EXHIBIT EXPLORATION GUIDE

GET LOST IN LEARNING
minotaur mazes

Dear Educator,

This activity guide is designed to help facilitate exploration of the *Amazing Pollinators* exhibition in a way that complements classroom curriculum. Activities in this guide are divided into two parts including 1) a pre-exploration engager and 2) suggestions for activities to maximize learning during exhibit exploration.

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

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

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

A note on facilitating your field trip:

Amazing Pollinators is a hands-on, minds-on, immersive experience. For best engagement and enjoyment, **we recommend**:

- Planning these visits to last **45-60 minutes.**
- Preparing students with **expectations** ahead of time.
- Watching the **Orientation Video** before participating in any life chart missions.
- 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 manage materials instead.
- **Debrief the experience** with the suggested discussion questions for each topic.
- 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.

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!
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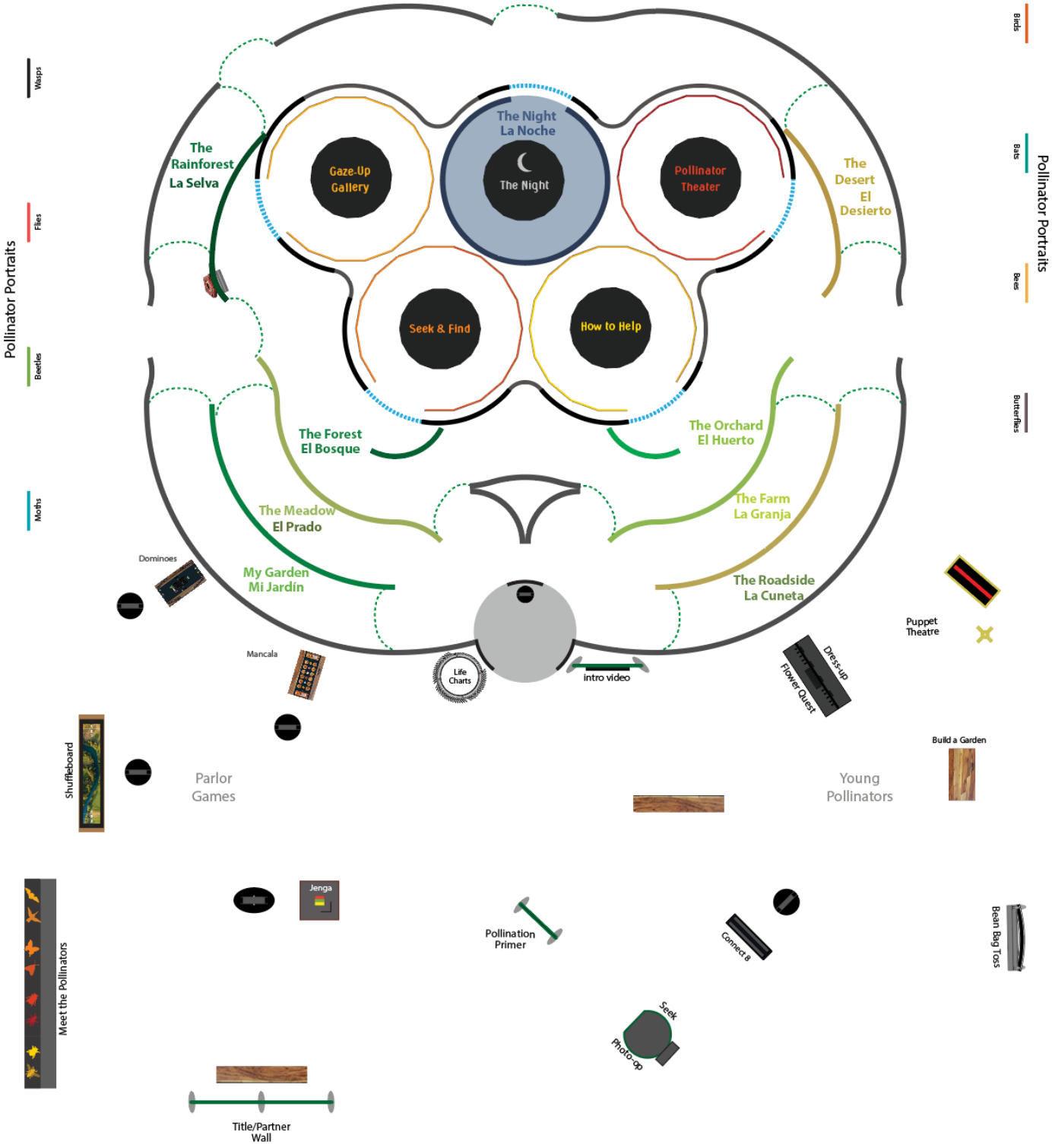
Contents

Amazing Pollinators
Standard Exhibit Layout



Amazing Pollinators

Annotated Exhibit Components

Entrance

- **Title Panel with Sponsor logos**
- **Meet the Pollinators** – Features 8 types of pollinators, a description of the unique adaptations that make them well suited for collecting nectar and moving pollen, and recognizable items that serve as analogies for the structure and function of their mouthparts.
- **Pollinator Portraits** – 8 high resolution photos printed on canvas hang around the perimeter of the gallery.
- **Pollination Primer** – One side of this panel outlines the basic steps of pollination while the other uses statistics and figures to illustrate the importance of pollinators.
- **Life Chart Rack** – Life Charts for 8 pollinator groups each contain sets of 5 missions relating to that pollinator group. Groups include: Bees, Wasps, Bats, Birds, Butterflies, Moths, Flies, and Beetles. Missions send the pollinator into the Mission Maze to find a specific type of flower and collect nectar, pollen or other resources. Some missions require "Migration," or visiting multiple flowers.
- **Orientation Video** – This 2-minute orientation video describes how to use the life chart to participate in game play and should be watched prior to participating in the Life Chart missions.

Mission Maze

- **Environment Panels** – Concentric rings of environments represent some of the diverse global habitats that require pollination. The environments are filled with 180+ interactive flowers and stories. Environments and their flowers are listed below.
    - **My Garden** – Christmas Candlestick, Goldenrod, Crimson-eyed Rosemallow, Lantana, Phlox, Mexican Sunflower
    - **The Meadow** – Beebalm, Mountain Laurel, Australian Honeysuckle, Bluebell, Mirror Orchid, Yarrow, Silverweed
    - **The Forest** – Darwin's Orchid, Trumpet Vine, Dogwood, Tasmanian Blue Gum, Northern Catalpa
    - **The Rainforest** – Corpse Flower, Lotus, Black Mangrove
    - **The Roadside** – Blanket Flower, Tall Thistle, Common Sunflower, Petunia, Beardtongue, Tickseed
    - **The Farm** – Alfalfa, Strawberries, Blueberry, Carrot
    - **The Orchard** – Almond, Fig, Date Palm, Apple, Cacao
    - **The Desert** – Saguaro, Starfish Flower, Yucca, Chuparosa, Crinklemat, Agave
- **The Night Room** – Black-light room with UV flowers for nighttime pollinators. Flowers include: Balsa Tree, Sumatran Wild Banana, Long-necked Bell Flower, Moonflower, Saguaro, Agave, Corpse Flower
- **Gaze-Up Gallery Room** – Lean back, relax, and immerse yourself in pollinator activity as they flutter and flap overhead. An ambient noise soundtrack plays in the background.

- **Seek & Find Room** – A beautiful mural featuring 30 pollinators in an Eastern North America woodland scene. Four mural-based scavenger hunt activities simulate community science observation programs.
- **How to Help Room** – 6 info and activity panels describe ways to help pollinators. 8 info panels share more information about each of the featured pollinator groups
- **Pollinator Theater Room** – This room showcases the 15-minute documentary, Pollinators Under Pressure, providing a multimedia enhancement of key concepts.

- **Parlor Games**
    - **Mason Bee Mancala** – Mason Bees are solitary insects and can compete with each other for food and nest sites. 4 players 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 players can play this game, 2 vs. 2
    - **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 players can play this game, 2 vs. 2.
    - **Connected Corridors (Connect 8)** – A twist on the game Connect 4, this game asks players to compete to create connected habitat for plants and pollinators. 4 players can play this game, 2 vs. 2.
    - **Balance Tower (Jenga)** – 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 players can play this game at the same time, as individuals.
    - **Bean Bag Pollen Toss** – This toss game simulates the process of cross-pollination as players try to deliver pollen (bags) to flowers of the correct matching flower.

- **Young Pollinators**
    - **Flower Quest** – An age-appropriate way for pre-reading age students to engage with the Mission Maze. Visitors use pollinator shaped pieces to help find flowers and collect nectar or pollen.
    - **Dress Up** – Young visitors can really role play the part, with butterfly wings, bug-eyed goggles, antennae, and other pollinator parts. Mix and match costume parts to design your own unique pollinator.
    - **Puppet Theater** – Hand puppets and plush toys can be used to act out scenes of pollination and plant-animal relationships.
    - **Build a Garden** – An open-ended play table with flower pieces of different sizes, shapes and colors lets young visitors create their own pollinator gardens.

Orientation Video

Amazing Pollinators Orientation Video
This 2-minute video should be watched by visiting groups prior to participating in the Life Chart missions.

Transcript

Introduction

- In the Pollinator Maze, you will take on the role of butterflies, wasps, or other pollinators on a Quest for Survival.
- You'll visit flowers, collect nectar and pollen, find insects and mates, and try to survive hidden threats.

How to Play

- First, choose which pollinator you'd to be and take a Life Chart.
- Turn your mission book to card #1.
- Set all your beads to zero.
- Cards tell you all you need to know. Who you are, where to go, what flower you're looking for, and what to do.
- When you reach the environment, and find your target flower, look for mouthpart tools to help you complete your mission.
- Perform your mission.
- Move your beads as you collect nectar, pollen, and other resources.
- After you complete a mission, turn to the next page in your mission book.
- Do not reset your beads.
- Keep count of all the resources you collect as you take on each mission.

Did you survive?

- [Complete all 5 missions and see if you survived.]
- To survive, your beads must all land within the Survival Zone.
- If they did, nice job pollinator! Return your board and play again as another pollinator.
- Didn't survive? Reset your beads and try again.

- Now are you ready?
- Go pollinate!

Pollinator Types and Diversity

Grades: K-HS

Content Connection:
Life Science
NGSS.LS1.A: Structure and Function
NGSS.LS4.C: Adaptation

Objective: Students will explore the *Amazing Pollinators* exhibit to explore the great diversity of animal pollinators.

Materials:
- One of the following books:
  - K-2nd – Meet the Pollinators: A Night and Day Adventure by Barbara Ciletti
  - K-2nd – Protect the Pollinators by Rachael Rose Zoller
  - 3rd-6th – Flower Talk: How Plants Use Color to Communicate by Sara C. Levine, illustrated by Masha D'yans.
  - 3rd-6th – Flowers Are Calling by Rita Gray, illustrated by Kenard Pak
- Unusual Pollinators Card Game (See Corresponding Classroom Activities below)

Key exhibit components:
- Meet the Pollinators station
- K-2nd grade – Flower Quest missions
- 3rd-HS grade – Life Chart missions
- Gaze Up Gallery room

Before exploring:
- K-5th grade – Ask students to think about any flowers they've seen. Have they ever seen any animals visit a flower? Create a list for reference. What was that visitor doing? And why do you think it was doing that? Does the flower need visitors? Why?
  - Read one of the following books:
    - K-2nd – Meet the Pollinators: A Night and Day Adventure
    - K-2nd – Protect the Pollinators
    - 3rd-6th – Flower Talk: How Plants Use Color to Communicate
    - 3rd-6th – Flowers Are Calling
- 6th-12th grade – Play the Unusual Pollinators Card Game (More information in Corresponding Classroom Activities below)

- Reflect on the book or game and ask students to recall what types of pollinators are listed. How does this compare to the list they created earlier. What familiar and unfamiliar pollinators were described?

In the exhibition:

- All students should visit the Meet the Pollinators station to learn about the 8 types of pollinators and the unique adaptations that make them well suited for collecting nectar and moving pollen.
- Divide students into pairs or small groups to explore the Mission Maze using the age-appropriate game. Students should complete as many quests, from as many pollinator groups as time allows.
    - Grades K-2 (pre- or early reading age): Flower Quest
    - Grades 3-12 (reading-age): Life Chart
- As students explore the exhibit, challenge them to find all the groups of pollinators, especially those discussed in the books.

Debrief:

- Following free exploration, debrief the experience with a discussion around the following questions:
    - How many types of pollinators are in the exhibit? (Answer: 8 types)
    - Which group do you think has the most pollinators? (Answer: beetles)
    - Which group has the most effective type of pollinator? (Answer: bees)
    - One type of pollinator that surprised you?
    - Were there any pollinators mentioned in the book but not highlighted in the exhibit, or vice versa?

Corresponding Classroom Activities:

Unusual Pollinators Card Game

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!

Backyard Phenology

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.

What is Pollination?

Grades: K-HS

Content Connection:

Life Science

NGSS.LS1.A: Structure and Function
NGSS.LS1.B: Growth and Development of Organisms
NGSS.LS2.A: Interdependent Relationships in Ecosystems

Objective: Students will review the process of pollination and the different ways that pollination can be achieved. Then, using the *Amazing Pollinators* exhibit, students will simulate the act of pollination by pollinators.

Materials:

- One of the following books:
  - Before the Seed: How Pollen Moves by Susannah Buhrman-Deever, illustrated by Gina Triplett and Matt Curtius
  - What's Inside a Flower by Rachel Ignotofsky

Key exhibit components:

- Pollination Primer
- K-2nd grade – Flower Quest missions
- 3rd-HS grade – Life Chart missions
- Parlor Games: Pollen Toss, Mason Bee Mancala

Before exploring:

- Introduce or reinforce the concept of pollination by reading one of the following books. Reading can also be assigned and shared.
  - K-2nd - Before the Seed
  - 3rd-6th - What's Inside a Flower
- Ask students to summarize the process of pollination. Make sure to highlight how it happens, who (if anyone) does it, and why it is important.

In the Exhibition:

- Gather students near the entrance of the exhibit and review the content of the Pollination Primer panel as a group (text is provided below for reference).
  - Pollination is flower reproduction.
  - The transfer of pollen from a flower's male parts to a flower's female parts produces new plants.

1. What is pollination?
    a. Anther (male flower part) / releases pollen
    b. + Stigma (female flower part) / collects pollen
    c. = New plants and flowers grow
2. How does it happen?
    a. A few flowers pollinate themselves
    b. Some are pollinated by wind or water
    c. All the rest need visits from pollinators
3. Why do pollinators visit flowers?
    a. Food and drink
    b. Finding mates
    c. Nesting and egg laying
4. What happens next?
    a. The pollen fertilizes the eggs in the ovule of the flower
    b. The plant produces seeds
    c. The seeds grow into new plants

- Ask students to compare/contrast this description to that from the book, or other prior knowledge. What would they add or change about either description?
- Divide students into pairs or small groups for Life Chart or Flower Quest missions.
    - Pre-reading age students can find and match flowers and collect nectar or other resources using the Flower Quest tokens.
    - Reading-age students should work through the pollinator Life Charts. Assign groups of students one of the eight types of pollinators to complete.
- After completing a few missions, allow students time to free explore the other areas of the exhibition including the Gaze Up Gallery room and Parlor Games (specifically Pollen Toss, Mason Bee Mancala)

Debrief:

- Following free exploration, debrief the experience by asking the following questions:
    - What flowers need pollinating? Or, What types of environments did the pollinators visit on their missions?
    - Which pollinator species…
        - … were you already familiar with?
        - …. was new to you?
        - … help produce crops?
        - … migrate?
        - … pollinates at night?

Corresponding Classroom Activity:

<u>Let's Pollinate!</u>

In this lesson, students model the process of pollinators transferring pollen using Cheetos (or other powder-coated snack) and bee finger puppets.

Pollination Syndromes

Grades: 3rd-HS

Content Connection:
Life Science
NGSS.LS1.C: Organization for Matter and Energy Flow in Organisms
NGSS.LS2.A: Interdependent Relationships in Ecosystems

Objective: Students will role play as different pollinators to help develop an enhanced understanding of pollination and the unique relationship between plants and their pollinators.

Materials:
- One of the following books:
  - Flower Talk: How Plants Use Color to Communicate by Sara C. Levine and illustrated by Masha D'yans
  - Flowers Are Calling by Rita Gray and illustrated by Kenard Pak
- Sticky notes and a pen (optional)

Key exhibit components:
- K-2nd grade – Flower Quest missions
- 3rd-HS grade – Life Chart missions

Before Exploring:
- Ask students to consider their favorite foods. If they were to go into the kitchen looking for a snack, would they pick a certain food?
- Instead of going to a fridge or a cupboard to grab a snack, pollinators visit flowers to eat nectar, pollen, or sometimes insects. Just like humans have favorite foods, so do animals. A lot of times the flowers that pollinators like best are the ones that are the right size or shape for them.
- Read one of the following books (omit reading for older groups)
  - Flower Talk: How Plants Use Color to Communicate
  - Flowers Are Calling
- After reading, ask students to summarize what flowers are preferred by what types of pollinators. These preferences are known as "syndromes."
- The goal of the day is to learn more about pollinators and what flowers they prefer.

In the Exhibition:

- Divide students into partners or small groups and assign them one of the eight pollinator groups to role play. As students complete their missions, ask them to pay attention to which flowers they visit meet the criteria for their pollination syndrome.
- Missions in which pollinators visit flowers that match their syndrome include:
  - **Bat 1**: Mexican Long-tongued Bat and Moonflower
  - **Bat 2**: Leaf-nosed Bat and Balsa
  - **Bee 1**: Hibiscus Bee and Crimson-eyed Rosemallow
  - **Bee 4**: Bumble Bee and Petunia
  - **Bee 5**: Honey Bee migration
  - **Beetle 4**: Soldier Beetle and Goldenrod
  - **Beetle 5**: Longhorn Beetle and Mexican Sunflower
  - **Bird 1**: Blue-faced Honeyeater and Australian Honeysuckle
  - **Bird 2**: Golden-winged Sunbird and Christmas Candlestick
  - **Bird 3**: Costa's Hummingbird and Agave
  - **Butterfly 1**: Common Buckeye and Lantana
  - **Butterfly 4**: Green Hairstreak and Silverweed
  - **Fly 3**: Green Bottle Fly and Corpse Flower
  - **Fly 5**: Hover Fly and Starfish Flower
  - **Moth 1**: Morgan's Sphinx Moth and Darwin's Orchid
  - **Moth 2**: Geometrid Moth and Northern Catalpa
  - **Moth 3**: Yucca Moth and Yucca
  - **Moth 4**: White Plume Moth and Moonflower
  - **Wasp 4**: Yellowjacket and Sunflower
  - **Wasp 5**: Tiphiid Wasp and Date Palm

Debrief:

- After exploring the exhibition, ask students to reflect on whether or not syndromes are a hard-and-fast rule, or whether they are general guidelines that can be bent.
- Ask students to share any interesting information they gathered about their pollinators as they were playing.

Corresponding Classroom Activity:

Pollination Syndromes

In this lesson, students will use observation skills to complete a matching game that demonstrates an understanding of pollination syndromes.

Flowers: Structure & Function

Grades: 3rd-HS

Content Connection:

Life Science

NGSS.LS1.A: Structure and Function
NGSS.LS1.B: Growth and Development of Organisms

Objective: Students will use the *Amazing Pollinators* exhibit to enhance understanding of the function of flower adaptations within different environments.

Materials:

- What's Inside a Flower by Rachel Ignotofsky
- *Optional:* Before the Seed: How Pollen Moves by Susannah Buhrman-Deever, illustrated by Gina Triplett and Matt Curtius
- Images of flowers with distinct anatomy
- *Taking a Closer Look* worksheet
- Pencils

Key exhibit components:

- Pollination Primer
- 3rd-HS grade – Life Chart missions
- Environment Panels

Before Exploring:

- Introduce flowers and pollination as the big ideas for the day. Explain that flowers can be found on every continent (even Antarctica!), and pollinators are needed in every type of environment. The goal of visiting this exhibition is to learn more about process and importance of pollination.
- For 3rd-5th grade, read - What's Inside a Flower
    - For older students, omit reading if desired
- After reading, ask students to draw or summarize the life cycle of a flower
- Include a discussion about the role of a pollinator in a flower's life cycle
- *Optional:* Provide pairs or small groups of students with photocopied anecdotes of plant-pollinator interactions from Before the Seed book. Ask students to read and share with the class.

- Share images of flowers with obvious male and female parts as well as the environments in which the live. Compare/contrast the flower parts and discuss why they might look the way they do. Flowers with obvious male and female parts include:
    - Mallow family (Malvaceae): Hollyhock, Hibiscus, Rosemallow
    - Buttercup family (Ranunculaceae): Swamp buttercup, Pasque flower, Hepatica
    - Lily family (Liliaceae): Day Lily, Sand Lily, Tiger Lily
    - Nightshade family (Solanaceae): Angel's Trumpet, Okra, Moonflower, Tomato, Eggplant
    - Squash family (Cucurbitaceae): Zucchini, Pumpkin, Cucumber, Melon
    - Asparagus family (Asparagaceae): Yucca, Artichoke, Bluebells
    - Cactuses including: Hedgehog Cactus, Prickly Pear, Ocotillo
    - Add to this list with any locally relevant flowers

In the Exhibition:

- Gather students near the entrance of the exhibit and review the content of the Pollination Primer panel as a group noting specific parts of the flower that are highlighted. Compare this pollination description to that in the book, or other prior knowledge. The panel content is provided below for reference:
    - Pollination is flower reproduction.
    - The transfer of pollen from a flower's male parts to a flower's female parts produces new plants.
    5. What is pollination?
        a. Anther (male flower part) / releases pollen
        b. + Stigma (female flower part) / collects pollen
        c. = New plants and flowers grow
    6. How does it happen?
        a. A few flowers pollinate themselves
        b. Some are pollinated by wind or water
        c. All the rest need visits from pollinators
    7. Why do pollinators visit flowers?
        a. Food and drink
        b. Finding mates
        c. Nesting and egg laying
    8. What happens next?
        a. The pollen fertilizes the eggs in the ovule of the flower
        b. The plant produces seeds
        c. The seeds grow into new plants
- Divide students into partners or small groups and assign them one of the eight pollinator groups to role play. As students complete their missions, ask them to pay attention to the shape and anatomy of each flower they visit.
- Missions that visit flowers with easy to identify parts include:
    - **Bat 4**: Mexican Long-tongued Bat and Moonflower

    - **Bee 1**: Hibiscus Bee and Crimson-eyed Rosemallow
    - **Bee 4**: Bumble Bee and Petunia
    - **Beetle 2**: Tumbling Flower Beetle and Mountain Laurel
    - **Bird 1**: Blue-faced Honeyeater and Australian Honeysuckle
    - **Butterfly 4**: Green Hairstreak and Silverweed
    - **Fly 2**: Tachinid Fly and Flowering Dogwood
    - **Moth 1**: Morgan's Sphinx Moth and Darwin's Orchid
    - **Moth 4**: White Plume Moth and Moonflower
    - **Wasp 4**: Yellowjacket and Sunflower
- Encourage students to find the supplemental text for each flower within their environment to learn more about its unique adaptations.
- Students should also visit the interactive story flowers in each environment. These stories share more information about plant adaptations and plant-pollinator interactions.

Debrief:

- While debriefing, ask students to share what they observed about the flowers they visited across environments. Did flowers look different between environments? Did they all have obvious anatomy? What might be the advantages and disadvantages of different flower structures?
- Ask students to reflect on 5W's of Flowers:
    - Where can you find flowers? (Answer: every environment worldwide!)
    - What are the parts of a flower? (See Pollination Primer panel or review What's Inside a Flower book)
    - Why do flowers look the way they do? (Answer: to attract pollinators)
    - When does pollination happen? (Answer: when pollen from the male part of one flower lands on the female part of a different flower of the same type)
    - Who needs flowers? (Answer: pollinators and other animals including humans)
    - Any other W questions and answers?
- (Optional) As a summative debrief, provide students with record keeping sheet similar to *Taking a Closer Look* attached below. Let students return to the Mission Maze to sketch their flower and label its visible parts and other characteristics, such as how many petals, color, the number of stamens, etc.

Corresponding Classroom Activity:

Flower Structure

In this lesson, 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.

Taking a Closer Look

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):

_____
_____
_____

Draw Your Flower Below:

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

_____
_____

If this flower has nectar guides, please describe them.

_____

Mutualisms: Plant + Pollinator Relationships

Grades: Grades 3rd-8th

Content Connection:

Life Science

NGSS.LS1.A: Structure and Function
NGSS.LS4.B: Natural Selection
NGSS.LS4.C: Adaptation

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

Materials:

- Plant-pollinator mutualism photos (e.g. Ruby-throated Hummingbird and Magnolia, Daisy, Trumpet Vine, Milkweed)
- POLLEN: Darwin's 130-Year Prediction by Darcy Pattison, illustrated by Peter Willis
- *Optional:* Before the Seed: How Pollen Moves by Susannah Buhrman-Deever, illustrated by Gina Triplett and Matt Curtius

Key Exhibit components:

- Meet the Pollinators station
- 3rd-HS grade – Life Chart missions
- Parlor Games: Mutualism Dominos

Before Exploring:

- Show students a picture of a pollinator and a few flowers.
    - E.g., Ruby-throated Hummingbird and Magnolia, Daisy, Trumpet Vine, Milkweed
- Ask students to consider which flower the pollinator is most likely to visit and why.
- Read the following book
    - 2nd -6th - POLLEN: Darwin's 130-Year Prediction
    - *Optional*: Before the Seed may be used to add to the background knowledge using its anecdotes about mutualisms
- Ask students to reflect on Darwin's hypothesis and the subsequent discovery that supported his hypothesis.
- Explain that plants and pollinators evolved together. Flowers have grown to attract pollinators, and pollinators changed shape and behavior to suit the plants they pollinate.

In the exhibition:

- All students should visit the Meet the Pollinators station to learn about the 8 types of pollinators and the unique adaptations that make them well suited for collecting nectar and moving pollen. Ask them to consider:
    - How does each mouthpart tool function to collect nectar and pollen?
    - Do the mouthparts seem like they would be better suited for feeding on many types of flowers (generalist) or specific flowers (specialist)?
- Divide students into partners or small groups and assign them 2-3 missions from this list of missions that highlight pollinators with specific anatomical or behavioral adaptions:
    - **Bat 2: Leaf-nosed Bat**, uses many super senses including seeing in ultraviolet and echolocation
    - **Bat 3: Tube-lipped Nectar Bat**, has a tongue as long as its body for slurping nectar from flowers with long nectaries
    - **Bee 1: Hibiscus Bee**, is a specialist pollinator
    - **Bee 2: Chilean Desert Bee**, has an extra-long tongue for finding hidden nectar
    - **Bee 4: Bumble Bee**, can sense electromagnetic fields produced by flowers with or without nectar
        - Lift the flip doors on the Petunia to read about bumble bees electromagnetic sensitivity
    - **Wasp 3: Fig Wasp**, has a unique life cycle and is the only pollinator for figs
    - **Bird 3: Costa's Hummingbird**, the bill is the perfect shape for visiting the tubular flowers of Agave
    - **Butterfly 4: Green Hairstreak**, can see in ultraviolet to find nectar guides on flowers
    - **Fly 4: Midge**, are small enough that they are one of the main pollinators for tiny cacao flowers
    - **Moth 1: Morgan's Sphinx Moth**, has a tongue long enough to reach the nectar at the end of the Darwin's orchid's foot-long nectar
        - Read the story of the Darwin's orchid under one of the flower flip doors
    - **Moth 3: Yucca Moth**, has special body parts it uses to collect and carry pollen between flowers and is the primary pollinator for Yucca
- After students have completed their first mission set, assign them 1-2 of the following missions that highlight flower adaptations that are effective at attracting pollinators:
    - **Moth 4: visits Moonflower**, emits a strong aroma that this moth can smell up to a mile away
    - **Bat 1: visits Moonflower**, blooms at night when bats are active
    - **Fly 3: visits Corpse Flower**, emits the smell of rotting meat to attract the flies that pollinate it
    - **Wasp 2: visits Mirror Orchid**, looks like a female wasp to attract the male wasps that pollinate them
    - **Butterfly 1: visits Lantana**, which changes color as its flowers become pollinated to indicate which flowers still have nectar
        - Spin the interactive Lantana wheel to read its story

- **Butterfly 4: visits Silverweed**, has UV-visible nectar guides
    - Read the Silverweed story behind on of the floor flip doors
- **Beetle 2: visits Mountain Kalmia**, has spring-loaded stamen that launch pollen onto the backs of visiting pollinators
- **Beetle 3: visits Lotus**, produces heat to attract insect pollinators
    - Complete the Rainforest flower quiz to find Lotus flowers' unique ability

Debrief:

- Ask students to reflect on the following discussion questions:
    - In what ways have flowers evolved to attract specific pollinators? (Answers: color, smell, shape, nectar guides, time of blooming throughout the day or year, some even produce heat to attract insects)
    - How have some pollinators become the best pollinators for certain flowers? (Answers: mouthpart shape and length, body size and shape, unique life cycles)
    - Which pollinator adaptations seem to be better for feeding on many types of flowers (generalist) or specific flowers (specialist)?

Corresponding Classroom Activity:

Mutualism Mouthpart Engineering

In this lesson, students will model and discuss animal adaptations and how adaptations impact plant-pollinator relationships.

Adaptations: Mimicry & Warning Colors

Grades: 3rd-8th

Content Connection:
Life Science
NGSS.LS1.A: Structure and Function
NGSS.LS1.B: Growth and Development of Organisms
NGSS.LS4.C: Adaptation

Objective: Students will role play as pollinators visiting flowers to enhance their understanding of the importance of physical adaptations, specifically coloration, as a survival strategy for animals.

Materials:
- Model & Mimic photo resources (See Corresponding Lesson for printable images)

Key Exhibit components:
- 3rd-HS grade – Life Chart missions

Before Exploring:
- Show students a set of model and mimic animal species and sort the cards into their appropriate piles. Discuss any visible differences between models and mimics. Then, let students explain how and why they think mimicry could be a useful survival adaptation. See Corresponding Lesson for printable images.
  - **Model:** 1) Monarch butterfly, 2) Coral snake, 3) Paper wasp, 4) Hornet, 5) Green snake, 6) Pygmy owl, 7) Mason bee
  - **Mimics:** 1) Viceroy butterfly, 2) King snake, 3) Longhorn beetle, 4) Wasp moth, 5) Spicebush swallowtail caterpillar, 6) Owl butterfly, 7) Hoverfly
- Explain that animals can mimic:
  - Their surroundings, known as cryptic coloration or camouflage
  - Parts of other animals (like the big eyes of owls), known as automimicry
  - Warning colors (or aposematic coloration) that are displayed by some species can be copied by others to fool predators
- Ask students to consider what function these traits serve?
- Explain to students that a goal for visiting this exhibit is to learn how the adaptation of coloration can help plants and animals survive.

In the Exhibition:

- To learn more about specific pollinators and their tricky adaptations, divide students into partners or small groups and assign them a few of the following missions that highlight color adaptations:
    - **Bee 4: Bumble Bee**, yellow and black bands are examples of warning colors
    - **Beetle 5: Longhorn Beetle**, exhibits mimicry of wasps, ants, and other beetles to appear more threatening. Note: There is also a Longhorn Beetle flip door challenge near these flowers.
    - **Butterfly 1: Common Buckeye**, exhibits auto mimicry through the use of eyespots
    - **Butterfly 5: Monarch Butterfly**, exhibits warning colors and is mimicked by Viceroy butterflies
    - **Fly 5: Hover Fly**, exhibits mimicry of bees
    - **Moth 2: Geometrid Moths**, are often camouflaged the color of leaves or bark
    - **Wasp 2: Scoliid Wasp and Mirror Orchid**, in this case, the flower mimics the female wasp to attract the male wasp for pollination
    - **Wasp 4: Yellowjacket**, yellow and black bands are examples of warning colors
    - **Wasp 5: Tiphiid Wasp**, yellow and black bands act as warning colors

Debrief:

- Ask students to reflect on the following discussion prompts:
    - In what different ways was color used to aid pollinator survival?
    - Did they find one solution to be better than the other? If so, why?
    - Do you think one strategy would be better in certain environments over others? Why or why not?
- As a summative evaluation, 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.

Corresponding Classroom Activity:

<u>Candy Camouflage</u>

In this activity, students will use candy to model a predator-prey relationship that demonstrates the advantage of mimicry for animal survival.

Animal Migration

Grades: 3rd-12th

Content Connection:

Life Science

NGSS.LS1.B: Growth and Development of Organisms
NGSS.LS4.C: Adaptation

Objective: Students will simulate annual migrations for a variety of pollinators, thereby strengthening their knowledge of this behavioral adaptation for survival as well as the natural and human-made challenges to migration success.

Materials:

- K-5th – Home is Calling: The Journey of the Monarch Butterfly by Kathrine Pryor, Illustrated by Ellie Peterson

Key Exhibit Components

- 3rd-HS grade – Life Chart missions
- Parlor Games: Connect 8

Before Exploring

- K-5th – Read Home is Calling: The Journey of the Monarch Butterfly
- 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.

While Exploring:

- Divide the class into partners or small groups. Assign each group a Life Chart mission set that includes one of the migration missions (see below). Note: Migration Missions require players to visit multiple flowers and complete 4 mini-missions. If time is limited, ask groups to complete only the migration mission. If time allows, students should complete all 5 missions of their pollinator set.
- Pre-reading age students may complete these missions in small groups with assistance from an adult chaperone.

- Migration Missions include:
    - **Bee Mission 5**: Honey Bee
    - **Bird Mission 5**: Ruby-throated Hummingbird
    - **Butterfly 5**: Monarch Butterfly
    - **Moth Mission 5**: Blackwitch Moth
- While completing missions, students can consider potential threats faced by their pollinator as they migrate.
- If time allows, or as students complete their missions, instruct them to visit the Parlor Games area 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 observe the types of landscapes that might pose hazards to pollinator migration.

Debrief:

- Gather students together and ask them to reflect on their experience.
    - Provide each group a piece of paper and ask them to draw their "migration" as they visited flowers around the exhibit on their mission.
    - How challenging was the mission? How does this game analogy compare to real-life migration?
    - What specific challenges were faced by each type of pollinator?
    - How many different environments did you visit on each mission? How many different environments might a real migrating pollinator visit? What does that mean about the challenge of their journey?
    - How could connected corridors help migrating pollinators? (if students played Connect 8)
    - What other solutions could help migrating pollinators?

Corresponding Classroom Activity:

- Complete the Monarch Migration Game lesson.
- 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.

Pollination and You

Grades: 3rd-HS

Content Connection:

Life Science

NGSS.LS4.D: Biodiversity and Humans

Earth & Space Science

NGSS.ESS3.A: Natural Resources

Objective: Students will explore human dependence on the environment, specifically pollinators, by role playing the pollination of several important human food sources.

Key exhibit components:

- 3rd-HS grade – Life Chart missions
- Interactives in the Farm and Orchard environments
- Pollinator Theater – Pollinators Under Pressure video

Before Exploring:

- Facilitate a "walking vote," where students use movement to select between two options. Designate two locations for students to go in response to each question below, and ask them to move to either side to indicate which option they choose.
    - Vanilla or strawberry ice cream?
    - Chocolate chip or Oatmeal raisin cookies?
    - Apples or oranges?
    - French fries or potato chips? (Note that potatoes are primarily self-pollinated, but also rely on bees.)
    - Spicy or not spicy food?
    - Guacamole or salsa?
    - Are tomatoes a: fruit or vegetable?
    - Any others?
- Debrief the voting. Explain that whatever option they picked, that choice relied on something that came from a pollinated plant. With that knowledge, ask students to reflect on the impact of pollinators (or their disappearance) on their preferences.
- Optional, watch the Pollinators Under Pressure video. This video plays in the Pollinator Theater room. It provides an excellent overview of the importance of pollinators, and it may be easier to facilitate viewing as a pre-exploration group activity.

In the Exhibition:

- Divide students into partners or small groups and assign them a few of the following missions that highlight pollinators critical to the production of foods and other commercial products.
    - **Bat 2:** Leaf-nosed Bat and Balsa Tree (wood)
    - **Bat 4:** Cave Nectar Bat and Sumatran Wild Bananas
    - **Bat 5:** Mexican Long-nosed Bat and Agave (sweetener)
    - **Bee 3:** Leafcutter Bee and Alfalfa (an important forage for dairy cows, horses, and other livestock)
    - **Bee 6:** Honey Bee and Almonds, Apples, and Strawberries
    - **Bird 3:** Costa's Hummingbird and Agave (sweetener)
    - **Fly 1:** Housefly and Carrot
    - **Fly 2:** Midge and Cacao
    - **Wasp 3:** Fig Wasp and Fig
    - **Wasp 5:** Tiphiid Wasp and Date palm
- Make sure students complete the Food Sliders and Plate interactive in the Farm and Orchard environments to see other foods and goods that rely on pollinators.
- If not already watched as a class, encourage students to visit the Pollinator Theater room to watch the Pollinators Under Pressure video.

Debrief:

- While debriefing the exhibit, ask students to share what evidence they found of how important pollinators are, as well as anything that surprised them.
- As a summative evaluation, ask students to draw their own favorite meal on a plate. Discuss with a partner and then identify the items that require pollination. How would their day-to-day life look different without abundant pollinators?

Corresponding Classroom Activity:

- 2nd-3rd grade
    - Read the book: The Reason for a Flower: A Book About Flowers, Pollen, and Seeds (Explore!) by Ruth Heller
    - As a class, create a list of foods and everyday items from pollinated plants that were identified in the book. Discuss whether there was anything missing or anything surprising? Like rubber or medicine?
    - Ask students to illustrate a comic strip of their daily routine that highlights items they use that come from pollinated plants.
- 4th-8th grade - Pollination is Big Business lesson plan
    - In this lesson, students will be able to describe the economic importance of pollinators after solving word problems containing chocolate production statistics.

Pollinators in Peril

Grades: 3rd-8th

Content Connection:

Life Science

NGSS.LS4.D: Biodiversity and Humans

Earth & Space Science

NGSS.ESS3.A: Natural Resources

NGSS.ESS3.C: Human Impacts on Earth Systems

Objective: Students will complete survival-based role-play activities to understand some of the natural and human-made threats faced by pollinators.

Materials:

- What if there were no bees? A book about the grassland ecosystem by Suzanne Slade, illustrated by Carol Schwartz

Key Exhibit Components:

- Pollinator Theater room – Pollinators Under Pressure video
- 3rd-HS grade – Life Chart missions
- Parlor Games: Balance Tower, Connect 8, Invasive Species Shuffleboard

Before exploring:

- 3rd-5th grade, read: What if there were no bees? A book about the grassland ecosystem
- 6th-8th grade, as a class, watch the Pollinators Under Pressure video. This video plays in the Pollinator Theater room, but it may be easier to facilitate pre-exploration.
- Ask students to reflect on what a world without pollinators would be like.
- As a class, identify a list of challenges that pollinators could face. Prompt them with examples if necessary.
- Divide students into small groups and assign them a type of pollinator (bees, butterflies, birds, flies, etc.) and ask them to brainstorm one challenge for their specific pollinator group as well as one way to help solve that challenge. Discuss as a group.
- The goal of the day is to learn about pollinators and come up with solutions that will ensure they survive and that we continue to benefit from all the goods they provide!

In the exhibition:

- Divide students into partners or small groups and assign them 2-3 of the following missions that include information regarding Threats (X's). We recommend assigning

missions from different pollinator groups to allow students to consider how threats can vary across each type of pollinator.
    - **Bat 3:** Tube-lipped Nectar Bat and Long-necked Bell Flower
    - **Bat 4:** Cave Nectar Bat and Sumatran Wild Bananas
    - **Bat 5:** Mexican Long-nosed Bat and Agave
    - **Bee 3:** Leafcutter Bee and Alfalfa
    - **Bee 4:** Bumble Bee and Petunia
    - **Beetle 4:** Soldier Beetle and Goldenrod
    - **Beetle 5:** Longhorn Beetle and Mexican Sunflower
    - **Bird 4:** White Winged Dove and Saguaro
    - **Butterfly 4:** Green Hairstreak and Silverweed
    - **Fly 4:** Midge and Cacao
    - **Fly 5:** Hoverfly and Starfish flower
    - **Wasp 4:** Yellowjacket and Sunflower
    - **Wasp 5:** Tiphiid Wasp and Date Palm
- As students complete their missions, send groups to play Parlor Games, specifically Balance Tower (Jenga), Connect 8, and Invasive Species Shuffleboard. These games explore some of the natural and human-made threats faced by pollinators.

Debrief:

- Ask students to reflect on the following discussion prompts:
    - What are examples of natural threats to pollinators?
    - What are examples of human made threats to pollinators?
    - How do threats vary between different groups of pollinators?
    - Are there some groups of pollinators that may face more threats than others? Why or why not?
    - What would be the consequence of losing pollinators?
    - Is there anything new that you discovered in the exhibition from what was discussed prior to exploration?
    - Brainstorm some possible solutions to these threats.

Corresponding Classroom Activity:

- As an engineering design extension, build bee or butterfly hotels.

Pollinators: How to Help

Grades: 3rd-8th

Content Connection:

Life Science

NGSS.LS4.D: Biodiversity and Humans

Earth & Space Science

NGSS.ESS3.A: Natural Resources

NGSS.ESS3.C: Human Impacts on Earth Systems

Objective: Students will complete several challenges within the *Amazing Pollinators* exhibition to learn more about potential threats and successes for pollinators.

Materials:

- What if there were no bees? A book about the grassland ecosystem by Suzanne Slade, illustrated by Carol Schwartz
- Pencils and paper

Key Exhibit Components:

- Pollinator Theater room – Pollinators Under Pressure video
- How to Help room
- Seek-and-Find room
- Parlor Games: Balance Tower, Connect 8

Before exploring:

- 3rd-5th grade, read: What if there were no bees? A book about the grassland ecosystem
- 6th-8th grade, as a class, watch the Pollinators Under Pressure video. This video plays in the Pollinator Theater room, but may be easier to facilitate as a pre-exploration group activity.

In the exhibition:

- Divide students into partners or small groups and assign them 1) Life Chart Missions, 2) How to Help Room, 3) Seek-and Find room, 4) Parlor Games. Facilitate these activity areas as stations and rotate groups through each station.
- Groups completing missions should be assigned life charts for Bats, Bees, or Butterflies. These life charts include missions for the following at-risk or endangered pollinators:
    - **Bat 1:** Mexican Long-tongued Bat
    - **Bat 2:** Leaf-nosed Bat
    - **Bat 3:** Tube-lipped Nectar Bat

    - **Bat 5:** Mexican Long-nosed Bat
    - **Bee 3:** Leaf-cutter Bee
    - **Bee 4:** Bumble Bee
    - **Bee 5:** Honey Bee
    - **Butterfly 2:** Marsh Fritillary
    - **Butterfly 4:** Green Hairstreak
    - **Butterfly 5:** Monarch
- Students visiting the How-to-Help and Seek-and-Find Rooms should complete the tasks shown on each of the wall panels.
- Students in the Parlor Games activity area should take turns playing the games. The games Balance Tower and Connect 8 provide examples and suggestions for supporting pollinators.

Debrief:

- Use following discussion prompts to debrief the experience:
    - Summarize the different activity areas and lessons learned.
    - What are the 6 ways outlined to support pollinators in the How to Help room?
        - Plant native flowers that bloom in different seasons
        - Keep your yard chemical-free
        - Protect nesting and host plants
        - Reduce your impact by making sustainable choices
        - Learn more about the importance of pollinators in our everyday lives
        - Share what you know to encourage friends and family to make pollinator-friendly choices
    - What is Community Science and how can it support pollinators?
        - Community Science is a way to crowdsource lots of data that can be used by researchers to evaluate, understand, and inform decision-making that will conserve pollinator populations.
    - Following all of the content and ideas from the exhibit, provide each student with a flower shaped cutout and ask them to write down one action they could or want to take to help support pollinators. Discuss as a group and identify any common solutions. If desired, students can add their flower to a wall designated as a “community idea garden.”

Corresponding Classroom Activity:

- As an engineering design extension, build bee or butterfly hotels.

Pollinator Friendly Gardening

Grades: K-8th

Content Connection:

Life Science

NGSS.LS1.A: Structure and Function

Earth Science

NGSS.ESS3.C: Human Impacts on Earth Systems

Objective: Students will explore the flowers and pollinators that can be found in different habitats, then use this information to design a pollinator garden.

Materials:

- K-5th – The Garden Next Door by Collin Pine, illustrated by Tiffany Everett
- Paper and drawing utensils (pencils, crayons, colored pencils, or markers)
- Pollinators Under Pressure video

Key Exhibit Components:

- K-2nd grade – Flower Quest missions
- 3rd-HS grade – Life Chart missions

Before exploring:

- Explain to students that the goal of the day is to think about the importance of pollinators and how to provide safe havens for them in our backyards or neighborhoods. After visiting the exhibit, students will design a pollinator-friendly garden.
- K-5th, read The Garden Next Door book
- 6th-8th grade, watch the Pollinators Under Pressure video.

In the Exhibition:

- As students explore the exhibit, encourage them to consider what a pollinator-friendly garden should include.
- Divide students into pairs or small groups to explore the Mission Maze using their age-appropriate game as outlined below:
- Grades K-2 (pre- or early reading age) – Flower Quest missions can include:
    - **Ornate Checkered Beetle**, Blanket Flower, The Roadside
    - **Common Buckeye**, Lantana, My Garden
    - **Monarch Butterfly**, Tall Thistle, The Roadside
    - **Yellowjacket**, Common Sunflower, The Roadside

    - Pre-reading age students can count the different number and types of flowers in each environment they visit. Adults may assist younger students in finding and reading the flower descriptions found in each environment to make observations about similarities and differences of plants.
- Grades 3-8 (reading-age) – Life Chart missions (Bee, Butterfly, Bird, or Beetle) include**:**
    - **Bee 1:** Hibiscus Bee, Crimson-eyed Rosemallow, Garden
    - **Bee 4:** Bumble Bee, Petunia, Roadside
    - **Bee 5:** Honey Bee, Tickseed, Roadside
    - **Butterfly 1:** Common Buckeye, Lantana, Garden
    - **Butterfly 2:** Marsh Fritillary, Bluebells, Meadow
    - **Butterfly 5:** Monarch Butterfly, Garden, Roadside, Meadow
    - **Bird 1:** Blue-faced Honeyeater, Australian Honeysuckle, Meadow
    - **Bird 2:** Golden-winged Sunbird, Christmas Candlestick, Garden
    - **Bird 5:** Ruby-throated Hummingbird, Garden & Roadside
    - **Beetle 1:** Ornate Checkered Beetle, Blanket Flower, Roadside
    - **Beetle 4:** Soldier Beetle, Goldenrod, Garden
    - **Beetle 5:** Longhorn Beetle, Mexican Sunflower, Garden
    - Extend each mission by asking students to scan the surrounding environment walls to find information about the target flower for each mission. Descriptions of plants can be found on the environment wall at the end of, or opposite to, the walls that hold the flowers.
- As students complete their mission sets, let them free explore the maze by completing other life chart missions or visiting the rooms.

Debrief:

- Ask students to reflect on the exhibit experience using following discussion prompts:
    - Environment Panels
        - Pollinators can be found on every continent, in every type of environment. What environments did they see on the graphics? Did any of the environments look like where they live? How do the graphics influence what type of garden you would design for pollinators?
    - Life Chart Missions
        - Did anyone discover any flowers that were visited by multiple pollinators? Did any pollinators visit multiple flowers?
- As a summative activity, ask students to draw a garden describe its pollinator-friendly features. Younger students may simply draw in flowers on a map, older students may use graph paper to chart out the area required for plants.

Corresponding Classroom Activity:

<u>Design a Pollinator Garden</u>

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.

Bibliography & Suggested Reading

Bat Count: A Citizen Science Story (2017) by Anna Forrestor, illustrated by Susan Detwiler

Before the Seed: How Pollen Moves (2024) by Susannah Buhrman-Deever, illustrated by Gina Triplett and Matt Curtius

Flowers Are Calling (2015) by Rita Gray, illustrated by Kenard Pak

Flower Talk: How Plants Use Color to Communicate (2019) by Sara C. Levine, illustrated by Masha D'yans.

The Garden Next Door (2022) by Collin Pine, illustrated by Tiffany Everett

Home is Calling: The Journey of the Monarch Butterfly (2023) by Kathrine Pryor, Illustrated by Ellie

Know Your Pollinators: 40 Common Pollinating Insects including Bees, Wasps, Flower Flies, Butterflies, Moths, & Beetles, with Appearance, Behavior, & How to Attract Them to Your Garden (2020) by Tim Harris

Meet the Pollinators: A Night and Day Adventure (2024) by Barbara Ciletti

My Pollinator Garden: How I Plant for Bees, Butterflies, Beetles, and More (2025) by Jordan Zetchkenbaum, illustrated by Kate Cosgrove

Protect the Pollinators (2019) by Rachael Rose Zoller

POLLEN: Darwin's 130-Year Prediction (2019) by Darcy Pattison and illustrated by Peter Willis

Pollinators & Native Plants for Kids: An Introduction to Botany (2025) by Jaret C. Daniels

The Reason for a Flower: A Book About Flowers, Pollen, and Seeds (Explore!) (1999) by Ruth Heller

What Is Pollination? (2010) by Bobbie Kalman

What if there were no bees? A book about the grassland ecosystem (2010) by Suzanne Slade, illustrated by Carol Schwartz

What's Inside a Flower (2021) by Rachel Ignotofsky