Activity Overview

In preparation for their visit to the Desert Botanical Garden, students examine the process of transpiration and, following the scientific method, explore ways that desert plants have adapted to meet the challenge of transpiring in a desert environment. The activity begins with a review of the transpiration process in which students consider the role that roots, stems, and leaves each have in the process. Next, the class studies photos of selected desert plants and completes a table describing their observations, questions, and hypotheses about how each plant part might be uniquely adapted for transpiration in the desert. Each student completes their own Student Worksheet to bring to the Desert Botanical Garden where they will continue their investigation.

To support the Inquiry in the Garden lesson plans, you may also use the tutorials and Virtual Habitat in DBG’s Digital Desert. These interactive activities will prepare students for their investigations by teaching them about the characteristics of deserts and the Sonoran Desert habitat.

continued…
Materials Note:
(Note: All of the following materials are provided as downloadable graphics.)

- The Water Cycle and Transpiration Process (prepared to share with the class as a print, on an overhead transparency, on a smart board, or as a student handout)
- Student Worksheet – Transpiration Adaptations Table (one copy prepared to share with the class as a print, on an overhead transparency, or on a smart board and one copy per student)
- Teacher Reference – Transpiration Adaptations Table (to use as a guide when completing the Table as a class)
- Roots – photos of desert scene and desert plants:
  - Desert scene 1 (showing dry, desert environment but lush mesquite and saguaro)
  - Desert rainfall data
  - Mesquite tree
  - Saguaro
- Stems – photos of desert scene and succulent desert plants:
  - Desert scene 2 (with many succulents)
  - Saguaro
  - Prickly pear cactus
  - Agave
  - Barrel cactus
- Leaves – photos of desert scene and leaves:
  - Desert scene 3 (showing plants with tiny leaves)
  - Ocotillo
  - Palo Verde Tree
  - Mesquite Tree
  - Creosote bush

continued…
Learning Objectives

Upon completion of this activity, students will be able to...

- Explain how water cycles through plants in the transpiration process.
- Describe the challenges to which plants must adapt in a desert environment.
- Explain the role that roots, stems and leaves have in the transpiration process.
- Ask questions based on observations of desert plants.
- State a relevant hypothesis based on observations and questions.
- Identify a saguaro cactus, mesquite tree, prickly pear cactus, agave, barrel cactus, ocotillo, palo verde, and creosote bush.

Background Knowledge

These are concepts the educator should understand and that can be found in the glossary.

- Condensation
- Hypothesis
- Inquiry Process
- Observation
- Precipitation
- Prediction
- Transpiration
Activity Procedures

1. Introduction.

Explain to students that they will be visiting the Desert Botanical Garden where they will be studying desert plants. Through an inquiry discussion, review with students the name of our desert (the Sonoran Desert) and the characteristics of deserts in general (hot, dry, high evaporation, low rainfall, and extreme temperature fluctuations).

2. Introduce transpiration.

During the field trip, the class will be investigating the transpiration process in desert plants. Specifically, they will be investigating the role that different plant parts play in the process. Commence a class review of transpiration by asking students the following questions:

- How does water cycle through plants in the transpiration process?
- How does water get into plants?
- Through what plant parts does water move?
- Where does water go when it transpires out of plants?


Bring out the graphic image, The Water Cycle and Transpiration Process, and call on students to review the different parts of the cycle. Be sure students understand that the transpiration process is part of the larger water cycle. The process involves the movement of water in plants from the soil into the roots, up through the stems, and up and out through the leaves into the air. While transpiration is specifically the evaporative loss of water through the leaves, the process involves the entire plant. An important part of the cycle is precipitation which occurs when water vapor in the air condenses (condensation) then falls back to the earth as rain, sleet, or snow. Water is then available in the soil to again be a part of the transpiration process in plants.

continued…
**Activity Procedures**

4. Consider transpiration in desert conditions.

Point out that water is the key factor in the transpiration process. Without water, plants’ cells dry up. Plants would not be able to hold their shape and they would not be able to photosynthesize. Simply put, without water, plants die. Ask students to again consider our desert and the conditions of a desert environment (hot, dry, high evaporation, low rainfall, and extreme temperature fluctuations). With this in mind, might desert plants have certain challenges to deal with as they transpire? Ask students what these challenges might be and discuss responses.

5. Introduce and review the *Transpiration Adaptations Table*.

Display the *Student Worksheet – Transpiration Adaptations Table* on the overhead transparency or smartboard and hand out one copy to each student. Explain that for the rest of this activity the class will be following the scientific method to investigate transpiration in desert plants. Refer to the *Table* to explain that as a class, students will review each plant part, the role it plays, and the challenges it faces in the transpiration process. Next, they will observe some photos of desert plants which will likely provoke some questions. They will then come up with a hypothesis about how each plant part might be uniquely adapted for transpiration in the desert and make predictions based on their hypotheses. (*Note: If necessary, review the term adaptation – physical or behavioral characteristics that help a plant or animal survive in its environment.*)

continued…
Activity Procedures

6. Review the scientific method if necessary.

   If necessary, review the scientific method with students and reinforce the steps used in the process. You may use the following as a guide in your discussion:

   The scientific method follows a series of logical steps to help explain the world around us. The steps are:

   **Make observations** – The first step in the process is to observe the world around us and to take note of the natural phenomena that occur.

   **Ask questions** – When something is observed, it usually provokes a question. Asking questions gets our attention and guides our focus.

   **Form a hypothesis** – A hypothesis is a possible explanation that answers the questions provoked by the observations.

   **Make a prediction** – A prediction is made to test the hypothesis. A prediction states what will happen when the hypothesis is tested through some kind of experiment or investigation. A prediction is an “if” “then” statement: “If (the hypothesis) is true, then (the prediction) should happen.

   **Conduct an investigation** – The next step in the process is to perform an experiment to test the prediction.

   **Record results** – The data gathered during an experiment or investigation are the results.

   **State conclusions** – A conclusion states whether or not the hypothesis is true based on the results of the experiment.

   **Share your knowledge** – Allow others to gain knowledge from your findings.

continued…
**Activity Procedures**

7. Complete the *Transpiration Adaptations Table.*

   With the entire class participating, go through the *Transpiration Adaptations Table* row by row beginning with the “roots” row. For each plant part, first complete the “Role in Transpiration Process” and “Challenges in a Desert Environment” columns. Then, bring out the photos associated with that plant part and give students time to carefully observe the photos, state their observations, and come up with a question. Use the *Teacher Reference* as a guide to help direct student responses. As students respond, fill in the table on the transparency or smartboard and give them time to fill in the table on their own *Student Worksheets.* Next, have students come up with a hypothesis – possible explanations for their observations – and write that in the table.

8. Save *Student Worksheets – Transpiration Adaptations Table.*

   Explain that students will continue their investigation at the Desert Botanical Garden. There, they will have the opportunity to answer some of their questions by making and testing predictions based on their hypotheses. Remind students that in the scientific process, one does not always arrive at the right answer all the time. An important part of the process is revising questions and hypotheses based on test results. At the Botanical Garden, you may or may not test your hypotheses exactly as stated, but you will likely come up with answers to your questions!
<table>
<thead>
<tr>
<th>Plant Part</th>
<th>Role in Transpiration Process</th>
<th>Challenges in a Desert Environment</th>
<th>Observations</th>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roots</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stems</td>
<td></td>
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<tr>
<td>Leaves</td>
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</tbody>
</table>
## Transpiration Adaptations Table

**Plant Part** | Role in Transpiration Process | Challenges in a Desert Environment | Observations | Question
---|---|---|---|---
Roots | Roots move water from the soil into the plant. | Limited rainfall makes it difficult to collect water. | Plants need water and there is very little water in the desert. | How do plants collect water? 
Stems | Stems move water from a plant’s roots to its leaves. | Limited rainfall and dry conditions. Plants need to conserve water. | Some saguaro stems appear fat. Some saguaro stems appear skinny. | Why are some saguaro stems fat and some skinny? 
Leaves | Water transpires into the air through the leaves. | Limited rainfall and dry conditions. Plants need to conserve water. | Some desert leaves are small. | Why are desert leaves small?
Inquiry in the Garden

Water Cycle and Transpiration Process
Inquiry in the Garden

Desert Rainfall Data

Average Annual Precipitation (inches)

<table>
<thead>
<tr>
<th>Location</th>
<th>Precipitation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organ Pipe</td>
<td>9.5</td>
</tr>
<tr>
<td>Yuma</td>
<td>3.8</td>
</tr>
<tr>
<td>Calexico</td>
<td>2.4</td>
</tr>
<tr>
<td>Phoenix</td>
<td>7.6</td>
</tr>
<tr>
<td>Gila Bend</td>
<td>6.1</td>
</tr>
<tr>
<td>Tucson</td>
<td>11.2</td>
</tr>
</tbody>
</table>
Desert Scene 1
INQUIRY IN THE GARDEN

Transpiration

Mesquite Tree
Inquiry in the Garden

Transpiration

Saguaro
Transpiration

Desert Scene 2
Prickly Pear
Inquiry in the Garden

Transpiration

Saguaro
Inquiry in the Garden

Transpiration

Agave
Inquiry in the Garden

Transpiration

Barrel Cactus
Desert Scene 3
Ocotillo
Palo Verde
Inquiry in the Garden

Transpiration

Mesquite
Inquiry in the Garden

Transpiration

Creosote
## Related ADE Standards:

### Writing Strand 1: Writing Process

<table>
<thead>
<tr>
<th>Concept 1: Prewriting</th>
<th>Performance Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prewriting includes using strategies to generate, plan, and organize ideas for specific purposes.</td>
<td>PO 1. Generate ideas through a variety of activities (e.g., prior knowledge, discussion with others, printed material or other sources).</td>
</tr>
<tr>
<td></td>
<td>PO 6. Maintain a record (e.g., lists, journal, folder, notebook) of writing ideas.</td>
</tr>
</tbody>
</table>

### Writing Strand 3: Writing Applications

<table>
<thead>
<tr>
<th>Concept 2: Expository</th>
<th>Performance Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expository writing includes nonfiction writing that describes, explains, informs, or summarizes ideas and content. The writing supports a thesis based on research, observation, and/or experience.</td>
<td>PO 1. Record information (e.g., observations, notes, lists, charts, map labels and legends) related to the topic.</td>
</tr>
</tbody>
</table>

### Language Arts Strand 3: Listening and Speaking

<table>
<thead>
<tr>
<th>Standard 3: Listening and Speaking</th>
<th>Performance Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students effectively listen and speak in situations that serve different purposes and involve a variety of audiences.</td>
<td>LS–E3. Interpret and respond to questions and evaluate responses both as interviewer and interviewee.</td>
</tr>
</tbody>
</table>
## Related ADE Standards:

### Science Strand 1: Inquiry Process

#### Concept 1: Observations, Questions, and Hypotheses

<table>
<thead>
<tr>
<th>Performance Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>PO 1. Differentiate among a question, hypothesis, and prediction.</td>
</tr>
<tr>
<td>PO 2. Formulate questions based on observations that lead to the development of a hypothesis.</td>
</tr>
</tbody>
</table>

#### Concept 1: Structure and Function in Living Systems

<table>
<thead>
<tr>
<th>Performance Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>PO 1. Explain the importance of water to organisms.</td>
</tr>
<tr>
<td>PO 6. Relate the following structures of living organisms to their functions:</td>
</tr>
<tr>
<td>Plants</td>
</tr>
<tr>
<td>• transpiration – roots</td>
</tr>
<tr>
<td>• absorption – roots</td>
</tr>
<tr>
<td>PO 7. Describe how the various systems of living organisms work together to perform a vital function</td>
</tr>
</tbody>
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