3}$  Skittles. Students are trying to pick out Skittles from a bowl of M&Ms and Skittles. Debrief as above with the added reflection on: Did it get harder or easier to find new prey? Why? This scenario represents the challenges faced by predators when disease or an environmental change affects their prey.

### **Round 3:**

Fill the bowl with Skittles and Mike & Ikes. Students are trying to pick out the Skittles. Debrief with the same questions as in Round 2 as well as the following questions: Were there any Skittles that were more likely to survive? If the Skittles could change, what changes could they make them harder to spot? An example answer is that they could develop color patterns that make them look long and skinny like Mike & Ike and maybe change color a bit.

### **Reference:**

[You Don't Taste the Way You Look: Understanding Mimicry](#) (Flight of the Butterflies Educator Guide):

# Look Alikes

Mimicry is an anti-predatory adaptation by some animals, in which one species, called the mimic, resembles the color, form and/or behavior of another species, called the model species. In so doing, the mimic acquires some survival advantage. Here are several examples of mimicry in different species.

Mimic

Model Species



Viceroy (non-poisonous)



Monarch (poisonous)



King Snake (non-venomous)



Coral Snake (venomous)



Longhorned Beetle (non-threatening)



Paper Wasp (threatening sting)



Wasp Moth (non-threatening)



Hornet (threatening sting)



Spicebush Swallowtail Butterfly caterpillar  
(non-threatening)



Green Snake (threatening predator)



Owl Butterfly (non-threatening)



Pygmy Owl (threatening predator)



Hover Fly (non-threatening)



Mason Bee (threatening sting)

(All images sourced from Wikimedia Commons)

# Design a Pollinator Garden

## Content Connections:

Math - Area, Perimeter, measuring

Engineering - Design a solution to a problem using available tools and resources

Language Arts - Research and application

Visual Arts - Colors and Patterns, functional design

**Grades:** 2nd-7th

**Time:** 1-2 hours

**Objective:** Students will use graph paper to map out a garden plot according to the space requirements of different plants and flower preferences of different types of pollinators.

## Materials:

- One-inch graph paper per group
- Pencils
- Flowering plant inventory list or research materials
- Flower Talk: How Plants Use Color to Communicate by Sara C. Levine and illustrated by Masha D'yans

## Procedure:

1. Read Flower Talk: How Plants Use Color to Communicate by Sara C. Levine and illustrated by Masha D'yans.
2. Discuss how butterflies and other insects use plants for food and how plants need pollinators for reproduction. Explain that pollinators, especially insects, need special plants at different times in their life cycle.
3. Introduce the project, to plan and design a pollinator friendly garden that will support all types of pollinators throughout the year (Spring-Fall). Discuss with students what things they need to consider and what will they need to do more research on to find out how to best design their garden. Allow students time to research (independently or with materials provided).

Questions to consider include:

- a. What are the types of pollinators?
- b. What types of flowers does each type of pollinator prefer?
- c. Do these pollinators need different types of plants at different life stages?
- d. When do each plant's flowers bloom?

- e. How long does each type of flower bloom?
- f. How much sunlight does each flowering plant need to grow?
4. If research time is limited, instructor can provide students with a plant inventory sheet that includes a picture of the flower to show shape and color, flower size, bloom time, bloom length, whether it is an annual or perennial, and mature plant size. If desired, alter the provided flowers to match local wildflowers (See attached inventory sheet)
5. Provide students with one-inch graph paper and explain that on our grid, one inch will equal one foot. Tell students they may use any combination of plants they choose, as long as they follow the space requirements. Give students about 30 minutes to design their gardens with their partners.
6. Make a career connection with Landscape Architecture. As students are working, Make suggestions as to the garden design, such as choosing colors that blend and making sure all plants are visible (i.e., tall in back, short in front).

### **Extensions:**

- For early elementary students, provide pictures of flowers cut to size and shape that will fit on graph paper. Ask them to fill the space and consider making patterns in the garden.
- Challenge upper elementary students to create a garden that includes other shapes such as circles, triangles, and octagons. Ask students to design a three-dimensional garden that includes fencing, wire cages, or climbing poles.
- Ask older students to create garden maps for younger students who are planting a garden plot, and then have them assist the younger students in following the plan.
- Explore varieties of plants and try planning a pollinator garden for a different environment. How would the garden and flowers change if it were planted in a different part of the world?






### **References:**







New Jersey Agricultural Society: [Making A Garden Map](#)  
Clemson Cooperative Extension: ["Bee" A Friend to Pollinators](#)

# Design a Garden

## Flower Inventory:

Use this list of flowers and their characteristics to help you determine which plants you will put in your garden to attract all types of pollinators all year long!

Flowering Plant	Pollinators Attracted	Bloom Time	Plant spacing when planting	Amount of sunlight
<b>Bluebells</b> 	Bumble Bees, Butterflies	Mid-April through Late- May	6" apart	Partial shade
<b>Phlox</b> 	Butterflies, Moths	April through June	18" apart	Full sun to partial shade
<b>Penstemon</b> 	Bees, Hummingbirds	May through June	24" apart	Full sun to partial shade
<b>Petunia</b> 	Bumble Bees, Butterflies, Hummingbirds	Late-May through August	12" apart	Full sun
<b>Tickseed</b> 	Beetles, Solitary Bees	June through September	24" apart	Full sun

<p><b>Milkweed</b></p> 	<p>Butterflies, Moths,</p>	<p>June through August</p>	<p>18" apart</p>	<p>Full sun</p>
<p><b>Blanketflower</b></p> 	<p>Bumble Bees, Bees, Flies, Wasps, Butterflies</p>	<p>June-September</p>	<p>18" apart</p>	<p>Full sun</p>
<p><b>Yarrow</b></p> 	<p>Beetles, Flies</p>	<p>June through September</p>	<p>18" apart</p>	<p>Full sun to partial shade</p>
<p><b>Bee Balm</b></p> 	<p>Bees, Bumble Bees, Butterflies, Moths, Hummingbirds</p>	<p>July through September</p>	<p>18" apart</p>	<p>Full sun</p>
<p><b>Aster</b></p> 	<p>Beetles, Flies, Bees</p>	<p>August-October</p>	<p>24" apart</p>	<p>Full sun to partial shade</p>
<p><b>Goldenrod</b></p> 	<p>Beetles, Bees, Flies</p>	<p>August through October</p>	<p>36" apart</p>	<p>Full sun</p>



### Garden Summary:

My garden will be...

\_\_\_\_\_ feet by \_\_\_\_\_ feet, or \_\_\_\_\_ feet square

In my garden, I will plant...

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And will attract...

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The first flower to bloom will be \_\_\_\_\_ (flower) in \_\_\_\_\_ (month)

The last flower to bloom will be \_\_\_\_\_ (flower) in \_\_\_\_\_ (month)

# Flower Structure & Plant Reproduction

## Content Connections:

Life Science - Plant life cycle

**Grade:** 4-8

**Time:** 45-60 minutes

**Objective:** Students will dissect and identify parts of the flowers. They will learn about plant anatomy and be able to demonstrate the mechanism of pollination by examining several types of flowers.

## Materials:

- A variety of fresh flowers (the number of flowers depends on how you will divide up students to facilitate this activity)
- Small sharp scissors
- *Anatomy of a Flower* diagram (showing flower structure and function)
- *Taking a Closer Look at Flowers* record sheet, 1 for each type of flower
- Flower anatomy worksheet, 1/participant
- Felt markers
- Recycled materials and craft supplies including tape and glue

## Background:

Pollination of a plant occurs when a pollen grain moves from the anther (male part) of a flower to the stigma (female part). This is the first step in a process that produces seeds, fruits, and the next generation of plants. This can happen through self-pollination, wind and water pollination, or through the work of pollinators that move pollen within the flower and from bloom to bloom.

## Procedure:

1. Give each participant a copy of a flower anatomy worksheet.
2. Spread fresh flowers out on a table, or place individual flowers in plastic cups. Place one *Taking a Closer Look at Flowers* sheet labeled with the name of the flower with each sample for recording observations.

3. As a group examine the flowers and discuss: What parts of the flower are visible? How are flowers different? How are they similar? Encourage participants to notice and compare flower characteristics such as shape, petals (color, patterns, texture, and number), scent, and whether the flower is composite (composed of many small flowers), like a sunflower, or simple, like a lily.
4. Divide students into groups of 2 or 3 to examine one flower and record their observations on *Taking a Closer Look at Flowers* sheet.
5. Have each group dissect their flower with the sharp scissors, carefully laying out the different parts and comparing the real flower to their flower anatomy worksheet. If necessary, identify the basic flower structures using the *Anatomy of a Flower* diagram.
6. Have each participant complete *Taking a Closer Look at Flowers* sheet to reinforce and/or review the basic structure of a flower.
7. As a whole group or in small groups, look at each dissected flower and the accompanying *Taking a Closer Look at Flowers* sheets. If students were given different flowers, ask them to compare and contrast the structures in their flower with those from a neighboring group.
8. Discuss as a group the features they have identified, i.e., floral color, form, scent, and structure in addition to any similarities and differences between different flowers.
9. Using the parts of the dissected flowers, discuss the basic process of pollination using the *Anatomy of a Flower* diagram. Depending on the age of your group, focus on the cross-section of the flower and the development of the pollen grain, pollinating agents, and types of pollination.

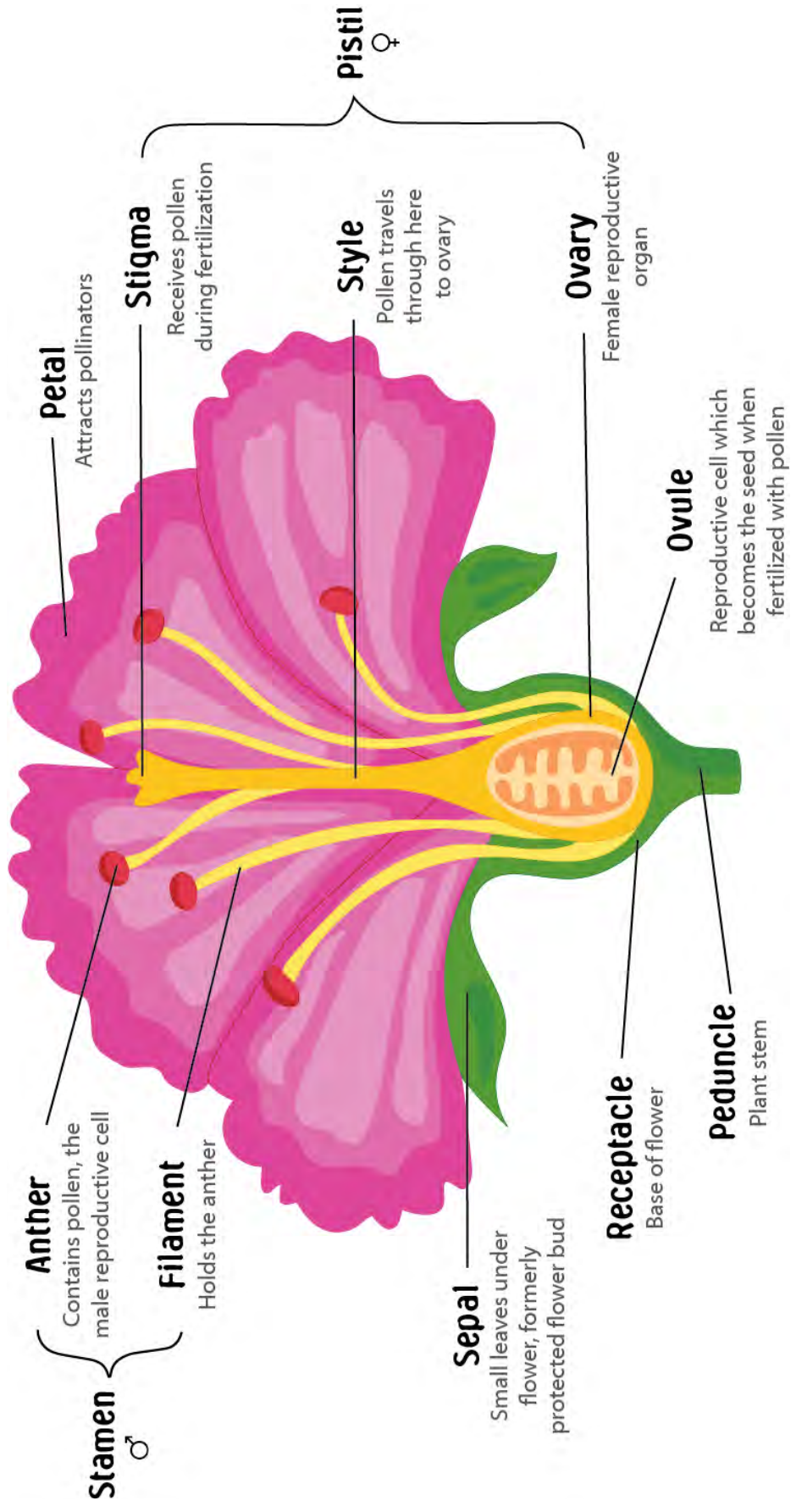
**Extension:**

To demonstrate understanding, ask students to build a model of a flower with provided materials. Give students a variety of recycled materials and craft supplies, including tape, glue, and scissors. Ask them to build a flower that models the key parts identified in the *Flower Anatomy* sheet.

**References:**

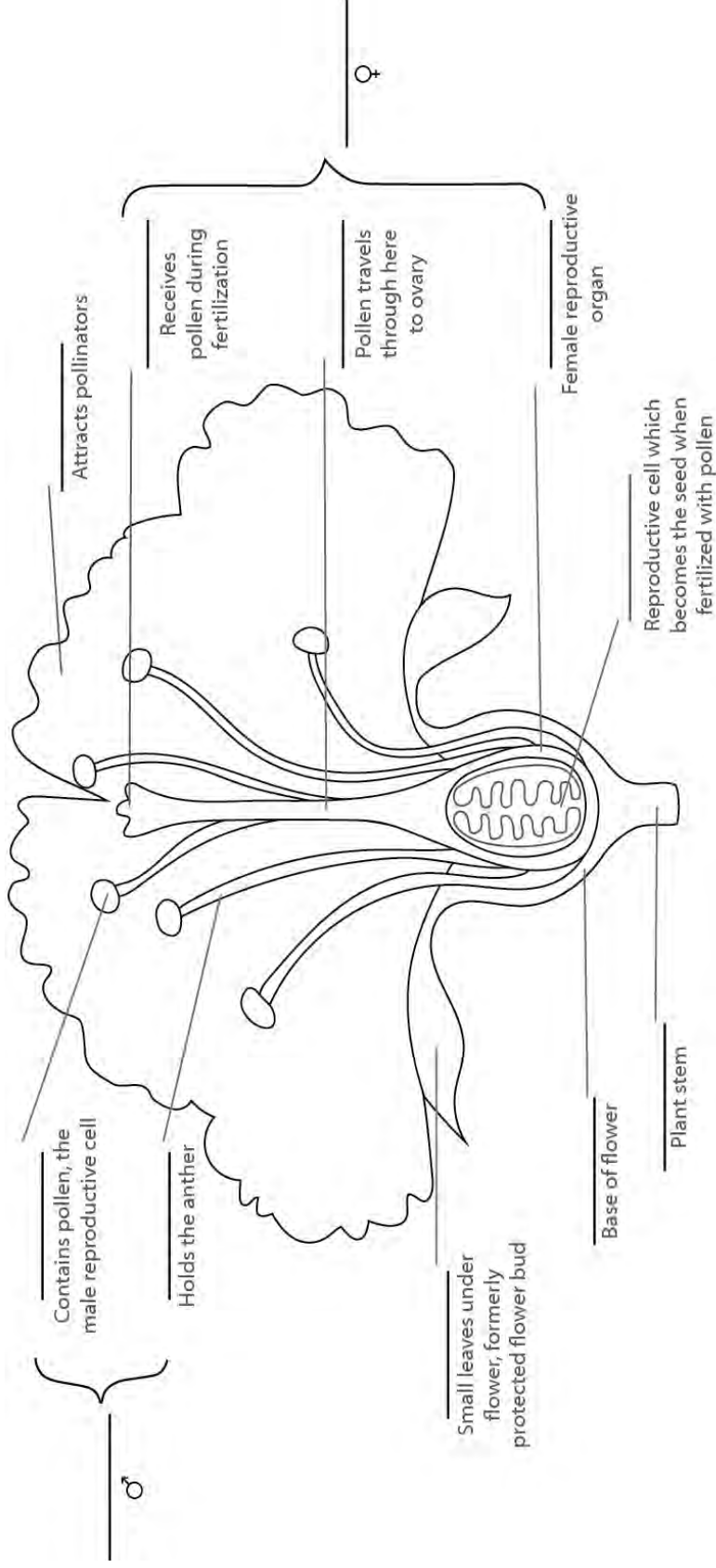
For more information and ideas, visit the NAPPC curriculum guide activity on [Understanding Flower Structure & Plant Reproduction](#), Pg 51.

# Anatomy of a Flower



# Anatomy of a Flower

Use the word bank to help you fill in the blanks and name the missing parts of the flower



Stamen	Filament	Petal	Anther	Ovary	Style
Pistil	Ovule	Peduncle	Sepal	Stigma	Receptacle

# Taking a Closer Look at Flowers

Name of Flower: \_\_\_\_\_

Describe the parts of the flower. Include number of various parts, size (length or diameter). Colors, patterns, texture (smooth, rough, sticky), and shape. Draw them if you can.

Sepal:

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Petals:

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Stamens (Anther & Filament):

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Pistil (Stigma, Style, & Ovary):

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Scent:

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What type of pollinator do you predict would pollinate this flower? Why?

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If this flower has nectar guides please describe them.

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## Let's Pollinate! (with Cheetos!)

### Content Connections:

Life Science - Life cycle of a plant and the role of pollination

**Grades:** K-5th

**Time:** 30-60 minutes

**Objective:** In this lesson, students learn how pollination works by using Cheetos and bee finger puppets to simulate pollen transfer from flower to flower.

### Materials:

- Flower print outs
- Crayons
- Black and yellow pipe cleaners or bee cut outs
- Scissors
- Cupcake wrappers
- Cheetos (or other powdery, coated snack)
- *Let's Pollinate* worksheet
- Hand wipes or access to a wash station or bathroom

### Engage:

- Read *What Is Pollination?* by Bobbie Kalman

### Explore:

- Ask students to recall a list of pollinators that were described in the story.

### Explain:

- With the help of the students, summarize the process of pollination. Reiterate that flowers need to exchange pollen in order to be able to make seeds. Since flowers can't move, they need help from pollinators. So deep in their petals, flowers produce a sweet sugary nectar that pollinators like bees, bats, birds, butterflies, and other insects love to eat.

- Remind students that in order for pollination to happen, pollinators need to visit multiple flowers of the same type so that pollen is transferred to the right kind of flower.

### **Elaborate:**

- Tell students that today they are going to act out pollination! Give each student a picture of a flower to color and cut out. Alternatively, teacher can provide students with these already completed.
- Set a cupcake paper in the middle of the flower and fill it with Cheetos.
- Provide students with a bee hand puppet made out of a paper cutout or piper cleaners. This should go on their hands so that the fingers stick out and represent the bees legs.
- Tell students to put on their bee puppets and then eat the Cheetos. If desired, let students fly around the room to other flowers and eat one or two Cheetos at a time. Tell the students to be sure NOT to brush or lick the Cheetos crumbs from their hands!
- When they are finished eating, the bee's feet (student's fingers) should be covered with Cheetos crumbs.
- Wait until everyone has gathered lots of pollen on their legs (Cheetos dust on their fingers), then instruct them to fly to a friend's flower and land on it. Ask them what they notice when they land on a flower. They should leave pollen (Cheetos dust) behind on the flower. Let the students fly around the room and pollinate a few flowers.
- After a few pollination trips, instruct students to wash their hands.

### **Evaluate:**

- Lastly, discuss with the students what they observed using the *Let's Pollinate!* worksheet guide discussion and illustrate the sequence of events in pollination.

### **Reference:**

- [Pollination – A Sticky Situation!](#) (New Jersey Agricultural Society).

# Let's Pollinate!

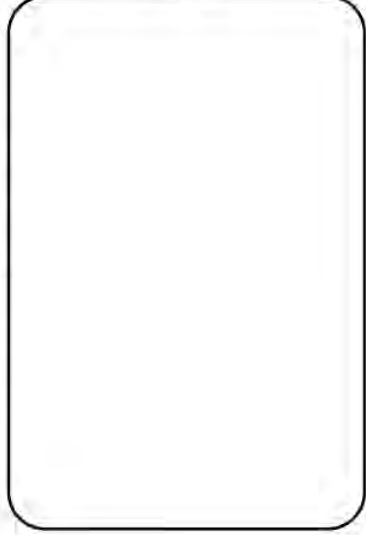
Name: \_\_\_\_\_

My Cheetos represent...

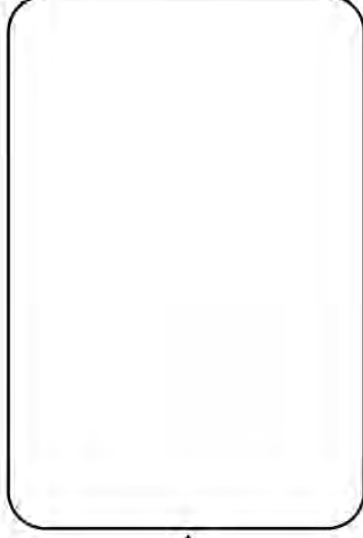
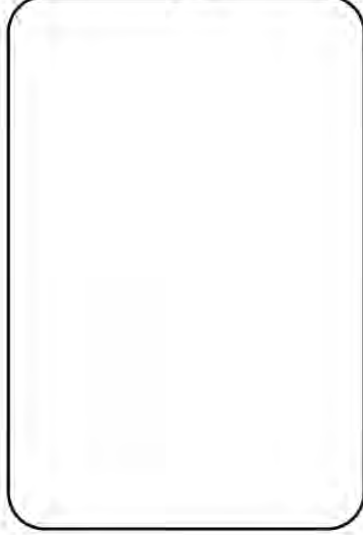
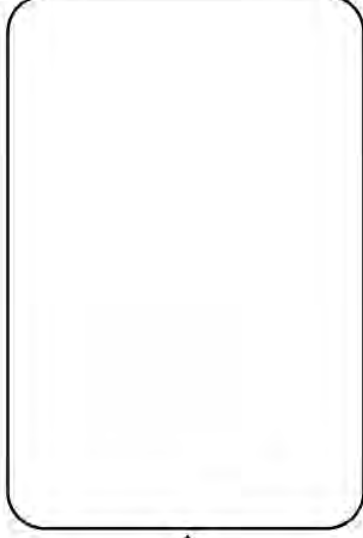
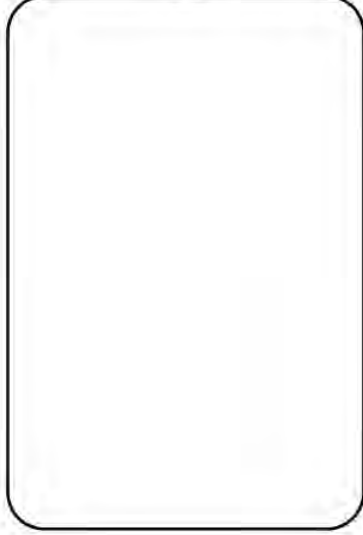
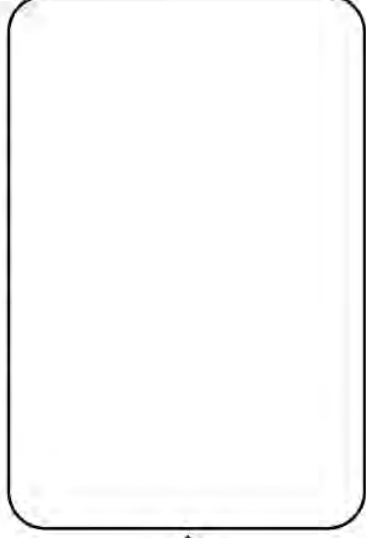
My fingers represent...

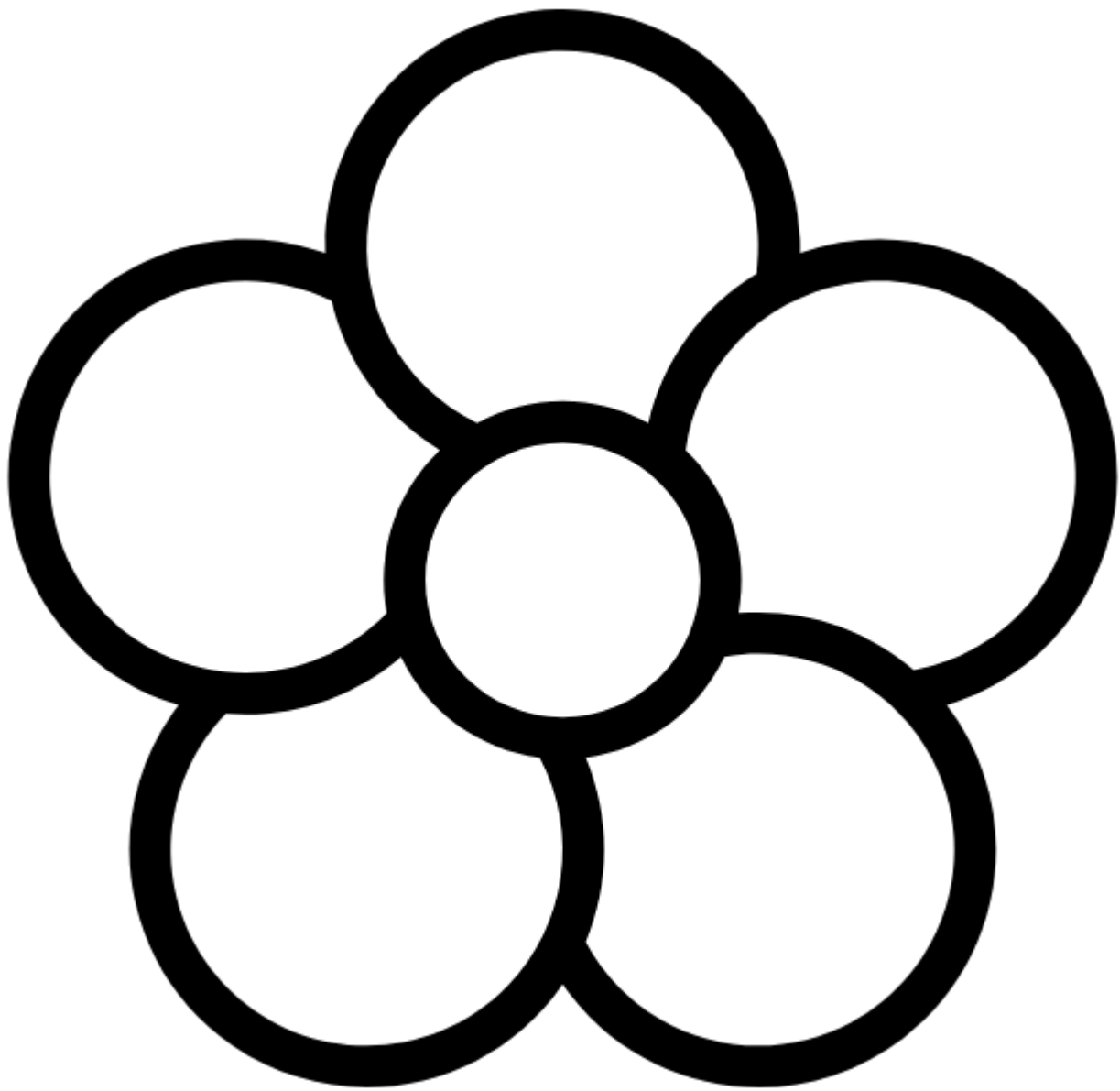
When I touched a friends flower...

Draw your answer

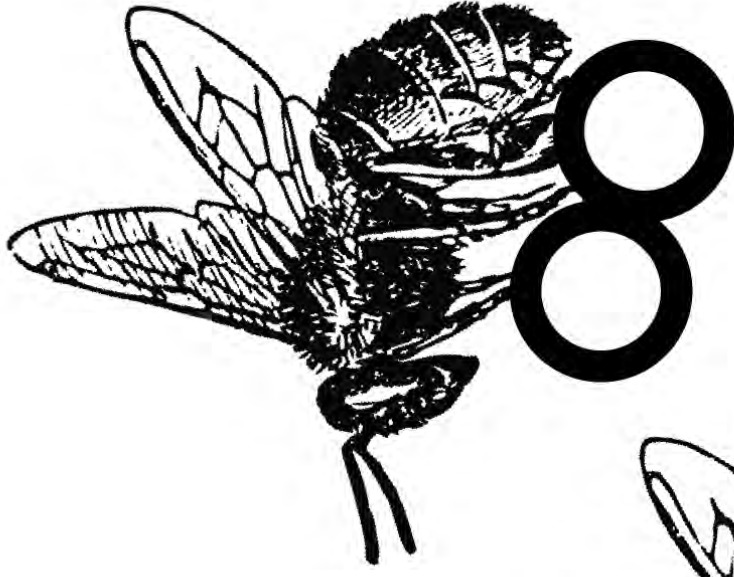


Write your answer





Print out one flower for each student to color and cut out.  
Place cupcake wrapper in center.  
Fill cupcake wrapper with Cheetos to represent pollen.



Print on cardstock or laminate  
Let students color bees  
Cut out bee body and inside the  
two white circles for fingers

# Mutualism Mouthpart Engineering

## Content Connections:

Engineering - Compare different solutions to completing a task

Life Science - Animal adaptations

**Grades:** 2nd-6th

**Time:** 30-60 min

**Objective:** Students will model and discuss animal adaptations and how adaptations impact plant-pollinator relationships.

## Materials:

- Eye droppers (1-2 per group)
- Clothespins (1- per group)
- Sponges (1-2 per group)
- Pipettes (1-2 per group)
- Bendy straws (1-2 per group)
- Cups of assorted sizes (1 each per group of Dixie cups, 5 oz cups, bottle caps)
- Bowls of assorted sizes and shapes (1 each per group of soup bowls of 3 different sizes)
- Plates of assorted sizes and shapes (1 each per group of saucer, plate, Tupperware lid)
- Test tubes (1 per group)
- Tall and narrow bottles of different sizes, such as soda bottles (1-2 per group)
- Colored water
- Colored beads

## Background:

Pollination is a mutualism in which two interactors benefit from each other: a plant rewards pollinators by providing nectar and pollen in return for the service of pollination. Many plants are able to be pollinated by a variety of pollinators. Additionally, many pollinators are adapted to feed from many plants. These

pollinators are known as generalists. However, some pollinators and plants are almost completely reliant on one another. These types of pollinators are known as specialists because they are perfectly adapted to feed almost exclusively on specific plants.

### Mouthpart Activity Station Prep:

- Set up activity stations as described in the instructions below for students to explore pollinator mouthparts. There should be enough stations to accommodate 4-5 students at each station (i.e. 20 students equals 4-5 stations).
- Each station should include at least one of each Pollinator Mouthpart Tool listed in the table below, as well as the materials listed under Flower Shape in the table below. Fill each Flower Shape with the corresponding materials listed under Nectar Source. These materials simulate different types of mouthparts and flowers, as well as whether these mouthparts might belong to a generalist or specialist pollinator.

Type of Pollinator	Pollinator Mouthpart Tool	Flower Shape	Nectar Source
Generalist	Eye dropper	3 cups of different sizes (i.e. Dixie cups, 5oz cups, etc.)	Cup with small amount of colored water
Generalist	Clothespin	3 Bowls of different sizes (i.e. soup bowls, tea cups, etc.)	Colored beads taped to paper (represents pollen)
Generalist	Sponge	3 Plates of different sizes (i.e. bottle caps, plates, saucers, plastic lids, etc.)	Colored water on plates
Specialist	Pipette	Test tube	Test tubes with colored water
Specialist	Bendy straw	Tall, narrow bottle (such as glass or plastic soda bottle)	Fill bottom of bottle with small amount of colored water

## Procedure:

1. Ask students to share what food they like to eat and how they eat food. What tools do they need to help them eat? Can you eat spaghetti very well with a spoon? Can you eat soup very well with a fork?
2. Just like we use forks, spoons, and knives to help us eat different foods, and not every tool is good for every food, pollinator mouthparts are better suited for feeding from certain types of flowers.
3. Because animals don't use silverware to eat food like we do, they have different adaptations to help them eat. Some animals have long noses, or long tongues, some have sharp teeth, some have flat teeth.
4. Pollinators have special mouthpart adaptations to help them get their food from different types of flowers. To model the close relationship between plants and pollinators, have the class complete the Mouthpart Activity Stations.
5. Before starting the activity, model to students how to complete the activity by interacting with each of the types of mouthparts and flower shapes. Explain their objective: identify which type of mouthpart works best for types of pollinators. Let the students explore the mouthparts and discover what types of flowers work best for each food source.
6. Debrief the activity with the students. Ask students to share which mouthpart worked best for each flower shape and food type. Students should identify that the eye droppers, clothespins, and sponges worked for multiple flower types whereas the pipette and bendy straws only worked for certain types of flowers.
7. Ask students to try and explain an analogy between this activity and real-life plant-pollinator relationships. Explain to students that what they observed with the mouthpart tools is similar to real life. Some pollinators are Generalists and can feed off a variety of different types of flowers. Conversely, some pollinators are Specialists with mouthpart tools that can only feed on certain types of flowers.

### **Extensions:**

1. As time allows, provide students with an opportunity to demonstrate their understanding of mouthpart tools, mutualism, generalist and specialist pollinators by asking them to design a pollinator that would pollinate a certain flower.
2. Provide each student, or partners, with pictures of unfamiliar, oddly shaped flowers (see images in provided [Design a Pollinator](#) resource sheet) and ask them to draw a pollinator that might like to find food in that flower.
3. As they draw, ask them to consider:
  - a. What size would the pollinator be? Would they need to be large and strong to get to the pollen and nectar, or would a small pollinator have a better chance?
  - b. What would be the best type of mouthpart for reaching the nectar? (Beak, proboscis — long or short?)

## Design a Pollinator

There are lots of unique flower shapes out there, and each one needs to get pollinated. Select one of these funky flowers and design the perfect pollinator for it. As you're brainstorming, think about these questions:

- What size should the pollinator should be? Does it need to be large and strong to get into the flower to the pollen and nectar, or would a small pollinator have a better chance?
- What would be the best type of mouthpart for reaching the nectar? (Beak, proboscis — long or short)

Have fun and get creative!



Heliconia (*Heliconia* sp.)



California Dutchman's Pipe  
(*Aristolochia californica*)



*Catalpa (Catalpa speciosa)*



*Jack-in-the-Pulpit (Arisaema triphyllum)*



Lady Slipper Orchid (*Cypripedium* sp.)



Hairy Clematis (*Clematis hirsutissima*)



Saguaro Cactus (*Carnegiea gigantea*)



Wild Ginger (*Asarum* sp.)



Dutchman's Breeches (*Dicentra cucullaria*)



Snapdragon (*Antirrhinum majus*)



Purple Coneflower (*Echinacea purpurea*)

# Pollination is Big Business!

## Content Connections:

Math - basic algebra, word problems

Social Studies - understanding how humans interact with and affect their environment and vice versa

**Grade Level:** 4th-8th

**Time:** 20-30 minutes

**Objective:** Students will be able to describe the economic importance of pollinators after solving word problems containing actual chocolate making statistics.

## Materials:

- Chocolate Math worksheets
- Pencils
- Calculators
- Drawing and writing paper

## Background:

The Cacao tree grows in the tropics and produces cacao pods, the source of chocolate. Each tree produces approximately 30 pods a year. Each pod contains roughly 40 cocoa beans. It takes approximately 500 beans to make 1 pound of chocolate, so therefore each tree produces about 2 pounds of chocolate a year.

To put that in context, Americans alone consume 2.8 billion pounds of chocolate each year, or over 11 pounds per person, so that means the average American needs the pods from 5 and a half cacao trees. 1.4 billion trees are needed to produce enough chocolate to satisfy Americans alone. Cacao pod production wouldn't be possible without pollinators!

## Procedure:

1. Tell students that we're about to find out just how much pollinators matter! Ask them who likes chocolate? Everyone likes chocolate! Explain that chocolate comes from a tree that is pollinated by a little insect, the midge.
2. Have students work individually to complete the Chocolate Math worksheet to find out how many pods it takes to make a bar of chocolate! After they

complete the worksheet, work with them to extrapolate how many cacao pods it would take to feed the class.

3. Ask students to react to the Chocolate Math worksheet. Is this statistic surprising? How important are midges?
4. Now let them make a list of some of the other foods they eat pretty regularly. If foods are processed, include what they are made from (i.e. corn chips don't grow, but they are made out of corn, which is grown).
5. Explain that 84% of commercially grown crops are insect pollinated. What does that mean for the food on our lists we just created? Discuss in partners and then share back with the whole group.
6. Ask students to cross off  $\frac{1}{3}$  of the items on the list. Explain that pollinators are responsible for  $\frac{1}{3}$  of every bite of food we take and without pollinators, our list of favorite foods would be a lot shorter! Additionally, they are responsible for half the world's oils, fibers, and raw materials.
7. To summarize, ask students to draw a model or visual representation of the importance of pollinators in the world.

Name: \_\_\_\_\_

## Chocolate Math

HELP! The Hershey Chocolate Factory is going berserk! They have lost part of the recipe for making chocolate! They have some of the information, but they need YOUR help to figure out the rest! See if you can solve the following problems to help the chocolate factory get back on track. GOOD LUCK!

1. A Cacao tree grows approximately 30 pods a year. Each cacao pod contains about 40 cocoa beans. How many cocoa beans does each tree produce every year?

\_\_\_\_\_ beans

2. Round your answer from number 1 to the nearest thousand. \_\_\_\_\_

3. If it takes approximately 500 cocoa beans to produce 1 pound of chocolate, how many pounds of chocolate can each Cacao tree produce in 1 year?

\_\_\_\_\_ pounds

4. How many Cacao trees would you need to make 40 pounds of chocolate?

\_\_\_\_\_ trees

5. An average milk chocolate bar weighs about 1.5 ounces. There are 16 ounces in a pound. How many chocolate bars can be made with one pound of chocolate?

\_\_\_\_\_ bars

6. How many chocolate bars can be made from 35 pounds of chocolate?

\_\_\_\_\_ bars

## Chocolate Math Answer Sheet

1.  $30 \text{ pods} \times 40 \text{ beans} = 1,200 \text{ beans}$
2. 1000
3. 2 pounds
4.  $40 \text{ pounds} \div 2 \text{ pounds per cacao tree} = 20 \text{ trees}$
5.  $1 \frac{1}{2} (1.5) \times 10 = 15$  Therefore you can make 10 bars per pound
6.  $35 \text{ pounds} \times 10 \text{ bars per pound} = 350 \text{ bars}$

# Pollination Syndromes

## **Content Connections:**

Life Science - Plant and animal adaptations, behavior, and interactions

Visual Arts - Recognizing and using colors and patterns

**Grade:** 3rd-8th

**Time:** 30-45 minutes

**Objective:** Students will use observation skills to complete a matching game that demonstrates an understanding of pollination syndromes.

## **Materials:**

- Flower pictures or collected specimens of a variety of flowers
- Student journals and pencils
- Meet Your Pollinator packet (see attached resource)
- Design Your Flower sheet (optional)

**Prep:** Collect a variety of flowers or print off pictures to share with students. Print off enough copies of pictures from the Meet Your Pollinator packet (below) so that each student can have one pollinator or one plant picture and text.

## **Background:**

Flowers attract pollinators by offering them a reward (nectar and pollen) and then use the opportunity to distribute or gather pollen (the plant's male reproductive cell) via the pollinator. Different types of pollinators are typically attracted to specific types of flowers. This preference for certain flowers is known as a Pollination Syndrome.

Pollination Syndromes vary by types of pollinators. This table provides the flower characteristics for the pollination syndromes of common types of pollinators.

Trait	Bats	Bees	Beetles	Bird	Butterflies	Flies	Moths
<b>Color</b>	Dull white, green or purple	Bright white, yellow, blue, or UV	Dull white or green	Scarlet, orange, red or white	Bright, including red and purple	Pale and dull to dark brown or purple; speckled	Pale and dull red, purple, pink or white
<b>Nectar Guides</b>	Absent	Present	Absent	Absent	Present	Absent	Absent
<b>Odor</b>	Strong musty; emitted at night	Fresh, mild, pleasant	None to strongly fruity or fetid	None	Faint but fresh	Putrid	Strong sweet; emitted at night
<b>Nectar</b>	Abundant; somewhat hidden	Usually present	Sometimes present; not hidden	Ample; deeply hidden	Ample; deeply hidden	Usually absent	Ample; deeply hidden
<b>Pollen</b>	Ample	Limited; often sticky & scented	Ample	Modest in amount	Limited	Modest in amount	Limited
<b>Flower Shape</b>	Regular; bowl shaped – closed during day	Shallow; have landing platform; tubular	Large bowl-like, Magnolia	Large funnel like; strong perch support	Narrow tube with spur; wide landing pad	Shallow; funnel like or complex and trap-like	Regular; tubular without a lip

Reference: [Pollinator Syndromes](#) (U.S. Forest Service).

## Procedure:

1. Show students the different flowers (or pictures) you have gathered.
2. Give students 10-15 minutes to look at all the flowers and jot down a paragraph stating what their favorite flower is with supporting reasons for their point of view. Their rationale can include the size, shape, color, texture, and fragrance. Younger students may draw a picture and write down notes about aspects of the flower that makes it their favorite.
3. After students have had time to write, go around the room and have several students share which flower is their favorite and why.
4. Explain to students that just like they prefer some flowers over others, pollinators also prefer some flowers over others. A lot of times the flowers they like best are the ones that are the right size or shape just for them. For example, because a butterfly has a long, slender mouth part (proboscis), they prefer flowers that are long and tube-like. Some flies, on the other hand, have short, round mouthparts much like a sponge so they prefer wide-open flowers that are easy to access. Or, for other pollinators, like moths, a flower that is open at night is preferred because that is when most moths are active.
5. The idea that pollinators prefer some plants over others is called a Pollinator, or Pollination, Syndrome. The term “syndrome” refers to the idea that just like we have symptoms or characteristics specific to a syndrome or illness, pollinators have characteristics that are specific to their preferred plants.
6. To emphasize the plant-pollinator relationships, complete the Meet Your Pollinator activity. This activity can be done individually, in pairs, or in small groups. Give each student/group one card, either a plant or pollinator, from the “Meet Your Pollinator” packet. Explain to them that they are to use the characteristics of their pollinators and plants to find their match - each plant has a specific pollinator. (Note: for several plants, the matching pollinator is not the only pollinator to help pollinate this plant. Have students write their pairs in a notebook.
7. Once students have found their matches, have them write explanations for the pairings they chose. When all students are done with their explanations have them report to the class their pairings/explanations and reasoning behind their answers.

**Extension:** Draw the plant that will attract you as a pollinator!

1. Give one *Designer Flowers* activity sheet to each student. Let each student complete the worksheet and then trade with a partner.
2. Ask students to brainstorm the question, If you were a pollinator what would your flower partner look, smell and taste like? Then let them draw a “designer” flower just for their partner! Encourage lots of creativity and fun in this activity; their flowers might have pizza slice petals, a candy bar pistil, a favorite drink could be the nectar, etc.
3. Give students time to brainstorm and design, then choose a few students to share back with the class.

**References:**

- To learn more about parts of this lesson, visit the activity [“Butterflies, Hummingbirds, and Bees Oh My! Pollinators on the Tallgrass Prairie”](#) by the National Park Service.

## Meet Your Pollinator!

**Directions:** Print enough copies for each student to have either one plant or one pollinator. Print each page and fold in half so picture is on one side and text is on the back side.

While many plants are pollinated by more than one of these pollinators, the idea is to have one pollinator match specifically with each plant. If students find a match other than the preferred pairs listed below, ask them to explain their reasoning. The intended matches are as follows:

### **Pollinator**

Bumble Bee  
Leafcutter Bee  
Bee Fly  
Southern Long-nosed Bat  
Fritillary Butterfly  
Ant  
Soldier Beetle  
Hummingbird  
Pollen Wasp  
Hawkmoth

### **Plant**

Snapdragon  
Aster  
Spring Beauty  
Saguaro Cactus  
Butterfly Milkweed  
Wild Strawberry  
Goldenrod  
Trumpet Vine  
Virginia Waterleaf  
Morning Glory



## Hummingbird

- I prefer flowers that are red in color.
- I do not land on the flower when drinking nectar, so I do not need a large landing spot.
- I seek flowers that are funnel shaped for my long, slender beak.
- I want flowers with plenty of nectar. I need a lot of energy to flap my wings this fast!



## **Bumble Bee**

- I am able to regulate my own body temperature through shivering and basking in the sun. Many early spring and fall blooming plants rely on me for pollination.
- I like to land on the flower when seeking nectar, I do not hover.
- Because I am a heavier pollinator, I pollinate plants that must “open” to reveal their nectar.
- I like lightly sweet smelling flowers.



## **Fritillary Butterfly**

- I like flowers that grow in clusters so I have plenty of room to land.
- I prefer brightly colored flowers, mainly red, yellow, and orange.
- I want flowers with lots of nectar.
- Because I have a long tongue, I often visit flowers with the nectar hidden deep inside.



## Ant

- I am not considered an important pollinator, but there are millions of me and we do visit flowers, so we do some pollinating.
- I cannot fly, so I visit flowers that are low to the ground.
- I often visit flowers with small, inconspicuous flowers.
- I only pollinate during the day.



## **Soldier Beetle**

- As a beetle, I am an extremely important pollinator. Beetles pollinate 86% of flowering plants!
- I often visit showy flowers that are yellow in color.
- I am not too particular on the type of flowers. I can pollinate large, solitary flowers like sunflowers, or small, cluster flowers like yarrow.



## Hawkmoth

- Unlike most moths, I am crepuscular, so I visit flowers at dawn and dusk. I am often mistaken for a hummingbird.
- I want flowers that have ample nectar. And with my long tongue I like the nectar to be hidden deep inside.
- I can be found feeding on hummingbird feeders, but I also like flowers that are purple, pink, white, or even blue.



## **Pollen Wasp**

- I am a wasp, but I would prefer to visit flowers rather than sting you!
- My tongue is not nearly as long as most bees or butterflies, so I need shallow flowers.
- I will visit a wide variety of flowers, but prefer flowers from the Waterleaf and Figwort families.



## Bee Fly

- I am actually a fly that mimics a bee.
- I do not land on the flower when drinking nectar to avoid predators (like spiders) lurking on the flowers, so I do not need a large landing spot.
- I am often one of the first pollinators out in the spring.
- Although I do not land on the flowers I pollinate, I do get some pollen on my legs to pass to other flowers.



## Leafcutter Bee

- I am a solitary bee, not a colony bee like Bumble Bees and Honey Bees
- I am named because I chew perfect circles out of leaves. I use this material to seal my eggs in their nest chamber.
- Although most Leafcutter Bees visit a wide variety of flowers, some species specialize in pollinating Asters and Pea flowers.



## **Southern Long-nosed Bat**

- I fly at night to find food.
- I mostly eat nectar, pollen, fruit, and flowers.
- Since I feed at night, I like flowers that are pale-colored with a strong smell so they're easy to find.



## **Saguaro Cactus**

- I am big, sturdy and white.
- I grow high off the ground.
- I have a strong smell that attracts pollinators from far away.
- I open at night and then die by the end of the next day.



## **Snapdragon**

- I can be found in a wide variety of colors including yellow, white, pink, red, and orange.
- I must be “opened” by pushing down on my large petal for a pollinator to reach my nectar.
- I provide my pollinators with a large landing platform.
- My nectar is at the bottom of a long tube.



## **Butterfly Milkweed**

- I am brightly colored and have lots of small flowers that form in clusters.
- I can be found in a wide variety of habitats including prairies, wetlands, and roadsides.



## Goldenrod

- I have clusters of flowers.
- Although there are lots of kinds of Goldenrod, my flowers are always bright, showy yellow.
- I bloom in the late summer.



## Trumpet Vine

- I have no landing platform for my pollinators.
- I have a long funnel shaped flower.
- I can be red or orange in color.
- I can grow as a bush or a vine.



## Morning Glory

- I can be blue, white, deep pink, or pale pink in color.
- I close my flowers at night, I open them first thing in the morning.
- I am a common garden flower and can be found climbing on fences or trellises.



## **Virginia Waterleaf**

- I grow on forest floors.
- I stay low to the ground.
- My flowers are not too deep which allows many pollinators to get to my nectar.



## **Spring Beauty**

- I am one of the first wildflowers to bloom in the spring.
- My flowers can be white, pink, or even striped.
- I am a small plant and do not grow very tall.



## **Wild Strawberry**

- I grow low to the ground and am often visited by crawling insects.
- I have small white flowers that are not very showy.
- I am usually found in shaded areas with plenty of indirect sunlight.



## **Aster**

- I am a small flower, but a single flower. I do not form clusters.
- I can be yellow, white, pink, or purple in color.
- My petals are long and narrow and although small, I have plenty of pollen and nectar.

# Designer Flowers

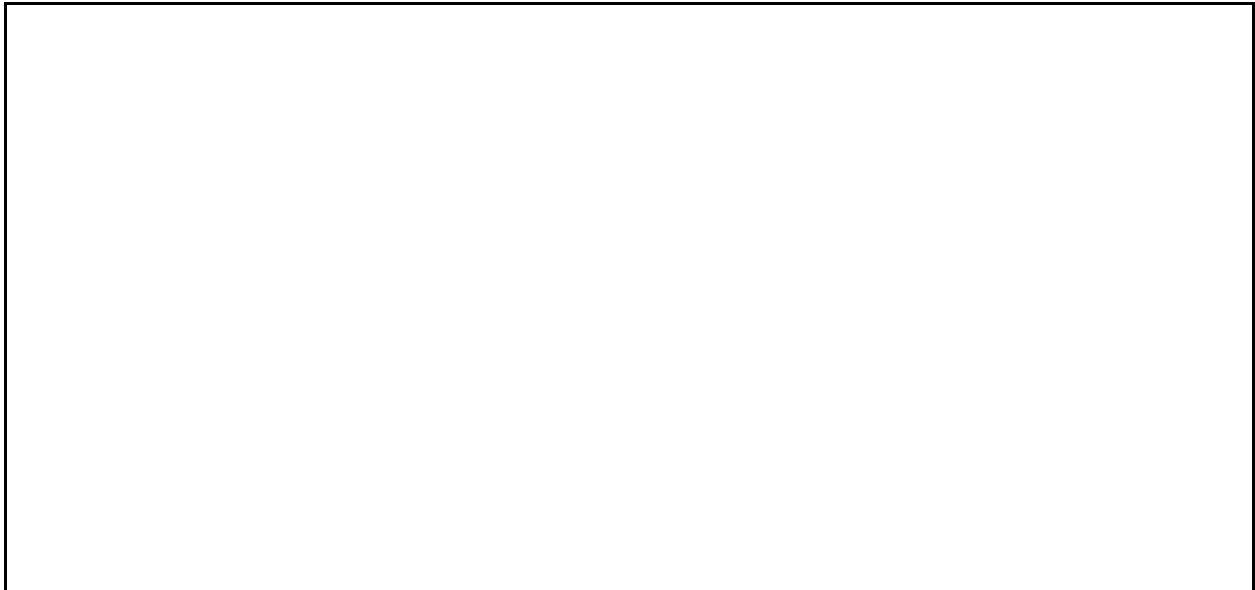
Fill out your preferences and give them to your partner:

Your favorite color: \_\_\_\_\_

Your favorite shape: \_\_\_\_\_

A smell you like: \_\_\_\_\_

Your favorite snack: \_\_\_\_\_



Imagine you are a flower adapting to your partner's preferences. In the area above, draw a "designer" flower to suit these preferences. Then, describe why the flower you created would appeal to your partner:

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## Unusual Pollinators Game

Time: ~ 15 minutes

Students may be surprised to learn that all sorts of animals can be pollinators, not just butterflies and bees! In this activity, students will learn about some unusual pollinators!

Print out the pollinator cards from the following three pages and cut them out to play the game. Tape the pollinator cards to students' backs. Tell students that all the animals on their backs can be pollinators. Then, instruct the students to ask each other yes/no questions about the animals on their backs until they can guess them correctly.

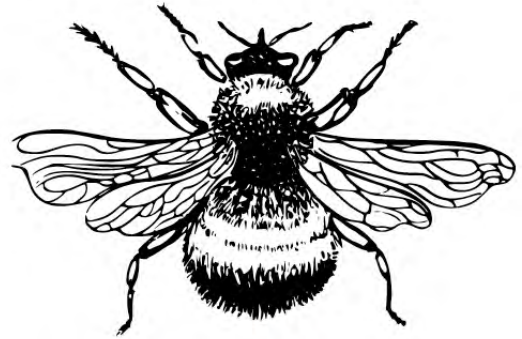
After the game, discuss the unusual pollinators with students. Were there any pollinators they already knew about? Were there any pollinators they were surprised by? What traits might make an animal a good pollinator?

Other important notes:

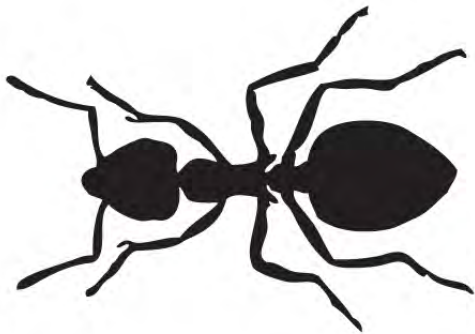
- 1.) Although there are many different animal pollinators, bees (especially honeybees) are usually considered the most important pollinator due to their key role in many ecosystems and their ability to pollinate a wide variety of different plants, including many food crops.
- 2.) Some of the animals from this activity are not always pollinators. For example, while some types of lizards are pollinators in certain ecosystems, not all lizards are pollinators.



*honeybee*



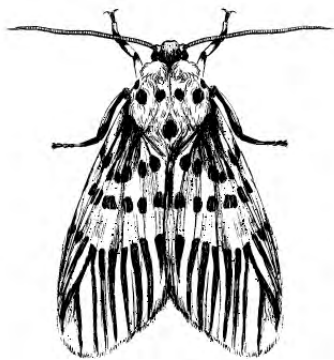
*bumblebee*



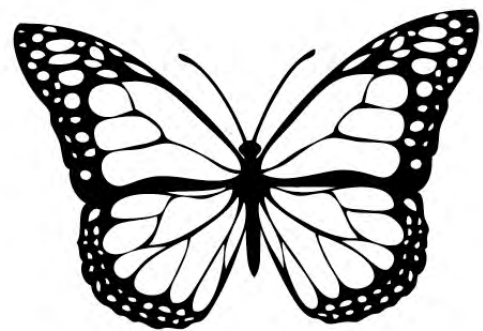
*ant*



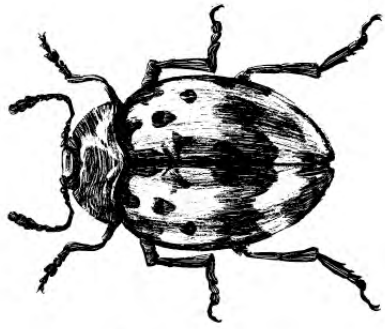
*wasp*



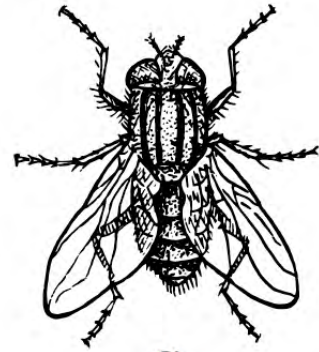
*moth*



*butterfly*



beetle



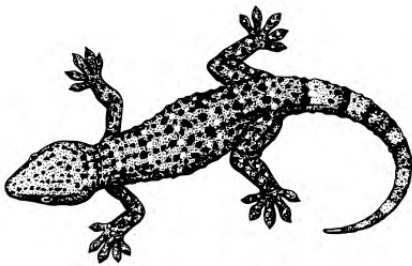
fly



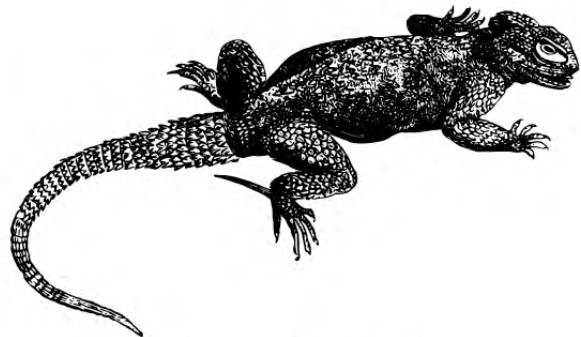
mosquito



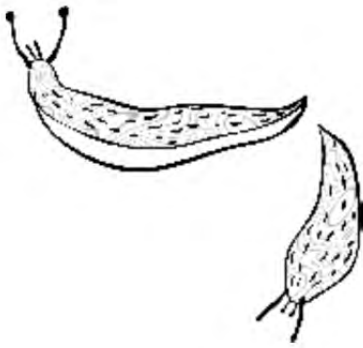
gnat



gecko



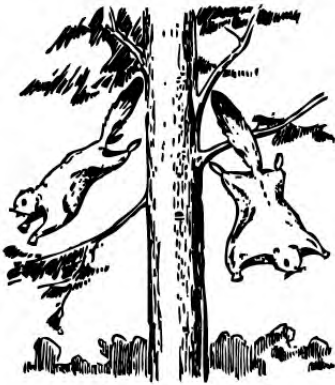
lizard



slug



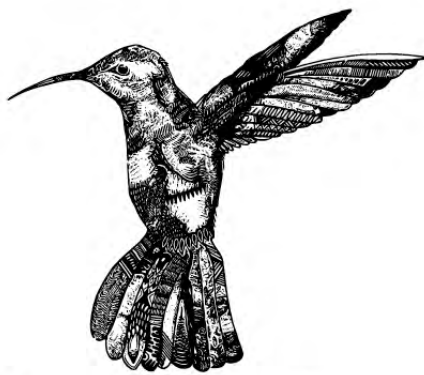
lemur



sugar glider



bat



hummingbird



parrot