Amazing Pollinators

Use this guide to help you make the most out of your visit!

Welcome! We are thrilled that you are planning to bring your students on a field trip to see *Amazing Pollinat*ors. We know you have a busy year and hope that this experience will help supplement and reinforce what you already teach in the classroom.

All activities in this guide are linked to Next Generation Science Standards for each grade level and participation meets Common Core Language Arts standards for reading comprehension of Informational Text and Science & Technical Subjects.

Use this chart to help select activities that target learning goals similar to what you're teaching in the classroom. Then continue below to see what the activity entails and how to prepare for your visit.

Grades	Activity Title	LS1.A Structure and Function	LS1.B: Growth and Development	LS1.C: Organization for Matter	LS2.A: Interdependent Relationships	LS4.B: Natural Selection	LS4.C: Adaptation	LS4.D: Biodiversity and Humans	ESS3.A: Natural Resources	ESS3.C: Human Impacts
PK-2nd	Pollinator Friendly Gardening			x						
K-3rd	Pollination Syndromes			x	x					
K-3rd	What is Pollination?	x	x		x					
3rd-6th	Super Power Adaptations	x				x	x			
3rd-6th	Pollinator Friendly Gardening							x		
3rd-8th	Flower Structure & Plant Reproduction	x	x							
3rd-10th	Mimicry and Trickery	x	x							
3rd-12th	Mutualism Mouthparts	x				x	x			
3rd-12th	Animal Migration		x				x			
5th-12th	Pollinator Threats							x	x	x
5th-12th	Parlor Games							x		x
6th-8th	Pollination Syndromes				x					
6th-12th	Pollinators Mean Business							x	x	

Feel free to adapt activities and resources to meet the needs of your students and classroom!

Thanks for choosing to visit *Amazing Pollinators*!

Please send any questions or feedback to: education@minotaurmazes.com

Produced by minotaur mazes In collaboration with FLORIDA MUSEUM and XERCES SOCIETY for Invertebrate Conservation

Pollinator Friendly Gardening (PK-2)

Recommended Ages: Grades Pre-K-2nd

Recommended Time: 30-45 minutes

Content Connection:

- Life Science
  - NGSS.LS1.C: Organization for Matter and Energy Flow in Organisms (K-LS1-1)
- Math
  - CCSS.Math.Content.2.MD.D.10 - Represent and interpret data
- Engineering Design (through optional post-visit classroom activity)
  - NGSS.ETS1.A: Defining and Delimiting Engineering Problems (K-2-ETS1-1)
  - NGSS.ETS1.B: Developing Possible Solutions (K-2-ETS1-2)

Objective: Students will explore the flowers and pollinators that can be found in different habitats and use simple graphs to help chart flower abundance. Students can then use this information to design a pollinator garden.

Prior Knowledge:

- A basic knowledge of the process of pollination and the relationship between plants and pollinators is helpful, but not necessary.

Pre-Visit:

- If students do not have basic background knowledge, review topics with them. Specifically, make sure students understand that pollinators are a special type of animal that visits flowers and, by doing so, helps the flowers reproduce and create new flowers.

What to do in the Exhibit:

Introduction:

- Gather students around the Maze Flower Quest wall.
- Ask students to look at how many different types of pollinators there are on the magnet board. As students point out the different pollinators, sort them into groups. There are 8 distinct types of pollinators, but there may be multiples of each type.
- Ask students to share if they know what each type of pollinator eats. Explain that the pollinators collect nectar and pollen from lots of different types of flowers.
- Pollinators are important because they help produce fruits, vegetables, and flowers that people like. How many of your students like apples! Or chocolate! They can thank a pollinator for that.

- Explain to the students that their task today is to explore the maze and find as many different types of flowers as they can so they can think about how to build a garden that will support pollinators and the good things they do for us and the environment.

Preparation:

- Divide students into partners or small groups of up to 4 students, with a chaperone or adult supervisor in charge of each group.
- Assign each group a different environment: Garden, Temperate Forest, Meadow, Tropical Rainforest, Roadside, Farm, Orchard, or the Night Room. Depending on how many groups you have, some groups may need to visit two or more environments.

While Exploring:

- Tell each group that their task is to go to each environment and count 1) how many different types of flowers there are, 2) how many flowers of each type, and 3) how many flowers total are in each environment.

Debrief:

- Students should return and report back their findings in order to make a class chart that reflects answers for each of the three counting prompts listed above. Older students may create a bar graph of results.
- Discuss the findings. Explain that each environment has different types of flowers, and different pollinators like each of those flowers.
- After students have debriefed and created a chart of all the flowers, give them the opportunity to explore the maze using the Maze Flower Quest game pieces and adult supervision.

Post Visit:

- In the classroom after the visit, students should recall the chart of flowers they created from the *Amazing Pollinators* exhibit. Remind students that pollinators in all kinds of environments need lots of different types of flowers to support them.
- As a summative evaluation, students can design a pollinator garden that includes many different types of flowers. Younger students may simply color flowers, older students may use graph paper to chart out the area required for plants. Use the *Design a Garden* activity guide with older students to help them inform their garden designs.

Activity Resources

- *Design a Garden* activity guide

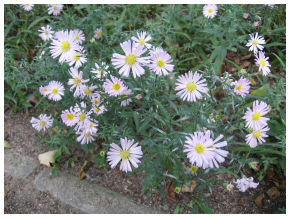
Design a Garden

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
Bluebells 	Bumble Bees, Butterflies	Mid-April through Late-May	6” apart	Partial shade
Phlox 	Butterflies, Moths	April through June	18” apart	Full sun to partial shade
Penstemon 	Bees, Hummingbirds	May through June	24” apart	Full sun to partial shade
Petunia 	Bumble Bees, Butterflies, Hummingbirds	Late-May through August	12” apart	Full sun

Milkweed 	Butterflies, Moths,	June through August	18” apart	Full sun
Blanketflower 	Bumble Bees, Bees, Flies, Wasps, Butterflies	June-September	18" apart	Full sun
Tickseed 	Beetles, Solitary Bees	June through September	24” apart	Full sun
Yarrow 	Beetles, Flies	June through September	18” apart	Full sun to partial shade
Bee Balm 	Bees, Bumble Bees, Butterflies, Moths, Hummingbirds	July through September	18” apart	Full sun

Aster 	Beetles, Flies, Bees	August-October	24” apart	Full sun to partial shade
Goldenrod 	Beetles, Bees, Flies	August through October	36” apart	Full sun

Garden Summary:

My garden will be...

_____ feet by _____ feet, or _____ feet square

In my garden, I will plant...

_____

_____

_____

And will attract...

_____

_____

_____

The first flower to bloom will be _____ (flower) in _____ (month)

The last flower to bloom will be _____ (flower) in _____ (month)

Pollination Syndromes (K-3rd)

Recommended Ages: Grades K-3

Recommended Time: 30-60 minutes

Content Connection:

- Life Science
    - NGSS.LS1.C: Organization for Matter and Energy Flow in Organisms (K-LS1-1)
    - NGSS.LS2.A: Interdependent Relationships in Ecosystems (2-LS2-2)

Objective: Students will develop an enhanced understanding of pollination and the unique relationship between plants and their pollinators by creating plant-pollinator pairs and assessing their characteristics.

Prior Knowledge:

- It is not necessary but is helpful for students to have a basic understanding of the interdependence of plants and animals. In particular, that plants need pollinators to help them reproduce and that pollinators need plants for food.
- This can also be used as an introduction to pollination lessons in the classroom.

Pre-Visit:

- Prepare students with field trip expectations.

What to do in the Exhibit:

Introduction:

- Gather students outside the exhibition, in a classroom space or on the ground. Show students pictures of 8-10 different flowers.
- Ask students to raise hands and share what their favorite flower is, with supporting reasons. Their rationale can include the size, shape, color, texture, and fragrance.
- 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 mouthpart (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.
- Remind students that the goal of this trip is to try and figure out what types of plants pollinators like the best, and to make some educated guesses about why the pollinators prefer those plants.

Preparation:

- Divide students into partners or small groups of up to 4 students, preferably with a chaperone or adult supervisor in charge of each group.
- Show groups an example of a magnet piece from the Maze Flower Quest magnet wall. Explain to students that they will each receive a piece and then go off into the mission maze to try find the matching flower.

While Exploring:

- Provide each partner or group one magnet piece from the following so that each pollinator group is represented (except Beetles). These pollinators visit flowers that meet the criteria of their syndrome:
    - Bat: Lesser Long-nosed Bat and Saguaro
    - Bird: Costa's Hummingbird and Agave
    - Bird: Ruby-throated Hummingbird and Trumpet Vine
    - Bee: Leafcutter Bee and Alfalfa
    - Wasp: Yellowjacket and Sunflower
    - Butterfly: Common Buckeye and Lantana
    - Butterfly: Marsh Fritillary and Bluebells
    - Moth: Morgan's Sphinx Moth and Darwin's Orchid
    - Fly: Hover Fly and Starfish Flower
- Ask students to complete their mission and return for debrief.
- As students find their flowers, adult chaperones can direct students to the flower information at the end of the environment panel to learn more about specific flowers.

Debrief:

- When students have completed their missions, having flown their pollinator to their flowers and returned, ask them to recall what the flower looked like. As a class, come up with a list of characteristics that each pollinator might like to visit. Create a chart similar to a pollination syndrome chart.
- Explain to students that, for the most part, each type of pollinator prefers the types of flowers that were listed in the chart.
- After students have debriefed and helped create a pollination syndrome chart, let them choose additional pieces and explore the maze.

Post Visit:

- As a summative evaluation, ask students to try to draw answers by memory in each square of the Pollination Syndrome BINGO sheet provided here.

Activity Resources:

- Pollination Syndrome Chart
- Pollination Syndrome Memory sheet

Pollination Syndrome Chart

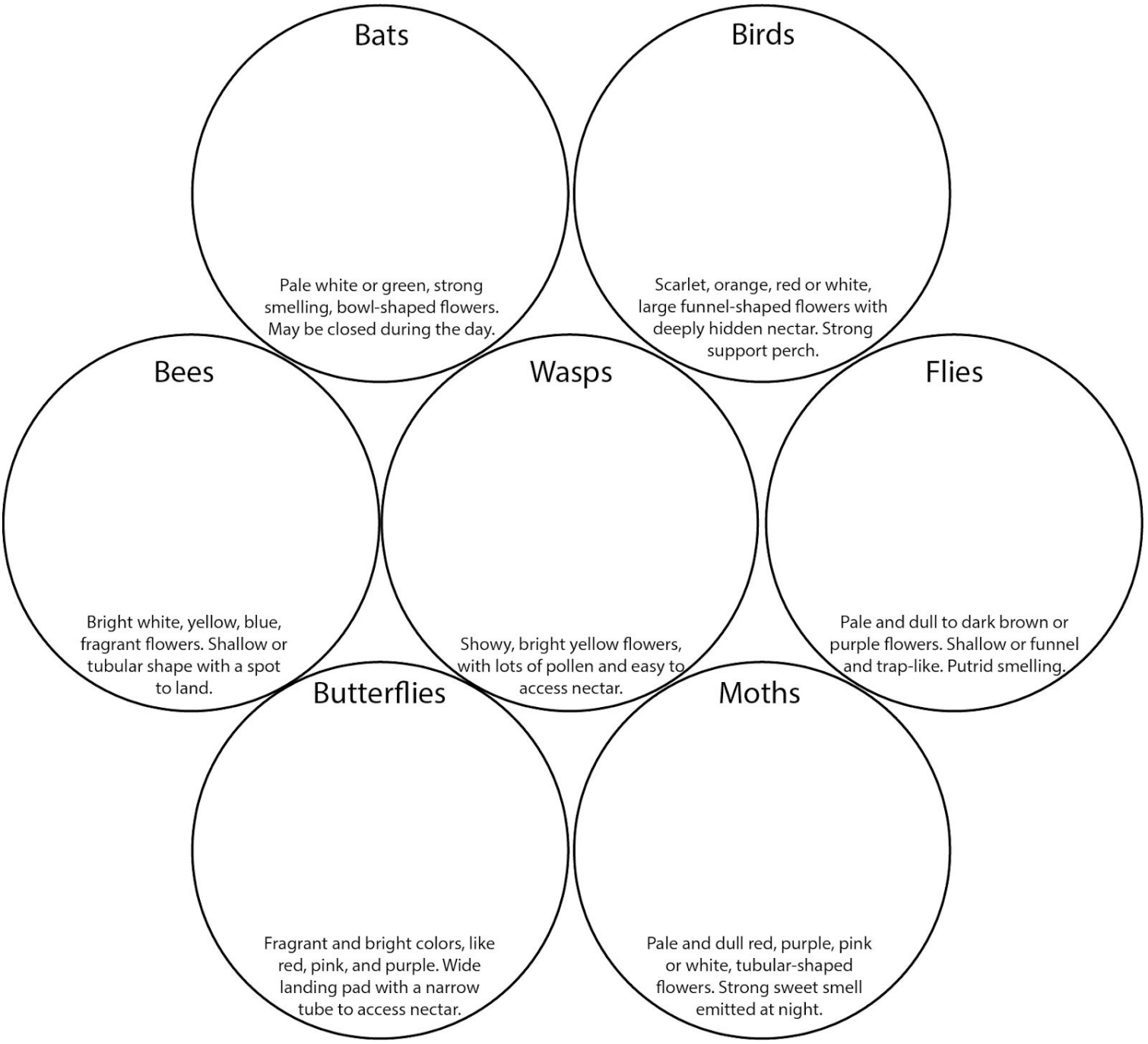
Pollination Syndromes vary by types of pollinators. This table provides the flower characteristics for the pollination syndromes of common types of pollinators.

Trait	Bats	Bees	Beetles	Bird	Butterflies	Flies	Moths
Color	Dull white, green or purple	Bright white, yellow, blue, or UV	Dull white, pink, 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
Nectar Guides	Absent	Present	Absent	Absent	Present	Absent	Absent
Odor	Strong musty; emitted at night	Fresh, mild, pleasant	None to strongly fruity or fetid	None	Faint but fresh	Putrid	Strong sweet; emitted at night
Nectar	Abundant; somewhat hidden	Usually present	Sometimes present; not hidden	Ample; deeply hidden	Ample; deeply hidden	Usually absent	Ample; deeply hidden
Pollen	Ample	Limited; often sticky & scented	Ample	Modest in amount	Limited	Modest in amount	Limited
Flower Shape	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).
https://www.fs.fed.us/wildflowers/pollinators/What_is_Pollination/syndromes.shtml

Pollination Syndrome Memory!

Draw the favorite flower for each pollinator group in its space below..
Use the hints to help find the perfect match!



What is Pollination?

Recommended Ages: Grades K-3

Recommended Time: 30-45 minutes

Content Connection:

- Life Science
  - NGSS.LS1.A: Structure and Function (1-LS1-1)
  - NGSS.LS1.B: Growth and Development of Organisms (1-LS1-2) (3-LS1-1)
  - NGSS.LS1.C: Organization for Matter and Energy Flow in Organisms (K-LS1-1)
  - NGSS.LS2.A: Interdependent Relationships in Ecosystems (2-LS2-2)

Objective: Students will role-play the act of pollination and develop a more clear understanding of the relationship between plants and pollinators.

Prior Knowledge:

- Students should possess basic knowledge about pollination and the relationship between plants and animals. However, background knowledge is not necessary and this experience can be used as an introduction to curriculum on pollination.

Pre-Visit:

- If prior knowledge is lacking, complete an introductory lesson before visiting. We recommend the following activities to help model pollination::
  - Pollination – A Sticky Situation! (New Jersey Agricultural Society). http://www.njagsociety.org/uploads/1/7/0/5/17057112/pollination_-_a_sticky_situation_lesson_plan.pdf
  - Cheeto Pollination Experiment (Little Warriors blog) http://littlekinderwarriors.com/2016/04/cheeto-pollination-experiment.html
- And the following YouTube video:
  - “Pollination lesson with stop motion science animation for kids” YouTube video by Science Up with the Singing Zoologist: www.youtube.com/watch?v=zy3r1zlC_IU.

What to do in the Exhibit:

Introduction:

- Explain to students that today they are going to act out pollination by becoming different pollinators and collecting nectar and pollen.

Preparation:

- Divide students into partners or small groups of up to 4 students, preferably with a chaperone or adult supervisor in charge of each group.
- Show groups an example of a magnet piece from the Maze Flower Quest magnet board. Explain to students that they will each receive a piece and then go off into the mission maze to try to find the matching flower and symbol. Their task is to remember how many flowers they had to visit before finding the correct symbol.

While Exploring:

- Allow student groups to select a pollinator from the Maze Flower Quest magnet board and take the pollinator to the environment to find its favorite flowers. Then using the tools hanging from the flowers, insert these “mouthparts” into the flowers to simulate the process of pollination.
- Students should make note of how many flowers they had to visit before finding the correct symbol.
- After students have finished one round, debrief the activity.

Debrief:

- Ask students to share how many flowers they had to visit before finding the right symbol.
- Explain to students that in real life, pollinators visit many flowers in order to find plenty of food, too. This is actually a good thing! For pollination to happen, pollinators have to move pollen from one flower to another, so the more flowers they visit, the more pollen gets moved and the more new flowers will be made!
- Then ask students to reflect on and respond to that explanation. What does this mean for the likelihood of pollination of their flowers? If they had to visit lots of flowers before finding the right symbol, they made it more likely that the flowers will be pollinated!
- Based on their answers, ask students if they were effective pollinators.
- After debriefing, and if time allows, let students complete more rounds of exploration with different pollinators from the Maze Flower Quest.

Post Visit:

- As a summative evaluation, have students draw the pollination relationship between plant and animal and write a sentence or short paragraph describing the relationship.

Super Power Adaptations

Recommended Ages: Grades 3-6

Recommended Time: 45-60 minutes

Content Connection:

- Life Science
  - NGSS.LS1.A: Structure and Function (3-LS4-2) (4-LS1-1)
  - NGSS.LS4.C: Adaptation (3-LS4-3)

Objective: Students will explore some of the more unique physical adaptations pollinators use to help them find food and serve as a more efficient pollinator.

Prior Knowledge:

- Students should have a basic understanding of what adaptations are and how they help plants and animals survive. However, background knowledge is not necessary and this activity may be used as an introduction to animal adaptation lessons in the classroom. This activity is limited to discussion of physical adaptations only, not behavioral.

Pre-Visit:

- If students do not possess a basic understanding of animal and plant adaptations, prepare them for this visit by completing an activity to develop this knowledge.
- ❖ Watch the **orientation video**, available at the Minotaur Mazes website for *Amazing Pollinators*, with your students so they are prepared to engage fully in this immersive exhibit experience! http://www.minotaurmazes.com/mazedetail.html?maze=26

What to do in the Exhibit

Introduction:

- Gather students around the *Meet the Pollinators* display.
- Instruct students to spend some time reading the Pollinator Powers listed for each pollinator group, or read powers aloud to students.
- After discussing all of the Pollinator Powers, asked students to raise their hands and share what powers stood out and how they think it helps the pollinator survive.
- Ask students to identify whether or not the 8 pollinator types discussed in this exhibit share certain adaptations.
- Remind students that these Pollinator Powers are adaptations that are developed over time to promote species survival and success. The goal of this exhibit visit is to learn about incredible animal adaptations that help them serve as extraordinary pollinators.

Preparation:

- Divide students into partners or small groups. If possible, assign adult chaperones to help supervise each group, or ask adults to split time between groups.
- Each set of students should collect only one Mission Board. Each student can wear a Mission Tracker on their wrist if desired.
- **Re-watch the orientation video** and practice moving beads on the Mission Boards.

While Exploring:

- Assign each group of students a mission from the following list. These missions highlight pollinators with incredible adaptations. Students should complete a mission, then return and report what super power the pollinator uses to help them pollinate in order to be assigned an additional mission.
    - Bat Mission #2 - Leaf-nosed Bat uses many super senses including seeing in ultraviolet and echolocation
    - Bee Mission #5 - Bumble Bee and electromagnetic sensing
    - Butterfly Mission #5 - Green Hairstreak using UV light detection
    - Fly Mission #4 - Green Bottle Fly and super smell
    - Moth Mission #4 - White Plume Moth and smell detecting feathery antennae
    - Wasp Mission #5 - Yellowjacket and social activity
- Remind students to read all the information on the mission card and mission station wall to learn more about each pollinator.

Debrief:

- At the end of the visit, gather the students together to discuss the results of the missions. Ask students to recall what super powers were used by each pollinator and how that adaptation helped the animal find food and survive.

Post Visit:

- Ask students to recall one of the missions completed in the exhibition. Students should either draw, write about, or create a model that explains the incredible adaptation used by their pollinator.

Pollinator Friendly Gardening (3rd-6th)

Recommended Ages: Grades 3-6

Recommended Time: 45-60 minutes

Content Connection:

- Life Science
    - NGSS.LS4.D: Biodiversity and Humans (3-LS4-4)
- Math (through post-visit classroom activity)
    - CCSS.Math.Content.3.MD.D.8 - Represent and interpret data

Objective: Students will explore the exhibit to visit flowers commonly planted in pollinator gardens. Then students can use this knowledge to help graph a pollinator friendly garden.

Prior Knowledge:

- Students should possess a basic knowledge of the process of pollination and relationship between plants and pollinators.

Pre-Visit:

- Review prior knowledge to get the most out of this exhibit experience.
- ❖ Watch the **orientation video**, available at the Minotaur Mazes website for *Amazing Pollinators*, with your students so they are prepared to engage fully in this immersive exhibit experience! http://www.minotaurmazes.com/mazedetail.html?maze=26

What to do in the Exhibit:

Introduction:

- Gather students around the outside of the exhibition and explain that the goal of the day is to think about plant-pollinator relationships. After visiting the exhibit, students will be tasked with designing a pollinator-friendly garden.

Preparation:

- Divide the class into partners or small groups. Each group should take one Mission Board, but each student can wear a wrist tracker if desired. Adults should accompany younger students.
- **Re-watch the orientation video** and have groups practice moving their beads.

While Exploring:

- Assign each group a mission set listed below. Students can start with any mission listed. The lists include flowers that are frequently planted in gardens across North America and are excellent attractors of pollinators.

- *Mission Set #1*
  - Bee Mission #1 - Hibiscus Bee, Rosemallow, Garden
  - Beetle Mission #4 - Blister Beetle, Aster, Garden
  - Fly Mission #2 - Elephant Mosquito, Yarrow, Meadow
  - Wasp Mission #5 - Yellowjacket, Common Sunflower, Roadside
- *Mission Set # 2*
  - Beetle Mission #1 - Ornate Checkered Beetle, Blanket Flower, Roadside
  - Beetle Mission #5 - Soldier Beetle, Goldenrod, Garden
  - Beetle Mission #6 - Longhorned Beetle, Mexican Sunflower, Garden
  - Butterfly Mission #4 - Sulphur, Yarrow, Meadow
- *Mission Set #3*
  - Bee Mission #5 - Bumble Bee, Petunia, Roadside
  - Butterfly Mission #5 - Green Hairstreak, Silverweed, Meadow
  - Butterfly Mission #1 - Common Buckeye, Lantana, Garden
  - Moth Mission #5 - Wasp Moth, Phlox, Garden

Debrief:

- After completing the missions, gather students together and ask students to share if they noticed any familiar flowers in the exhibition. If students have gardens at home or in their neighborhoods, they might indicate these kinds of flowers.

Post Visit:

- As a summative evaluation, students can design a pollinator garden that includes many different types of flowers. Younger students may simply draw in flowers on a map, older students may use graph paper to chart out the area required for plants.
- 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 they may 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:
  - What are the types of pollinators?
  - What types of flowers does each type of pollinator prefer?
  - Do these pollinators need different types of plants at different life stages?
  - When do each plant's flowers bloom?
  - How long does each type of flower bloom?
  - How much sunlight does each flowering plant need to grow?
- 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. Students may complete the design in class or as homework.

Activity Resources:

- *Design a Garden* activity guide

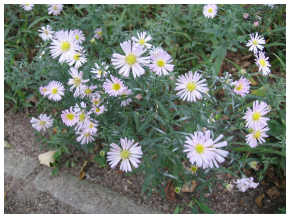
Design a Garden

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
Bluebells 	Bumble Bees, Butterflies	Mid-April through Late-May	6” apart	Partial shade
Phlox 	Butterflies, Moths	April through June	18” apart	Full sun to partial shade
Penstemon 	Bees, Hummingbirds	May through June	24” apart	Full sun to partial shade
Petunia 	Bumble Bees, Butterflies, Hummingbirds	Late-May through August	12” apart	Full sun

Milkweed 	Butterflies, Moths,	June through August	18” apart	Full sun
Blanketflower 	Bumble Bees, Bees, Flies, Wasps, Butterflies	June-September	18" apart	Full sun
Tickseed 	Beetles, Solitary Bees	June through September	24” apart	Full sun
Yarrow 	Beetles, Flies	June through September	18” apart	Full sun to partial shade
Bee Balm 	Bees, Bumble Bees, Butterflies, Moths, Hummingbirds	July through September	18” apart	Full sun

Aster 	Beetles, Flies, Bees	August-October	24” apart	Full sun to partial shade
Goldenrod 	Beetles, Bees, Flies	August through October	36” apart	Full sun

Garden Summary:

My garden will be...

_____ feet by _____ feet, or _____ feet square

In my garden, I will plant...

_____

_____

_____

And will attract...

_____

_____

_____

The first flower to bloom will be _____ (flower) in _____ (month)

The last flower to bloom will be _____ (flower) in _____ (month)

Flower Structure & Plant Reproduction

Recommended Age: Grades 3-8

Recommended Time: 45-60 minutes

Content Connection:

- Life Science
    - NGSS.LS1.A: Structure and Function (4-LS1-1)
    - NGSS.LS1.B: Growth and Development of Organisms (3-LS1-1) (MS-LS1-4)

Objective: Students will use the *Amazing Pollinators* exhibit to enhance understanding of flower anatomy and the function of pollinators in dispersing pollen among flowers.

Prior Knowledge:

- Students should possess a basic understanding of pollination and flower anatomy.
- Key vocabulary includes stigma, style, pistil, stamen, anther, pollen, ovule, and ovary.

Pre-Visit:

- If students do not possess prior knowledge, complete a lesson on flower anatomy and the mechanics of pollination.
- We recommend the lesson “Understanding Flower Structure & Plant Reproduction,” provided in the NAPPC (North American Pollinator Protection Campaign) curriculum. https://www.pollinator.org/pollinator.org/assets/generalFiles/curriculum.pdf
- ❖ Watch the **orientation video**, available at the Minotaur Mazes website for *Amazing Pollinators*, with your students so they are prepared to engage fully in this immersive exhibit experience! http://www.minotaurmazes.com/mazedetail.html?maze=26

What to do in the Exhibit:

Introduction:

- Before exploring the exhibit, gather students around the display panel called *Pollination - A Primer* and use the information on the panel to review the pollination process.
- Ask students to raise their hands and describe key terms relating to flower anatomy in their own words, including, stigma, style, pistil, stamen, anther, pollen, ovule, and ovary.
- Ask students to describe the process of pollination in their own words. Help students with key terms and the description of pollination as necessary.

Preparation:

- Divide students into partners or small groups with an adult chaperone, if possible. Instruct each group of students to take one Mission Board. They should take turns carrying this equipment on different missions.

- If students are working in partners or small groups, assign each student a different role, such as board holder, note taker, flower seeker, etc., then trade roles with each mission.
- Students may each wear an arm tracker to log which missions they have completed.
- **Re-watch the orientation video** and practice moving beads on the Mission Boards.

While exploring:

- Assign each group 3-4 missions from the following list. Depending on the amount of time available and ability level of students, be ready to assign additional missions to students who complete their set. These missions visit flowers with easy to identify flower parts.
    - Bat Mission #1 - Mexican Long-tongued Bat and Moonflower
    - Bee Mission #1 - Hibiscus Bee and Rosemallow
    - Bee Mission #5 - Bumble Bee and Petunia
    - Beetle Mission #2 - Tumbling Flower Beetle and Mountain Laurel
    - Butterfly Mission #3 - Longwing Butterfly and Squash
    - Butterfly Mission #5 - Green Hairstreak and Silverweed
    - Fly Mission #3 - Tachinid Fly and Flowering Dogwood
    - Moth Mission #1 - Morgan's Sphinx Moth and Darwin's Orchid
- Ask students to pay attention to the shape and anatomy of each flower they are pollinating and identify the basic anatomy of the flower. (If desired, provide students with a plant anatomy diagram and the record keeping sheet *Taking a Closer Look,* to make a note of the flowers they visited and characteristics of the different flower parts like how many petals, color, number of stamens, etc.)

Debrief:

- At the culmination of the visit, gather students together and review the findings and characteristics of each flower visited during the missions.
- Ask each student to think about one of the flowers they observed during their field trip, and what special characteristics it displayed.
- Then ask students to raise their hands and share how they think those characteristics contribute to its ability to be pollinated and reproduce.

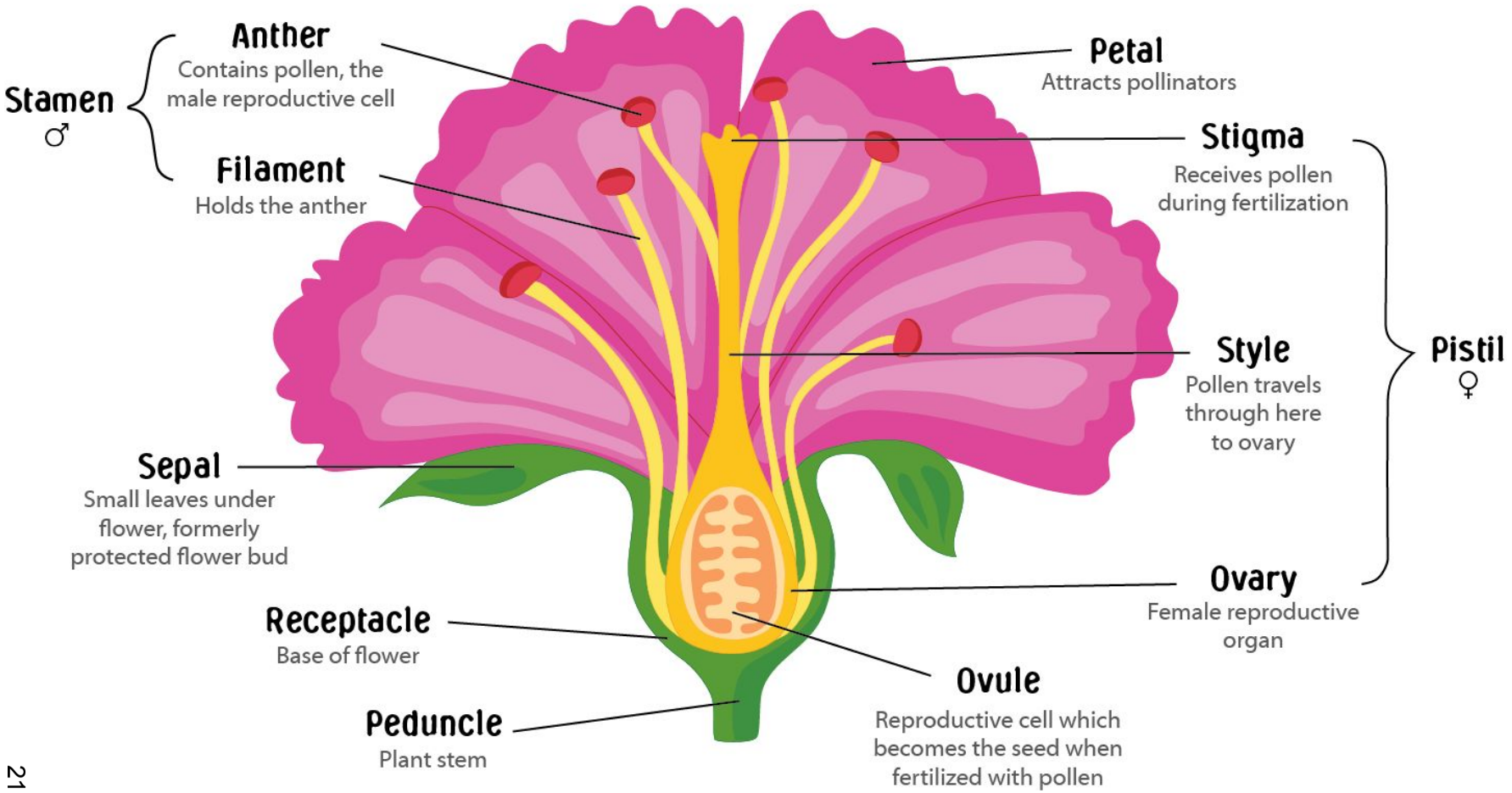
Post Visit:

- When you return to the classroom, as a summative evaluation for this experience, ask students to draw and label the parts of a flower, and describe, either verbally or in writing, the role of each part in the pollination process.

Exhibit Activity Resources:

- *Anatomy of a Flower* diagram - Can be used as a reference in the classroom prior to visiting the exhibit to help students develop important background knowledge
- *Anatomy of a Flower* worksheet - Can be used as diagnostic or summative evaluation tool to assess student understanding of the parts of a flower and their role in pollination
- *Taking a Closer Look* worksheet - Students may use this during their field trip to make a note of the flowers they visited and important characteristics.

Anatomy of a Flower



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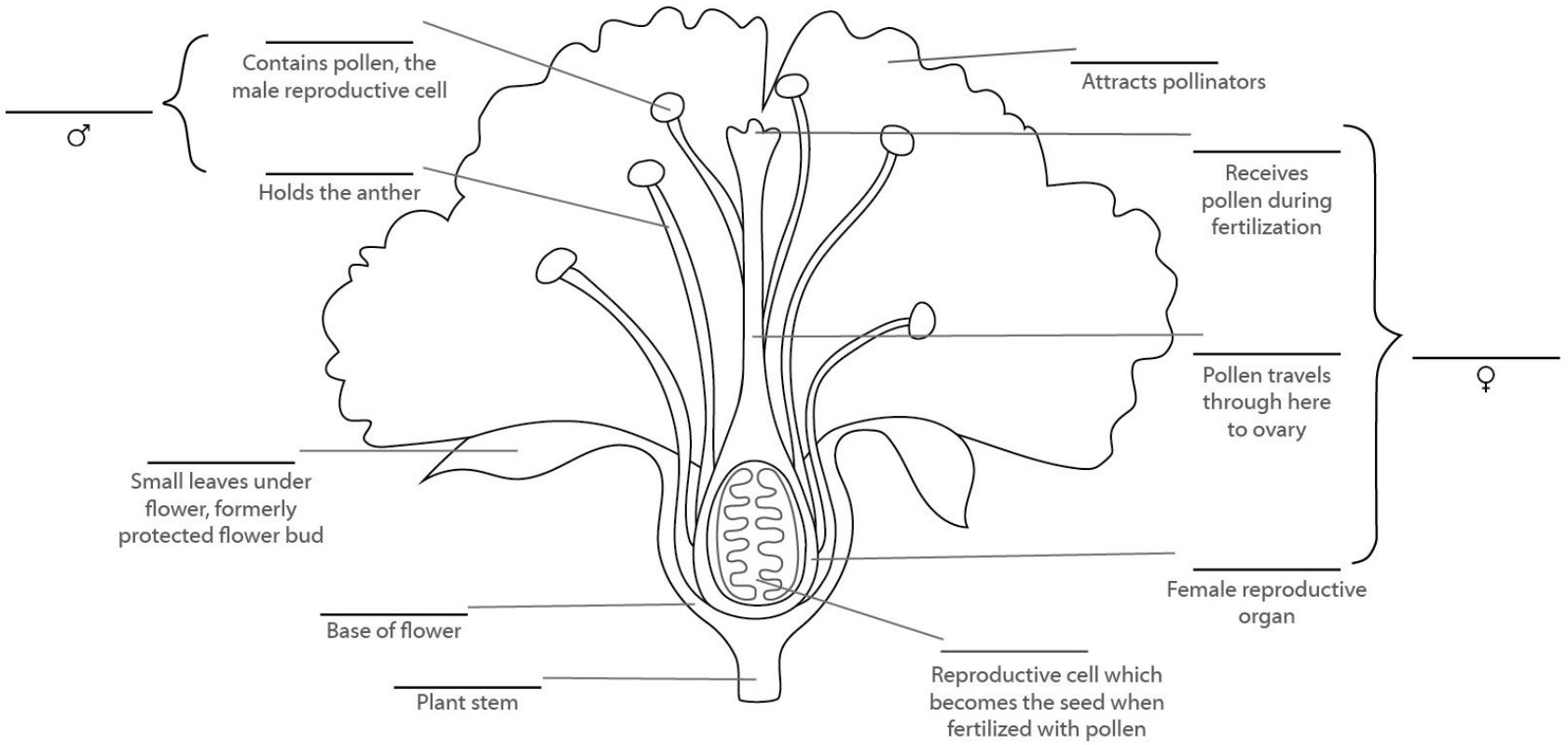
Anatomy of a Flower

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:

_____
_____
_____

Petals:

_____
_____
_____

Stamens (Anther & Filament):

_____
_____
_____

Pistil (Stigma, Style, & Ovary):

_____
_____
_____

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

_____
_____
_____

Mimicry & Trickery

Recommended Ages: Grades 3-10

Recommended Time: 45-60 minutes

Content Connection:

- Life Science
  - NGSS.LS1.A: Structure and Function (4-LS1-1)
  - NGSS.LS1.B: Growth and Development of Organisms (MS-LS1-4)
  - NGSS.LS4.C: Adaptation (3-LS4-3) (MS-LS4-6) (HS-LS4-2)

Objective: Students will strengthen their understanding of the importance of physical adaptations, specifically mimicry, as a survival strategy for animals.

Prior Knowledge:

- Students should have a basic understanding of what adaptations, specifically physical adaptations, are and how they help plants and animals survive.
- Key vocabulary includes adaptation, camouflage, and mimicry. Students are more likely to be familiar with camouflage, but mimicry is a more specialized form of camouflage.

Pre-Visit:

- If students do not possess a basic understanding of animal and plant adaptations, prepare them for this visit by completing an activity to develop this knowledge. Students will develop a more clear understanding of mimicry after visiting this exhibition.
- ❖ Watch the **orientation video**, available at the Minotaur Mazes website for *Amazing Pollinators*, with your students so they are prepared to engage fully in this immersive exhibit experience! http://www.minotaurmazes.com/mazedetail.html?maze=26

What to do in the Exhibit

Introduction:

- Gather students together outside of the Pollinator Maze area. Ask students to make a note of how many different types of environments are visible: Garden, Meadow, Temperate Forest, Roadside, Farm, Orchard, and Rainforest. Explain that plants and pollinators live around the world in these environments and have special physical adaptations that help them survive there.
- Explain to students that the goal of visiting this exhibit is to learn specifically about the adaptation of mimicry and how it helps plants and animals survive. Mimics are everywhere among pollinators!

Preparation:

- Divide students into partners or small groups. If possible, assign adult chaperones to elementary aged students.
- Each set of students should collect only one Mission Board. Each student can wear a Mission Tracker on their wrist if desired.
- Ask all students to **re-watch the orientation video** and practice moving the beads on their Mission Boards accordingly.

While Exploring:

- Assign each group of students a mission from the following list. These missions highlight pollinators or plants that use mimicry to enhance their likelihood of survival. Depending on time available and student ability, be ready to assign additional missions.
    - Beetle Mission #6 - Longhorned Beetle, exhibits mimicry of wasps, ants, and other beetles to appear more threatening
    - Butterfly Mission #1 - Common Buckeye, exhibits auto-mimicry through the use of eyespots to mimic owls
    - Butterfly Mission #6 - Monarch butterfly, exhibits warning colors and is mimicked by Viceroy butterflies
    - Fly Mission #6 - Hover Fly, exhibits mimicry of bees
    - Moth Mission #5 - Wasp Moth, exhibits mimicry of wasps
    - Wasp Mission #2 - Scoliid Wasp is tricked into pollinating flowers that look like female wasps
- While exploring, students should pay close attention to the appearance of plants and pollinators, and read all the information on the Mission Card and Mission Station wall to learn more about each pollinator.
- Ask students to try and come up with their own definition of mimicry while exploring.

Debrief:

- When students have completed their missions, gather them together to discuss the mimicry displayed by the plant or pollinator in each mission, including what each is mimicking and how it helps with the likelihood of survival for each organism.
- Based on what students observed while completing their missions, ask them to share aloud their own definitions of mimicry.

Post Visit:

- Print the photos provided in the Look Alikes resources shared below and ask students to note any differences they see. Reveal the mimic and its dangerous model species to the students. Then let each student choose from the look alikes and describe the relationship based on their understanding of mimicry as a survival mechanism.

Activity Resources:

- *Look Alikes* - photo resources

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)

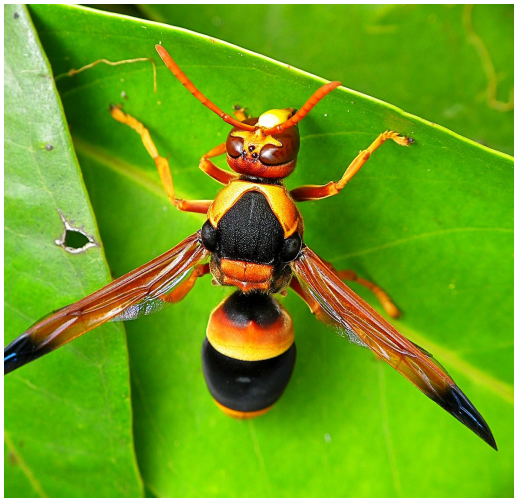
King Snake (non-venomous)

Coral Snake (venomous)

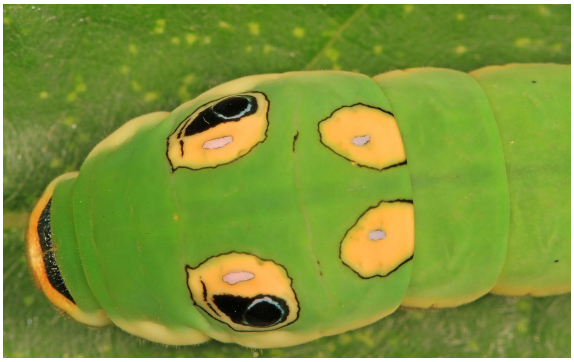
Longhorned Beetle (non-threatening)

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)

Mutualism Mouthparts

Recommended Ages: Grades 3-12

Recommend Time: 60 minutes

Content Connection:

- Life Science
  - NGSS.LS1.A: Structure and Function (4-LS1-1)
  - NGSS.LS4.B: Natural Selection (3-LS4-2) (MS-LS4-4) (HS-LS4-4)
  - NGSS.LS4.C: Adaptation (3-LS4-3)

Objective: Students will learn about physical adaptations that help pollinators gather food by studying analogous models. Then they will apply their knowledge to help them play an interactive role-play game that mimics pollinator food gathering behavior.

Prior Knowledge:

- Students should have a basic understanding of animal adaptations and their role in survival, and reproduction. This can also be used as an introduction to adaptations for younger students. This activity is limited to physical, not behavioral, adaptations.

Pre-Visit:

- Spend time reviewing the concept of physical animal adaptations.
- ❖ Watch the **orientation video**, available at the Minotaur Mazes website for *Amazing Pollinators*, with your students so they are prepared to engage fully in this immersive exhibit experience! http://www.minotaurmazes.com/mazedetail.html?maze=26

What to do in the Exhibit:

Introduction:

- Gather students around the *Meet the Pollinators* display. Divide students into 8 small groups of 3-4 students to rotate through each station pollinator display.
- As students look at and read about the mouthparts and the tools used to represent them.
- After all students have had a chance to visit each pollinator mouthpart station, ask them to consider as a group how each mouthpart tool functions to collect nectar and pollen.
- Remind students that the goal of this visit is to better understand animal adaptations, particularly mouthpart structure, and how these function to help them, and the plants they pollinate, survive.

Preparation:

- Divide students into partners or small groups. For elementary students, assign adult chaperones to help supervise each group, or ask adults to split time between groups.

- Each set of students should collect only one Mission Board. Each student can wear a Mission Tracker on their wrist if desired.
- **Re-watch orientation video** and practice moving Mission Board beads accordingly.

While exploring:

- Assign each group a set of 3 missions as indicated below. Each set includes 3 types of pollinators with different types of mouthpart tools. If groups may start with any mission from the set.
    - *Mission Set 1*
        - Bat Mission #3 - Tube-lipped Nectar Bat and Long Necked Bell Flower
        - Bee Mission #1 - Hibiscus Bee and Rosemallow
        - Beetle Mission #1 - Ornate Checkered Beetle and Blanket Flower
    - *Mission Set 2*
        - Bee Mission #3 - Chilean Desert Bee and Crinklemat
        - Beetle Mission #4 - Blister Beetle and Aster
        - Bird Mission #1 - Blue-faced Honeyeater and Australian Honeysuckle
    - *Mission Set 3*
        - Butterfly Mission #1 - Common Buckeye and Lantana
        - Fly Mission #1 - Housefly and Carrot
        - Moth Mission #1 - Morgan's Sphinx Moth and Darwin's Orchid

Debrief:

- After students have completed their mission sets, ask them to describe how each tool used in this exhibit models real life. How does each function to collect nectar and pollen.
- Ask students to reflect on the three types of mouthpart tools they used and whether or not the mouthparts would have worked on flowers other than the ones they visited. For example, would a beetle's mouthpart (plier-like pullers) work to get nectar or pollen out of a flower that was more commonly visited by a butterfly (using a long tongue).
- Ask students to determine if there was a type of mouthpart they think would be the most effective at getting nectar in this exhibit. In this case, the regular length tongue is best.
- Explain that there are generalist and specialist pollinators. Generalists are able to visit a wide variety of flowers, while specialists are best suited for one or only a few types.
- Ask students to think about the missions they completed and whether or not some were generalists or specialists.

Post Visit:

- To demonstrate understanding of mouthpart tools, mutualism, generalist and specialist pollinators, have students complete the *Design a Pollinator* activity provided in the resources here. Final products can be drawn, sculpted, or written.

Activity Resources:

- *Design a Pollinator* activity guide

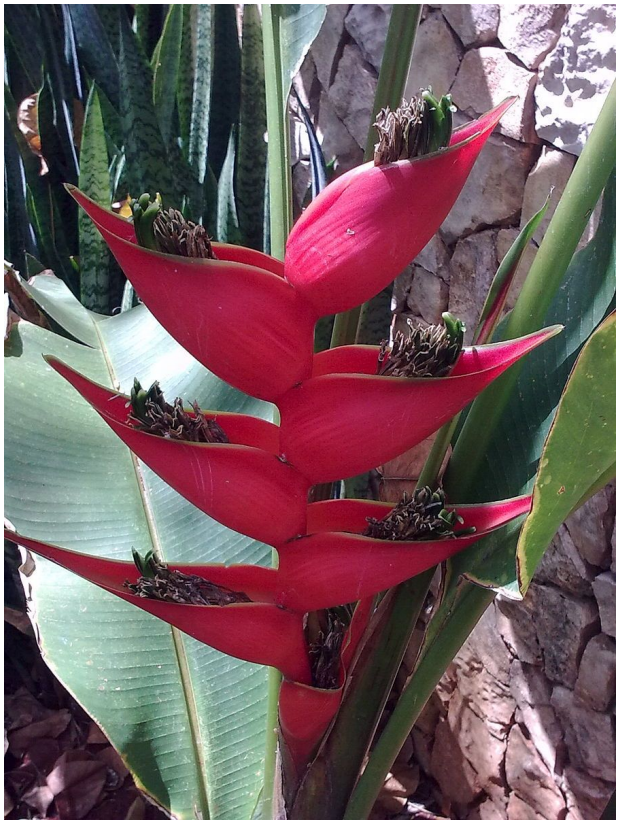
Design a Pollinator

Nectar is the sweet reward that attracts pollinators to a plant. It is typically stored at the base of the flower where it connects to the stem. There are lots of unique flower shapes out there, and each one needs to get pollinated!

What to do: 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, mandibles, 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*)

Animal Migration

Recommended Ages: Grades 3-12

Recommended Time: 45-60 minutes

Content Connection:

- Life Science
    - NGSS.LS1.B: Growth and Development of Organisms (MS-LS1-4)
    - NGSS.LS4.C: Adaptation (3-LS4-3) (HS-LS4-4)

Objective: Students will simulate annual migrations for a variety of pollinators, thereby strengthening their understanding the importance of this behavioral adaptation for survival.

Prior Knowledge:

- Students should be familiar with the difference between physical and behavioral adaptations. Migration is a behavioral adaptation for seasonal survival. This lesson may be used as an introduction to behavioral adaptations.

Pre-Visit:

- If desired, complete a preparatory lesson related to animal migration. There are several great resources related to Monarch Butterfly migration. We recommend “Monarch Migration Game” from the Flight of the Butterflies Educator guide created by Science World at TELUS World of Science https://www.scienceworld.ca/sites/default/files/FlightoftheButterflies_tg_0.pdf
- ❖ Watch the **orientation video**, available at the Minotaur Mazes website for *Amazing Pollinators*, with your students so they are prepared to engage fully in this immersive exhibit experience! http://www.minotaurmazes.com/mazedetail.html?maze=26

What to do in the Exhibit:

Introduction:

- Gather students together outside of the Pollinator Maze area. Ask students to make a note of how many different types of environments are visible: Garden, Meadow, Temperate Forest, Roadside, Farm, Orchard, and Rainforest.
- Explain that pollinators have physical adaptations that make them well suited for survival in their environments, many pollinators migrate through several of these environments throughout the year to find sufficient food, overwintering sites, and breeding grounds.
- Migration is a behavioral adaptation that promotes animal survival and reproduction.
- Tell students that the goal of this visit is to learn about a few different pollinator migrations through this immersive role-play exhibit.

Preparation:

- Divide the class into partners or small groups. *Note:* Older students may complete these missions individually or in partners. Younger students may complete these missions in small groups with assistance from an adult chaperone.
- Each group should take one Mission Board, but each student may wear a wrist tracker.
- **Re-watch the orientation video** and practice using the Mission Board beads correctly.

While Exploring:

- Assign each group a mission listed below. Because Migration Missions are more involved and generally involve visiting multiple flowers, assign each group one Migration Mission. If time allows, they may complete multiple missions. Migration Missions include:
    - Butterfly Mission #6 - Monarch Butterfly
    - Bee Mission #6 - Honey Bee
    - Bird Mission #6 - Ruby-throated Hummingbird
    - Moth Mission #6 - Blackwitch Moth
- While completing missions, students can consider potential threats faced by pollinators as they migrate.
- If time allows, instruct students to the Parlor Games to play a game of Connect 8. For larger classes, rotate smaller groups through the Parlor Games to help with student flow.
- Connect 8 is relevant to migration because it challenges players to create connected natural habitat before habitat loss and unnatural developments displace pollinators and disconnect migration pathways.
- While playing Connect 8 ask students to make notes about the types of landscapes that might pose hazards to pollinator migration and those that are beneficial.

Debrief:

- Gather students together and ask them to reflect on their experience.
    - How challenging were the missions? Why?
    - What specific challenges were faced by each type of pollinator?
    - How could connected corridors help migrating pollinators? (if students played Connect 8)

Post Visit:

- Ask students to think about what they could do at home or at school to support migratory pollinators. As a class, develop an action play and, if possible, work to install a pollinator friendly garden to act as a way-station for migrating pollinators.

Pollinator Threats

Recommended Ages: 5th-12th

Recommended Time: 60 minutes

Content Connection:

- Life Science
  - NGSS.LS4.D: Biodiversity and Humans (HS-LS4-6)
- Earth & Space Science
  - NGSS.ESS3.A: Natural Resources (HS-ESS3-1)
  - NGSS.ESS3.C: Human Impacts on Earth Systems (5-ESS3-1) (MS-ESS3-3) (HS-ESS3-3)

Objective: Students will role-play as threatened or endangered species to learn more about their importance as pollinators. Students will also play games that model complex ecosystems and how natural and human-made disturbances can change them.

Prior Knowledge:

- A basic understanding of pollination as the cause of plant reproduction is important but not necessary for a meaningful exhibit visit.

Pre-Visit:

- ❖ Watch the **orientation video**, available at the Minotaur Mazes website for *Amazing Pollinators*, with your students so they are prepared to engage fully in this immersive exhibit experience! http://www.minotaurmazes.com/mazedetail.html?maze=26

What to do in the Exhibit:

Introduction:

- Gather students around the display panel labeled “Why Pollinators are Important.” Read the facts aloud to the students and ask them whether they agree or disagree with the header on the panel.
- Explain to students that not only do we rely on pollinators for food, but they also produce products that become animal forage and building and home materials. However, many pollinators are threatened. The goal of this exhibit experience is to learn more about some threatened pollinators and the plants that are at risk as a result.

Preparation:

- Divide the class into partners or small groups. Each group should take one Mission Board, but each student can wear a wrist tracker if desired.
- **Re-watch the orientation video** and have groups practice moving their beads.

While Exploring:

- Assign each group 2-3 missions from the list below. This list of missions includes pollinators that are threatened or endangered due to habitat loss and disease.
    - Bat Mission #1 - Mexican Long-tongued Bat
    - Bat Mission #2 - Leaf-nosed Bat
    - Bat Mission #3 - Tube-lipped Nectar Bat
    - Bat Mission #5 - Lesser Long-nosed Bat
    - Bat Mission #6 - Mexican Long-nosed Bat
    - Bee Mission #5 - Bumble Bee
    - Bee Mission #6 - Honey Bee
    - Butterfly Mission #2 - Marsh Fritillary
    - Butterfly Mission #5 - Green Hairstreak
    - Butterfly Mission #6 - Monarch Butterfly
- Remind students to read information on the Mission Cards, Mission Station walls, and around the gallery to learn specific information about each pollinator.
- After students have completed their missions, direct them to the Parlor Games area. Here they will play games to help them understand the delicate balance of life on Earth. Instructions and descriptions are located near each game.
    - Connect 8 - A twist on the game Connect 4, this game asks players to compete to create connected habitat for plants and pollinators.
    - Balance Tower - This version of Jenga asks players to move specific pieces based on the results from a spinning wheel. Students will learn about different factors that affect the delicate balance of ecosystems.
    - Invasive Species Shuffleboard - Play as Native or Invasive species. Instructions include descriptions of native-invasive relationships and how one is competing with the other.

Debrief:

- Gather students around the FAQ panel to debrief the visit. Ask students about any initial reactions to completing the missions.
- Several of these missions included “Threats”. Ask students to reflect on what threats these pollinators faced in the game and how that relates to real life?
- As a group review ways to help pollinators listed on the FAQ panel, “How Can I Help?”

Post Visit:

- As a summative evaluation for this experience, students can conduct a brief research project on a threatened pollinator species discussed in *Amazing Pollinators*. They should write a 1-2 page paper including its life cycle, habitat, threats, and current mitigation measures that are being taken to help protect the animal. If no measures are being taken, students should make suggestions.

Parlor Games

Recommended Age: Grades 5th-12th

- ❖ Note that this experience is best for groups of 24 students or less due to space limitations in the Parlor Games area.

Recommended Time: 45 minutes

Content Connection:

- Life Science
  - NGSS.LS4.D: Biodiversity and Humans (HS-LS4-6) (HS-LS2-7)
- Earth & Space Science
  - NGSS.ESS3.A: Natural Resources (HS-ESS3-1)
  - NGSS.ESS3.C: Human Impacts on Earth Systems (5-ESS3-1) (MS-ESS3-3) (MS-ESS3-4) (HS-ESS3-3)

Objective: Students will play a variety of games that use analogies to help them understand complex ecosystem dynamics, as well as the impact of natural and human-made disturbances on ecosystem stability and pollinator health.

Prior Knowledge:

- No background knowledge is necessary for this experience.

Pre-Visit:

- No set up is necessary for this exhibit experience. However, if you would like your students to have the opportunity to participate in the missions in the Pollinator Maze, please watch **orientation video**, available at the Minotaur Mazes website for *Amazing Pollinators*, with your students so they are prepared to engage fully in this immersive exhibit experience! http://www.minotaurmazes.com/mazedetail.html?maze=26

What to do in the Exhibit

Introduction:

- Gather students in the Parlor Games area of the exhibition.
- Explain to students that this area of the exhibition is packed with games that they'll be expected to play to help them understand interactions between plants and pollinators, pollinators and pollinators, and humans and pollinators.

Preparation:

- If the group is large, divide students into groups of 4 and assign them to a game. The students will then be able to divide into partners or play individually at each game center.

- If the group is small, students may be able to play individually.
- Game instructions and descriptions are located near each game.
    - Connect 8 - A twist on the game Connect 4, this game asks players to compete to create connected habitat for plants and pollinators. 4 students can play this game, 2 vs. 2.
    - Balance Tower - This version of Jenga asks players to move specific pieces based on the results from a spinning wheel. Students will learn about different factors that affect the delicate balance of ecosystems. 4 students can play this game at the same time, as individuals.
    - Invasive Species Shuffleboard - Play as Native or Invasive species. Instructions include descriptions of native-invasive relationships and how one is competing with the other. 4 students can play this game, 2 vs. 2.
    - Nest Quest Mancala - Mason Bees are solitary insects and can compete with each other for food and nest sites. 4 students can play this game, 2 vs. 2.
    - Mutualism Dominoes - This version of Dominoes has players make connections between pollinators and the plants they pollinate in this exhibit. 4 students can play this game, 2 vs. 2
    - Pollination Toss - This bean bag toss simulates the process of cross-pollination. Students play as a pollinator delivering pollen to the correct matching flower.

While Exploring:

- Students should make a mental note about the relationships highlighted in each game.

Debrief:

- When students have had a chance to play all of the games, discuss what they learned at each station. Questions to ask during debrief could include:
    - What can disconnect habitat? (Relating to Connect 8)
    - What natural threats can affect pollinators? (Relating to Balance Tower)
    - How can an invasive plant affect a pollinator? (Relating to Invasive Species Shuffle Board)
    - How can native pollinators compete with each other? (Relating to Nest Quest)
    - What was a surprising plant-pollinator pairing? (Relating to Mutualism Dominoes)
    - How does cross-pollination work? (Relation to Pollination Toss)
- After students have had a chance to play all of the games and debriefed the experience, let them explore in the Pollinator Maze and try taking on missions.

Post Visit:

- As an evaluation tool, students can recreate versions of the Parlor Games to play with others. If possible, partner with a younger class and let students use their homemade models to re-teach some of these concepts to younger students.

Pollination Syndromes (6th-8th)

Recommended Ages: Grades 6th-8th

Recommended Time: 45-60 minutes

Content Connection:

- Life Science
    - NGSS.LS2.A: Interdependent Relationships in Ecosystems (MS-LS2-1) (MS-LS2-2)

Objective: Students will develop an enhanced understanding the interdependence of plants and pollinators by participating in a role-play game that mimics their unique relationships.

Prior Knowledge:

- Students should have a basic understanding of the purpose and importance of pollination and its role in the survival of both plants and pollinators.

Pre-Visit:

- If students do not possess prior knowledge, spend some time reviewing pollination and its importance to both plant and pollinator survival.
- ❖ Watch the **orientation video**, available at the Minotaur Mazes website for *Amazing Pollinators*, with your students so they are prepared to engage fully in this immersive exhibit experience! http://www.minotaurmazes.com/mazedetail.html?maze=26

What to do in the Exhibit:

Introduction:

- Gather students outside the exhibition, in a classroom space or on the ground. Show students pictures of 8-10 different flowers.
- Ask students to raise hands and share what their favorite flower is, with supporting reasons. Their rationale may include the size, shape, color, texture, and fragrance.
- 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 mouthpart (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.

- Remind students that the goal of this trip is to try and figure out what types of plants pollinators like the best, and to make some educated guesses about why the pollinators prefer those plants.

Preparation:

- Divide students into partners or small groups. If possible, assign adult chaperones to help supervise younger students.
- Each set of students should collect only one Mission Board, but each student can wear a Mission Tracker on their wrist if desired.
- **Re-watch the orientation video** and practice moving beads on the Mission Boards.

While Exploring:

- Assign each group one of the missions listed below that provide examples of pollinators visiting flowers that meet the criteria of their syndrome. Make sure that each pollinator type is represented as missions are assigned.
    - Bat Mission #5 - Lesser Long-nosed Bat and Saguaro
    - Bird Mission #4 - Costa's Hummingbird and Agave
    - Bee Mission #1 - Hibiscus Bee and Crimson Rosemallow
    - Wasp Mission #5 - Yellowjacket and Sunflower
    - Butterfly Mission #1 - Common Buckeye and Lantana
    - Moth Mission #1 - Morgan's Sphinx Moth and Darwin's Orchid
    - Fly Mission #6 - Hover Fly and Starfish Flower
    - Beetle Mission #3 - Sap Beetle and Lotus
- As students complete their first mission, ask them to make notes of the characteristics of the flower they visit and the type of pollinator they are.

Debrief:

- When students have completed their assigned mission, bring the group back together and discuss the pollinators and characteristics of flowers they visited.
- As a group, create a chart that describes flowers preferred by pollinators. This chart represents what are called "pollination syndromes". Compare the student created chart to a botanist's.
- After creating and reviewing the chart, allow students time to complete more of the missions listed above.

Post Visit:

- As a summative evaluation, ask students to try to draw answers in each square of the Pollination Syndrome BINGO sheet provided here.

Activity Resources:

- Pollination Syndrome Chart
- Pollination Syndrome BINGO sheet

Pollination Syndrome Chart

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
Color	Dull white, green or purple	Bright white, yellow, blue, or UV	Dull, light white, pink, 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
Nectar Guides	Absent	Present	Absent	Absent	Present	Absent	Absent
Odor	Strong musty; emitted at night	Fresh, mild, pleasant	None to strongly fruity or fetid	None	Faint but fresh	Putrid	Strong sweet; emitted at night
Nectar	Abundant; somewhat hidden	Usually present	Sometimes present; not hidden	Ample; deeply hidden	Ample; deeply hidden	Usually absent	Ample; deeply hidden
Pollen	Ample	Limited; often sticky & scented	Ample	Modest in amount	Limited	Modest in amount	Limited
Flower Shape	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).
https://www.fs.fed.us/wildflowers/pollinators/What_is_Pollination/syndromes.shtml

Pollination Syndrome Bingo!

For each pollinator group, find a mission where the pollinator visits a flower that is an example of its pollination syndrome. Draw the flower and write its name in the spaces below.
Use the hints to help find the perfect match!

Bats Pale white or green, strong smelling, bowl-shaped flowers. May be closed during the day. _____	**Bees** Bright white, yellow, blue, fragrant flowers. Shallow or tubular shaped with a good spot to land. _____	**Butterflies** Fragrant and bright colors, like red, pink, and purple. Wide landing pad with a narrow tube to access nectar. _____
Wasps Showy, bright yellow flowers, with lots of pollen and easy to access nectar. _____	**Pick your Favorite!**	**Beetles** Dull, light pink, white or green flowers with easy to access pollen and nectar. _____
Flies Pale and dull to dark brown or purple flowers. Shallow or funnel and trap-like. Putrid smelling. _____	**Moths** Pale and dull red, purple, pink or white, tubular-shaped flowers. Strong sweet smell emitted at night. _____	**Birds** Scarlet, orange, red or white, large funnel-shaped flowers with deeply hidden nectar. Strong support perch. _____

Pollinators Mean Business

Recommended Ages: 6th -12th grades

Recommended Time: 45-60 minutes

Content Connection:

- Life Science
  - NGSS.LS4.D: Biodiversity and Humans (MS-LS2-5) .
- Earth & Space Science
  - NGSS.ESS3.A: Natural Resources (MS-ESS3-1) (HS-ESS3-1)

Objective: Students will explore human dependence on the environment, specifically pollinators, by looking at several important human food sources produced by animal pollination.

Prior Knowledge:

- This activity can serve as an introduction or culmination for classroom lessons on the dependence of human society on the natural environment.

Pre-Visit:

- Watch the **orientation video**, available at the Minotaur Mazes website for *Amazing Pollinators*, with your students so they are prepared to engage fully in this immersive exhibit experience! http://www.minotaurmazes.com/mazedetail.html?maze=26

What to do in the Exhibit:

Introduction:

- When students arrive at the exhibit gallery, gather the group in front of the “Why Pollinators are Important” display. Read the contents of display aloud to the group.
- Ask students to react to the display, especially to the statistic that 1 out of every 3 bites of food consumed is the result of pollination. Do they agree or disagree that pollinators are important? Why?
- Explain to students that the goal of this visit is to use the exhibit to help understand the economic importance of pollinators to humans

Preparation:

- Divide the class into partners or small groups.
- Each group should take one Mission Board, but each student can wear a wrist tracker if desired.
- **Re-watch the orientation video** and have groups practice moving their beads.

While Exploring:

- Assign each group 3-4 missions to complete from the following list. Depending on the time available and the ability of the students to complete missions, be prepared to assign additional mission(s).
- These missions are to be completed in the Orchard, Farm, and Night environments and highlight pollinators that are crucial for food production.
    - Bat Mission #4 - Cave Nectar Bat and Sumatran Wild Bananas
    - Bee Mission #2 - Blueberry Bee and Blueberry Bush
    - Bee Mission #6 - Honey Bee and Almonds, Apples, and Strawberries (this is the most involved and longest of the missions listed here)
    - Butterfly Mission #3 - Longwing Butterfly and Squash
    - Fly Mission #1 - Housefly and Carrot
    - Fly Mission #5 - Midge and Cacao
    - Wasp Mission #4 - Fig Wasp and Fig
    - Wasp Mission #6 - Tiphiid Wasp and Date Palm

Debrief:

- Gather students around the “Why Pollinators are Important” display again to debrief the experience. Ask students to share any learning moments they had while completing missions.
- Have students reflect again on the statement that 1 out of every 3 bites of food requires pollination and discuss any changes in opinion. After completing these missions, do they now feel differently?

Post-Visit:

- To drive home the economic importance of pollinators, students can complete the Chocolate Math activity. This worksheet illustrates the sheer volume of Cacao pods required to produce the chocolate consumed in the world annually, and therefore the importance of Cacao pollinators like the Midge, that are often regarded as pests.

Activity Resources:

- Chocolate Math activity sheet and Answer Key

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 pods x 40 beans = 1,200 beans
2. 1000
3. 2 pounds
4. 40 pounds divided by 2 pounds per cacao tree = 20 trees
5. 1 1⁄2 (1.5) x 10 = 15 Therefore you can make 10 bars per pound
6. 35 pounds x 10 bars per pound = 350 bars