**Activity Overview**

In this investigation, students venture outside for a teacher-led, plant investigations walk in their own schoolyard. This activity is offered as an alternative field investigation for classes unable to visit the Desert Botanical Garden. The purpose of this activity is to get students outside and involved in real, hands-on field investigations about plants. It is suggested that classes first conduct the *Flower Power- the Genetic Journey* Inquiry Stage 1- Introductory Activity in preparation for this investigation. Although that introductory activity is primarily for classes visiting the Desert Botanical Garden, it provides foundational concepts and activities which are further explored in this investigation.

**Teacher Preparation**

The purpose of the plant investigations walk is for students to see plants in various stages of reproduction in nature and to follow the scientific method as they investigate aspects of plant reproduction. It is suggested that teachers first scout the school grounds before taking the students outside. Decide on a route that would be good for a plant investigations walk. The route should include a variety of plants including trees, shrubs, and cacti (if possible). It is recommended that at least three specific places or “stops” be identified along the route that would serve as focal points to investigate plant flowers, fruits, and seeds. Students will be better prepared for the investigation if the class first reviews and discusses the *Parts of a Flower, How a Fruit Develops*, and *Structure of a Seed* graphics provided in the *Flower Power- The Genetic Journey* Inquiry Stage 1- Introductory Activity.

**Materials**

- *Pollinator Partner* Cards (downloaded and printed, cut as directed, and potentially laminated)
- A variety of fruits including beans, bean pods, apple, orange, peach. etc.
- Optional depending on selected activities: pencils, paper, hand lens, dissecting kit (or simply knives for cutting open fruit), pliers, and/or other tools.
- *Student Investigation Journal*
- *Student Study Guide- Results and Conclusion*
**General Procedures**

Guide students on an outdoor plant investigation walk following your pre-planned route. At each stop, conduct an inquiry using the Discussion Questions to convey the Teaching Points presented for that stop. Following each discussion, conduct one or more of the Suggested Activities while students record in their Student Investigation Journals. Wrap up your walk by discussing students’ discoveries and reviewing the General Teaching Points. Complete student investigations by conducting the Flower Power- The Genetic Journey Inquiry Stage 3 – Concluding Activity.

**Plant Reproduction Investigation – General Teaching Points**

- Plant reproduction involves several plant structures (flowers, fruits, and seeds) and results from a series of processes (including pollination and fertilization).
- Plants and their pollinators have a symbiotic relationship and each have specific structures and adaptations to facilitate the process.
- Fruits develop from flowers and contain seeds that become new plants.
- Seeds contain all the genetic information necessary to develop into new plants.
- Some seeds have a dormant stage which is a survival strategy allowing them to rest and wait for the right conditions to germinate.

**Flowers Stop**

**Description**

The flowers stop should offer a good view of a variety of flowering or potentially flowering plants. The area should be large enough to accommodate the group and offer good opportunities for nearby observation (and if allowed, collection) of flowers.

**Teaching Points**

- Flowers are the primary reproductive structure of most plants.
- Pollination is a process in reproduction.
- Plants have specific structures used in the process of pollination.
- Flowers have specific male and female parts each having specific functions in pollination.
– Some pollinators are adapted to pollinating very specific types of flowers.
– The type of animal that pollinates a particular flower can often be surmised by the structure of the flower.
– The type of flower that an animal pollinates can often be surmised by the animal’s size, mouth parts, and other body structures.
– Pollination (involving a pollinator and plant) is an example of a symbiotic relationship.

**Discussion Questions and Activity Suggestions**

At the flowers stop, conduct an inquiry using the teaching points as your guide. Questions to help students arrive at the key points for this stop could include the following:

*Why do plants have flowers?*
*What are some of the differences we see in flowers?*
*Why are flowers so varied, fragrant, and colorful?*
*What happens in the process of pollination?*
*What kinds of things (environmental factors and animals) aid in the process of pollination? How?*
*What is a symbiotic relationship?*
*Why is pollination an example of a symbiotic relationship?*

After students have had a chance to discuss flowers, choose and conduct one or more of the following suggested activities.

Have students…

– Play a game using the Pollinator Partners cards to see if they can match the pollinator with its specific flower. Selected students could play particular flowers while other students play the pollinators. Can they make the right match?

– Look around the schoolyard to locate flowers and deduce from the shape of flower what kind of animal might pollinate it.

– Sit quietly for a designated amount of time and observe flowers to see what kind of animals visit the flower and potentially pollinate it.

– Use magnifying lenses to study the parts of a real flower. Can they identify the male and female parts?

– Observe, draw, and label the parts of a flower they either find in the schoolyard or bring from home.
Fruit Stop

Description
If possible, locate an area or areas of the schoolyard where there are fruiting plants. These could be fruit or bean trees (such as mesquite), bushes with berries or bean pods, or small forbs (e.g., weeds) in their fruiting stage.

Teaching Points
– Fruits come in many forms.
– The function of fruits in the reproductive process is to bear and nourish the seeds.
– A fruit is the result of a flower being pollinated then fertilized.
– A fruit is the fertilized and ripened ovary of the flower.

Discussion Questions and Activity Suggestions
At the fruits stop, conduct an inquiry using the teaching points as your guide. Questions to help students arrive at the key points for this stop, could include the following:

What is a fruit?
What is the purpose of fruit?
How does a fruit develop? From what plant part does it form?
Can anyone name some different types of fruits?
From where we are sitting, how many different types of fruits can you see?

After students have had a chance to discuss fruit, choose and conduct one or more of the following suggested activities.

Have students…
– Explore the area around the stop to discover different types of plant fruits. Some fruits may have already fallen from the plant so may be found on the ground under the plant.
– Collect different fruits that have fallen from plants. Categorize them according to similar and differing characteristics. What are some similarities and differences of fruits?
– Dissect fruits that have been collected (or brought along on the outing). How many seeds are inside? Can they see how the fruit developed from the flower?
– Draw the fruits they have dissected.
– Play a game in which they decide if a plant part is a fruit or not.
– Find a plant in different stages of fruit development. Collect and/or draw the fruit in its different stages of development.

SEEDS STOP

Description
The seeds stop could be similar to the fruits stop. Because the fruit bears the seed, it could even be the same stop. For variety however, it may be best to move to another location where there are a variety of plants that exhibit seeds.

TEACHING POINTS

– The basic structure of a seed includes the seed coat, embryo, and cotyledons.
– Seeds need water to germinate.
– Water must penetrate the seed coat to activate germination.
– A seed’s outer coating can vary in thickness and durability.
– Some seeds have a very hard, thick coat.
– A hard seed coat helps delay germination.
– Dormancy is a period of inactivity (during which the seed is in a “resting” or “pausing” stage).
– Many desert seeds have a dormant stage during which they are resting and waiting for the right conditions to germinate.
– Seeds carry the genetic information of plants to ensure the continuation of the species.

DISCUSSION AND ACTIVITY SUGGESTIONS
At the seeds stop, conduct an inquiry using the teaching points as your guide. Questions to help students arrive at the key points for this stop, could include the following:

What are the main parts (structures) of a seed?
Are all seeds the same?
What is the function of seeds?
What do seeds need to germinate?
When do seeds germinate?
Do environmental conditions affect seed germination? How?
Is it always a good time to germinate? Why or why not?
How might seeds control timing of their germination?
What information do seeds carry for/about plants?

After students have had a chance to discuss seeds, choose and conduct one or more of the following suggested activities.

Have students…

– Draw and label the parts of a seed.
– Walk around the area to find and collect different kinds of seeds. What are some of the similarities and differences of seeds? Do some seeds seem harder than other seeds?
– Look for signs of seeds germinating. Look under trees or bushes for new sprouts. Can students find seeds in different stages of germination? Can they find any newly sprouted seeds and see the cotyledons?
– List questions about seeds, based on their observations, that they could potentially research. For some of the questions, have them develop hypotheses and consider ways they could test their hypotheses.
– Conduct an investigation on the hardness of seeds. Are some seeds harder than others? Are desert seeds harder than seeds from other environments? (Note: This continues the investigation started in the Inquiry Stage 1- Introductory Activity, Procedures 11 and 12 in which students developed a hypothesis about seed hardness.) Help students set up the investigation by selecting seeds (seeds could be brought in from home) and providing tools to test seed hardness. (Pliers are good because students can tell the difference in how hard they must squeeze in order to crack the seed coat.) Have students compare and record which seeds are hardest to crack.
– Follow their seed hardness investigation through to the results and conclusions stage by completing the Student Study Guide – Results and Conclusions.
– Collect seeds from the area and attempt to grow them. Some seeds need their outer coat to be cracked or softened to germinate. Do some seeds germinate easier than others? How can students help activate germination? Conduct an investigation on this following the scientific method.
FLOWERS
1. Pollinator Partners- Who is your mate? Why are these two organisms a good match?

2. Observe, draw, and label the parts of a flower.

FRUIT
3. What are some similarities and differences among the fruit you found?

4. Draw your dissected fruit. How many seeds do you see?
SEEDS

5. Draw and label the parts of a seed.

6. What are some similarities and differences among the seeds you found?

7. Are some seeds harder? Which ones?
Instructions: Based on your experiences in class and during your Plant Reproduction Investigation, answer the questions below. If necessary, refer to your Student Investigation Journal. Be sure to answer all the “Questions for Discussion.” Complete the Final Project. Post your work online on the DBG Journal of Student Findings as instructed by your teacher.

Part A. Investigation Report

1. What was your class hypothesis about desert seeds?

2. What observations did you make both in the classroom and during the Plant Reproduction Investigation that led you to that hypothesis?

3. What question does your hypothesis attempt to answer?

4. Did you make a prediction about desert seeds and if so what was your prediction?

continued
5. Describe the experiment you conducted during the Plant Reproduction Investigation to test seed hardness.

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

6. What were the results of your experiment? Which seeds were easy to crack? Which were more difficult to crack?

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

7. State your conclusion. Was your hypothesis supported by your results? Be sure to describe the evidence that supports your conclusion.

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________
Part B. Questions for Discussion

1. What was common to all the seeds that were more difficult to crack?

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

2. What do you think would be the results if you conducted the experiment with other desert seeds?

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

3. Do you think there may be some desert seeds that would yield different results? Why? What might be different about those seeds?

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

4. Based on your findings, what are some other questions that arise that might lead to new investigations?

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

5. In the space below, draw a picture of a seed and the three main parts you studied:

[Space for drawing]
6. What is dormancy

_________________________________________________________________________

_________________________________________________________________________

7. What part of the seed aids in dormancy? How?

_________________________________________________________________________

_________________________________________________________________________

8. Why is dormancy in desert seeds a good survival strategy?

_________________________________________________________________________

_________________________________________________________________________

9. Describe some ways a hard seed coat could be cracked or softened in a desert environment.

_________________________________________________________________________

_________________________________________________________________________

10. Why is it important for seeds to survive? What information do seeds carry?

_________________________________________________________________________

_________________________________________________________________________

**Part C. Final Project:** Now that you know something about how desert seeds survive in the harsh, desert environment, consider other environments and the survival challenges seeds might have in those environments. Consider conditions such as freezing temperatures, constant rains and flooding, or salty mud flats. Select an environment and describe the environmental conditions to which plants and their seeds must adapt. Following the scientific method, state observations and questions and create a hypothesis about how seeds adapt to that environment. Describe how you could test your hypothesis, including step by step instructions for following your experiment. If possible, conduct the experiment!

**Post Your Findings on the Internet!**

As part of the Inquiry Process students may share their work with others by visiting the DBG Journal of Student Findings at [http://www.dbg.org/index.php/digital/students/journal](http://www.dbg.org/index.php/digital/students/journal). Here, students can submit investigation findings, poems, or original art inspired by their Inquiry in the Garden. For more ideas on art projects that tie into Garden themes, go to the Additional Resources section of the Digital Learning website.
Pollinator Partner Cards

Bee- Fuzzy flying insect seeking yellow, blue, or purple pal. Desires daytime interactions and would like to sit down and share a meal of pollen grains or nectar sips! (Do not waste your energy if red- not in my color vision.)
Pollinator Partner Cards

Palo Verde Bloom- Small, yellow flora seeking daytime dude. Will share a homegrown meal of nectar and pollen grains.
Pollinator Partner Cards

Butterfly- Fluttering, perching Lepidoptera seeks brightly colored, clustered pal. I am easily blown around in the wind so I seek a mate that will let me rest while I re-energize with a sugary nectar drink.
Pollinator Partner Cards

Lantana - Seeking winged mate who desires to use my colorful clustered petals to rest a bit.
Bat - Nocturnal mammal seeking nightblooming partner to draw me in with your strong scent. (I rely on my sense of smell more than sight so don’t waste your energy with fancy colors.) Prefer to meet atop the tallest location, where I will enjoy a snack of nectar and loads of pollen to energize me.
Pollinator Partner Cards

*Saguaro Blossom*- Nightblooming columnar cactus seeks hairy vertebrate that won’t judge me for my lack of color. I am only available to share my nectar and pollen if you can meet me at a high location.
Pollinator Partner Cards

Penstemon- Hanging, crimson flora seeking fast paced mate to share my nectar with. I do not produce any scents so you will have to find me by my bright color and distinctive tubular shape.
Pollinator Partner Cards

**Hummingbird** - Hovering busybody seeking bright red partner, but don’t waste your energy on perfumes or scents as I cannot smell. My sipping strategy is suited for tubular corollas.
Pollinator Partner Cards

Fly- Bumbling Diptera seeking rotting smells and dark red colors to lure me in. I feed on rotting meat so you will have to play along if we will be pals.
Pollinator Partner Cards

**Carrion Flower** - Darkly colored trickster seeks two winged partner to consort with. I will lure you in by impersonating rotting meat.
Pollinator Partner Cards

Wind - Force of nature blowing past. I seek no rewards but will help you move your pollen so long as it is lightweight and can ride on my breeze.
Pollinator Partner Cards

Wheat- Colorless, scentless grass seeking simple, unflashy partner to carry my pollen.
## Related ADE Standards:

### Reading Strand 1: Reading Process

<table>
<thead>
<tr>
<th>Concept</th>
<th>Performance Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>C4: Vocabulary</td>
<td><strong>PO 2:</strong> Use context to identify the intended meaning of unfamiliar words (e.g., definition, example, restatement, synonym, contrast).</td>
</tr>
<tr>
<td></td>
<td><strong>PO 3:</strong> Use context to identify the meaning of words with multiple meanings (e.g., definition, example, restatement, contrast).</td>
</tr>
</tbody>
</table>

### Writing Strand 3: Writing Applications

<table>
<thead>
<tr>
<th>Concept</th>
<th>Performance Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>C2: Expository</td>
<td><strong>PO 1:</strong> Record information (e.g., observations, notes, lists, charts, map labels and legends) related to the topic.</td>
</tr>
</tbody>
</table>

### Language Arts Standard 3: Listening and Speaking

<table>
<thead>
<tr>
<th>Standard</th>
<th>Performance Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students effectively listen and speak in</td>
<td><strong>LS-E3:</strong> Interpret and respond to questions and evaluate responses both as interviewer and interviewee.</td>
</tr>
<tr>
<td>situations that serve different purposes and</td>
<td></td>
</tr>
<tr>
<td>involve a variety of audiences.</td>
<td></td>
</tr>
</tbody>
</table>

### Science Strand 1: Inquiry Process

<table>
<thead>
<tr>
<th>Concept</th>
<th>Performance Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1: Observations, Questions, and Hypotheses</td>
<td><strong>PO 1:</strong> Formulate questions based on observations that lead to the development of a hypothesis.</td>
</tr>
<tr>
<td></td>
<td><strong>PO 2:</strong> Use appropriate research information, not limited to a single source, to use in the development of a testable hypothesis.</td>
</tr>
<tr>
<td></td>
<td><strong>PO 3:</strong> Generate a hypothesis that can be tested.</td>
</tr>
<tr>
<td>C2: Scientific Testing (Investigating and Modeling)</td>
<td><strong>PO 1:</strong> Demonstrate safe behavior and appropriate procedures (e.g., use and care of technology, materials, organisms) in all science inquiry.</td>
</tr>
<tr>
<td></td>
<td><strong>PO 2:</strong> Design a controlled investigation to support or reject a hypothesis.</td>
</tr>
<tr>
<td></td>
<td><strong>PO 3:</strong> Conduct a controlled investigation to support or reject a hypothesis.</td>
</tr>
<tr>
<td></td>
<td><strong>PO 5:</strong> Keep a record of observations, notes, sketches, questions, and ideas using tools such as written and/or computer logs.</td>
</tr>
<tr>
<td>C3: Analysis and Conclusions</td>
<td><strong>PO 3:</strong> Interpret data that show a variety of possible relationships between two variables, including:</td>
</tr>
<tr>
<td></td>
<td>• positive relationship</td>
</tr>
<tr>
<td></td>
<td>• negative relationship</td>
</tr>
<tr>
<td></td>
<td><strong>PO 4:</strong> Formulate a future investigation based on the data collected.</td>
</tr>
<tr>
<td></td>
<td><strong>PO 8:</strong> Formulate new questions based on the results of a previous investigation.</td>
</tr>
<tr>
<td>C4: Communication</td>
<td><strong>PO1:</strong> Communicate the results of an investigation.</td>
</tr>
<tr>
<td></td>
<td><strong>PO5:</strong> Communicate the results and conclusion of the investigation.</td>
</tr>
</tbody>
</table>
### Science Strand 4: Life Science

<table>
<thead>
<tr>
<th>Concept</th>
<th>Performance Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>C4: Diversity, Adaptation, and Behavior</td>
<td>PO 1: Explain how an organism’s behavior allows it to survive in an environment. &lt;br&gt;PO 2: Describe how an organism can maintain a stable internal environment while living in a constantly changing external environment. &lt;br&gt;PO 5: Analyze the following behavioral cycles of organisms:  &lt;br&gt;- dormancy (plants)  &lt;br&gt;PO 6: Describe the following factors that allow for the survival of living organisms:  &lt;br&gt;- pollination</td>
</tr>
</tbody>
</table>

### Educational Technology Strand 1: Creativity and Innovation

<table>
<thead>
<tr>
<th>Concept</th>
<th>Performance Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>C4: Original Works</td>
<td>PO 2: Use digital tools to collaborate with a group to communicate original ideas, products, or projects effectively in a creative or innovative style.</td>
</tr>
</tbody>
</table>

### Educational Technology Strand 2: Communication and Collaboration

<table>
<thead>
<tr>
<th>Concept</th>
<th>Performance Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1: Effective Communications and Digital Interactions</td>
<td>PO 1: Collaborate and communicate with peers, experts, or others employing a variety of digital tools to share findings and/or publish.</td>
</tr>
</tbody>
</table>

### Educational Technology Strand 6: Technology Operations and Concepts

<table>
<thead>
<tr>
<th>Concept</th>
<th>Performance Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>C2: Applications</td>
<td>PO 7: Identify and use network protocols for moving files and secure web access.</td>
</tr>
</tbody>
</table>

### Workplace Skills Standard 1: Students use principles of effective oral, written and listening communication skills to make decisions and solve workplace problems.

<table>
<thead>
<tr>
<th>Standard</th>
<th>Performance Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>IWP-E4</td>
<td>PO 3: Formulate related questions in a presentation &lt;br&gt;PO 4: Express opinions relating to the main idea in a presentation</td>
</tr>
</tbody>
</table>