Desert Plant Adaptations - Teacher's Guide

Abstract

In this two-part lesson, students perform an experiment to learn about a common desert plant adaptation - waxy leaf coverings. They also examine desert plant leaf samples to make careful observations and become familiar with common desert plants.

Grade level: 4th

Duration and Teacher Preparation

Preparation: 20 minutes

Activity

Part 1 - Plant observations and setting up sponge cacti (60 minutes)

Part 2 - Weighing sponges and analyzing data (60 minutes)

Next Generation Science Standards

- 4-LS1-1. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior and reproduction.

Common Core Standards

- 4.G.A.3 Recognize a line of symmetry for a two-dimensional figure as a line such that the figure can be folded across the line into matching parts. Identify line-symmetric figures and draw lines of symmetry.

Reference pages from Glimpse of the Chihuahuan Desert: pages 31-41

Materials (consumables underlined):

- 2 sponges cut into cactus pad shapes for each team (24 in kit)
- 1 plastic cup for each team (12 in kit)
- 2 foam plates per team (24 in kit)
- 3 scales
- 2 squares of wax paper for each team
- 12 rolls of tape
- Laminated leaf samples (5 species; 3 samples of each)
- 1 photo of banana and maple leaves
- 10 rulers
- Students need worksheets and pencils

Background

Chihuahuan Desert plants have developed numerous **adaptations** that allow them to cope with the low water availability in this environment. Some adaptations allow desert plants to collect and store water more efficiently. For example, perennial grass roots that are shallow and dense collect water quickly when it rains. Other plants, like honey mesquite, have deep roots that can tap into longer-term water sources. The barrel cactus has accordion pleating that allows it to expand and store large quantities of water when it is available.

Many other adaptations help plants reduce **transpiration**, the evaporation of water into the atmosphere from plant leaves and stems. For example, cacti and some other **succulents** use a special type of **photosynthesis** that functions only at night when temperatures are lower and humidity is higher. This reduces their water loss. Many desert plants have small leaves, thus reducing the **surface area** of the leaf exposed to the sun and wind. Another common desert plant adaptation is a waxy coating on the leaves to reduce water loss.

Conocimiento de fondo

Las plantas del Desierto Chihuahuense han desarrollado **adaptaciones** numerosas que les permiten sobrellevar el bajo abastecimiento de agua en este medio ambiente. Algunas adaptaciones permiten que las plantas colecten y almacenen agua con más eficiencia. Por ejemplo, las raíces cortas y densas del pasto perenne colectan el agua rápidamente cuando llueve. Otras plantas, como el mezquite, tienen raíces profundas que pueden alcanzar fuentes de agua a largo plazo. La biznaga tiene pliegues que la permite ampliar y guardar cantidades grandes de agua cuando está disponible.

Muchas otras adaptaciones ayudan a las plantas a reducir la **transpiración**, la evaporación de agua de las hojas y tallos de las plantas hacia la atmósfera. Por ejemplo, los cactos y algunos otros **suculentos** usan un tipo especial de **fotosíntesis** que funciona solamente en la noche cuando las temperaturas son más bajas y la humedad es más alta. Esto reduce su pérdida de agua. Muchas plantas desérticas tienen las hojas pequeñas, así reduciendo el **área superficial** de la hoja expuesta al sol y viento. Otra adaptación común de las plantas desérticas es una capa de cera en sus hojas para reducir la pérdida de agua.

Procedures - Part 1 (Plant Observations)

1. Inside the kit, you will find three samples of five species of common desert plants.

2. Distribute the plant samples around the classroom in stations and have students rotate through the stations to make careful observations on all five species.

3. Assist students as they make careful observations, fill out the Desert Plant Observations Table, and then complete the Analysis and Discussion questions.

Procedures - Part 2 (Sponge Cactus)

1. Using the background information and/or the desert plant and animal adaptations CD, discuss a few desert plant adaptations with your students.

2. Students should work in pairs or groups of three. There are supplies for up to 10 groups.

3. Go over the procedures listed on the worksheets with your students.

4. Emphasize that students should be very careful not to crease or crumple the wax paper as they construct the wax paper pouch. This will break the wax seal on the paper and affect the experiment results.

5. Choose how long you would like the experiment to run. The evaporation rate is affected by the temperature and humidity in your classroom, but there is generally enough difference in control and wax paper pouch sponges after just one day.

6. Help students complete the data tables and Analysis and Discussion questions.

Glossary

adaptation (*adaptación*) - a behavior or structure that allows a plant or animal to better survive and reproduce in a particular environment

control (*control*) - a subject in an experiment where the treatment is not applied, thereby serving as a comparison with the experimental group

line of symmetry (*línea de simetría*) - for a two-dimensional figure, the line across the figure such that the figure can be folded along the line into two matching parts

mean (*media*) - also called the "arithmetic mean," this is a measure of the central tendency of a group of numbers. For a set of data, the mean is calculated by taking the sum of the data and then dividing by the number of values in the set.

photosynthesis (*fotosíntesis*) - the process by which organisms like plants turn carbon dioxide and water into carbohydrates (glucose) and oxygen using energy from the sun

succulent (*suculenta*) - a plant with thick, fleshy leaves or stems which retain water

surface area (*área superficial*) - the total area of the surface of a three-dimensional object

transpiration (*transpiración*) - the evaporation of water into the atmosphere from plant leaves and stems

Glosario

adaptación (*adaptation*) - un comportamiento o estructura que permite que la planta o el animal sobreviva mejor y se reproduzca en un ambiente particular

área superficial (*surface area*) - el área total de la superficie de un objeto de tres dimensiones

control (*control*) - un sujeto en un experimento en el que no se aplica el tratamiento, sirviendo así para comparación con el grupo experimental

eje de simetría (*line of symmetry*) - para una figura de dos dimensiones, la línea imaginaria que atraviesa la figura de tal manera que la figura se puede doblar a lo largo de la línea en dos partes que hacen juego

fotosíntesis (*photosynthesis*) - el proceso por el cual los organismos como las plantas convierten el dióxido de carbono y el agua en carbohidratos (glucosa) y oxígeno usando energía del sol

media (*mean*) - también llamada "media aritmética," ésta es una medida de la tendencia central de un grupo de números. Para un grupo de datos, la media se calcula sumando los datos y después dividiendo por el número de valores en el grupo.

suculenta (*succulent*) - plantas con hojas gruesas y pulposas o tallos que almacenan agua

transpiración (*transpiration*) - la evaporación de agua de las hojas y tallos de las plantas hacia la atmósfera

Plant Adaptations - Part 1

Question: What are some common characteristics of desert plant leaves?

Materials

- Pressed, laminated samples of five Chihuahuan Desert plant leaves
- Ruler

Procedures

1. Make careful observations of the five pressed desert plant samples. For each sample, fill out a row of the Desert Plant Observations Table below.

2. Answer the Analysis and Discussion questions.

Desert Plant Observations Table

Species name	Length	Width at widest point	Is there a line of symmetry?	Other observations
Creosote bush	11 mm	13 mm	Yes	Leaf has two parts and a waxy coating
Honey mesquite	31 mm	4 mm	Yes	Leaf has small leaflets. Leaves pale green.
Tarbush	38 mm	11 mm	Yes	Coating on the leaves
Desert holly	52 mm	49 mm	No	Spikes on leaf tips
Fourwing saltbush	19 mm	1 mm	Yes	Pale, dusty green color leaves

Analysis and Discussion

1. How does the size of desert plant leaves compare to the size of non-desert plant leaves (e.g, maple leaves or banana leaves)? Why do you think this relationship exists?

   Desert plant leaves are smaller. Plants lose water through their leaves. By having smaller leaves, they lose less water.

2. Based on your observations of these plant samples, name at least two desert plant adaptations for survival in a dry environment.

   Desert plants have small leaves. Some have waxy leaf coatings. Some have little hairs on the leaves.

Desert Plant Adaptations - Part 2

Question: Which sponge "cactus" will lose the most water, the one with the waxy coating or the one without the waxy coating (the control)?

Hypothesis: We think the wax paper may soak up water from the sponge, so these sponges may lose more than the controls. (Note to teachers: Although this hypothesis is incorrect, it is a common hypothesis given by students. Please emphasize that scientists have incorrect hypotheses all the time; this is how we learn!)

Materials:

- 2 sponges cut in cactus pad shapes
- 1 plastic cup with water
- 2 wax paper squares
- Tape
- 2 foam plates
- Scale (for whole class to use)

Procedures

1. Read the question for this experiment, and write your hypothesis in the space above.
2. Collect your materials.
3. Place both of your sponges in the plastic cup with water. Watch the water soak into them.
4. Leave the sponges in the water while you create a small wax paper pouch for one of your sponges. **Be very careful with this process and try to keep the wax paper smooth and flat. If you fold or crumple the wax paper, it will not work well in this experiment.** Place one wax paper square on top of the other. Carefully tape three sides of the pouch, leaving the top open for now.
5. Take the sponges out of the water. Hold them over the plastic cup and turn them slowly to let excess water fall off. The goal is to have sponges that have soaked up all the water they can but are not still dripping.

6. Make sure the scale reads 0 g before you weigh your first sponge. You may have to press "Tare" to reset the scale.
7. Place your sponge on the scale and record the initial weight on the Sponge Cactus Data Table on the next page. This is your **control** sponge.
8. Place this first sponge directly on the foam plate (not in the wax paper pouch).
9. Turn off the scale and dry off the top.
10. Turn the scale on, make sure it reads 0 g, and then weigh your second sponge. Place this sponge inside the wax paper pouch you made in step 4. Record the weight on the Sponge Cactus Data Table.

Desert Plant Adaptations - Part 2

11. Carefully fold over the top of the wax paper pouch and tape it closed. Place the wax paper pouch on the second foam plate.

12. Use a piece of tape to label the plates with your name and the names of your partners.

13. After one day, carefully weigh your control sponge and record the final weight in the data table below.

14. Remove your other sponge from the wax paper pouch. Weigh this sponge and record the final weight in the data table below.

15. Calculate the total weight loss for your sponges (starting weight minus final weight).

16. With your class, fill out the Class Results Table on the next page.

17. Calculate the **mean** water lost in the control sponges and the **mean** water lost in the sponges that were in the wax paper pouches (directions are on the data table).

18. Answer the Analysis and Discussion questions.

Sponge Cactus Data Table

	Weight of the control sponge cactus	Weight of the sponge cactus in the wax paper pouch
Starting weight	52.6 g	56.8 g
Final weight	32.4 g	49.0 g
Total weight of water lost (starting weight minus final weight)	20.2 g	7.8 g
Total weight lost <u>rounded to the nearest gram</u>	20 g	8 g

Class Results Table

Group Number	Weight of Water Lost by **Control Sponge Cactus**	Weight of Water Lost by **Sponge Cactus in Wax Paper Pouch**
1	20 g	8 g
2	22 g	9 g
3	22 g	8 g
4	21 g	9 g
5	20 g	8 g
6	21 g	8 g
7	20 g	8 g
8		
9		
10		
Sum (total weight lost by all sponges in the column)	146 g	58 g
Mean (sum divided by the number of sponges in each group)	20.9 g	8.3 g

Analysis and Discussion

1. Which of <u>your</u> two sponges lost the most water? The control sponge.

2. When you examined the class results, which type of sponge cactus lost the most water?
   The control sponges.

3. Compare your answer to #2 with your hypothesis. Was your hypothesis correct or incorrect?
   My hypothesis was incorrect.

4. Based on the results of your experiment, why do you think many desert plants have a waxy coating on their leaves? Use another piece of paper if you need more room to explain your answer.

There is not much water in the desert, so it is very important for desert plants to be able to collect and keep all the water they can. A waxy coating helps reduce evaporation from the leaves, so it is a good adaptation for desert plants.

Name: _____ Date: _____

Desert Plant Adaptations - Part 1

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Procedures

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2. Answer the Analysis and Discussion questions.

Desert Plant Observations Table

Species name	Length	Width at widest point	Is there a line of symmetry?	Other observations

Analysis and Discussion

1. How does the size of desert plant leaves compare to the size of non-desert plant leaves (e.g, maple leaves or banana leaves)? Why do you think this relationship exists?

_____

2. Based on your observations of these plant samples, name at least two desert plant adaptations for survival in a dry environment.

_____

_____

Name: _____ Date: _____

Desert Plant Adaptations - Part 2

Question: Which sponge "cactus" will lose the most water, the one with the waxy coating or the one without the waxy coating (the control)?

Hypothesis: _____

_____

Materials

- 2 sponges cut in cactus pad shapes
- 1 plastic cup with water
- 2 wax paper squares
- Tape
- 2 foam plates
- Scale (for whole class to use)

Procedures

1. Read the question for this experiment, and write your hypothesis in the space above.
2. Collect your materials.
3. Place both of your sponges in the plastic cup with water. Watch the water soak into the sponges.
4. Leave the sponges in the water while you create a small wax paper pouch for one of your sponges. **Be very careful with this process and try to keep the wax paper smooth and flat. If you fold or crumple the wax paper, it will not work well in this experiment.** Place one wax paper square on top of the other. Carefully tape three sides of the pouch, leaving the top open for now.

5. Take the sponges out of the water. Hold them over the plastic cup and turn them slowly to let excess water fall off. The goal is to have sponges that have soaked up all the water they can but are not still dripping.
6. Make sure the scale reads 0 g before you weigh your sponge. You may have to press "Tare" to reset the scale.
7. Place your sponge on the scale and record the initial weight on the Sponge Cactus Data Table on the next page. This is your **control** sponge.
8. Place this first sponge directly on the foam plate (not in the wax paper pouch).
9. Turn off the scale and dry off the top.
10. Turn the scale on, make sure it reads 0 g, and then weigh your second sponge. Place this sponge inside the wax paper pouch you made in step 4. Record the weight on the Sponge Cactus Data Table.

Name: _____ Date: _____

Desert Plant Adaptations - Part 2

11. Carefully fold over the top of the wax paper pouch and tape it closed. Place the wax paper pouch on the second foam plate.

12. Use a piece of tape to label the plates with your name and the names of your partners.

13. After one day, carefully weigh your control sponge and record the final weight in the data table below.

14. Remove your other sponge from the wax paper pouch. Weigh this sponge and record the final weight in the data table below.

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18. Answer the Analysis and Discussion questions.

Sponge Cactus Data Table

	Weight of the control sponge cactus	Weight of the sponge cactus in the wax paper pouch
Starting weight		
Final weight		
Total weight of water lost (starting weight minus final weight)		
Total weight lost <u>rounded to the nearest gram</u>		

Name: _____ Date: _____

Class Results Table

Group Number	Weight of Water Lost by **Control Sponge Cactus**	Weight of Water Lost by **Sponge Cactus in Wax Paper Pouch**
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
Sum (total weight lost by all sponges in the column)		
Mean (sum divided by the number of sponges in each group)		

Analysis and Discussion

1. Which of <u>your</u> two sponges lost the most water? _____

2. When you examined the class results, which type of sponge lost the most water?_____

3. Compare your answer to #2 with your hypothesis. Was your hypothesis correct or incorrect?

_____

4. Based on the results of your experiment, why do you think many desert plants have a waxy coating on their leaves? Use another piece of paper if you need more room to explain your answer.

_____

_____

_____

_____

Nombre: _____ Fecha: _____

Adaptaciones de Plantas - Parte 1

Pregunta: ¿Cuáles son algunas características comunes de las hojas de las plantas desérticas?

Materiales
- Cinco muestras de hojas prensadas y laminadas de plantas del Desierto Chihuahuense
- Reglas

Procedimientos
1. Haz observaciones cuidadosas de las cinco muestras prensadas de las plantas desérticas. Para cada muestra, llena un renglón en la Hoja de Observaciones de Plantas del Desierto abajo.

2. Contesta las preguntas de Análisis y Discusión.

Hoja de Observaciones de Plantas del Desierto

Nombre de la especie	Largo	Anchura al punto más ancho	¿Hay un eje de simetría?	Otras observaciones

Análisis y Discusión

1. ¿Cómo se compara el tamaño de hojas de plantas desérticas con el tamaño de hojas de plantas que no son del desierto (ej., hojas de arce u hojas de bananas)? ¿Por qué piensas que esta relación existe?

_____

2. Basado en tus observaciones de estas muestras de hojas, nombra a lo menos dos adaptaciones de plantas desérticas para sobrevivir en un medio ambiente tan seco.

_____

_____

Nombre: _____ Fecha: _____

Adaptaciones de Plantas Desérticas - Parte 2

Pregunta: ¿Cuál ¨cacto¨ de esponja perderá la mayor cantidad de agua, el cacto con la capa de cera o el cacto sin la capa de cera (el control)?

Hipótesis: _____

_____

Materiales:

- 2 esponjas cortadas en forma de penca de cacto
- 1 vaso de plástico con agua
- 2 cuadrados de papel encerado
- Cinta adhesiva
- 2 platos de poliestireno
- Balanza (para la clase entera)

Procedimientos

1. Lee la pregunta para este experimento y escribe tu hipótesis en el espacio arriba.

2. Colecta tus materiales.

3. Coloca tus dos esponjas en el vaso de plástico con agua. Observa como el agua penetra en las esponjas.

4. Deja las esponjas en el agua mientras creas una bolsa pequeña de papel encerado para una de tus esponjas. **Ten cuidado con este proceso y trata de mantener el papel encerado liso y plano. Si doblas o estrujas el papel encerado, no servirá bien en este experimento.** Coloca un cuadrado de papel encerado encima del otro. Con cuidado pon cinta adhesiva en tres lados de la bolsa, dejando abierta la parte de arriba por ahora.

5. Saca las esponjas del agua. Detenlas sobre el vaso de plástico y dales vuelta lentamente para permitir que el exceso de agua caiga. La meta es tener esponjas que han absorbido toda el agua posible pero no gotean.

6. Asegúrate que la balanza diga “0 g” antes de pesar tu esponja. Puede ser que tengas que oprimir ¨Tare¨ para reiniciar la balanza.

7. Pon tu esponja en la balanza y anota el peso inicial en la Hoja de Datos de Cacto de Esponja. Ésta es la esponja de **control**.

8. Coloca esta esponja directamente en el plato de poliestireno (no en el bolsillo de papel encerado).

9. Apaga la balanza y seca la parte de arriba.

Nombre: _____ Fecha: _____

Adaptaciones de Plantas Desérticas - Parte 2

10. Enciende la balanza, asegúrate que diga “0 g” y después pesa la segunda esponja. Coloca esta esponja dentro de la bolsa de papel encerado que has hecho en el Paso #4. Anota el peso en la Hoja de Datos de Cacto de Esponja.

11. Con cuidado dobla la parte superior de la bolsa de papel encerado y pon cinta para cerrarlo. Pon la bolsa de papel encerado en el segundo plato de poliestireno.

12. Usa un pedacito de cinta adhesiva para rotular los platos con tu nombre y los nombres de tus compañeros.

13. Después de un día, pesa tu esponja de control con cuidado y anota el peso final en la hoja de datos abajo.

14. Remueve tu otra esponja de la bolsa de papel encerado. Pesa esta esponja y anota el peso final en la hoja de datos abajo.

15. Calcula la pérdida total de peso de tus esponjas (peso inicial menos peso final).

16. Con tu clase, llena la Tabla de Resultados de la Clase en la próxima página.

17. Calcula la **media** de pérdida de agua de las esponjas de control y la **media** de pérdida de agua de las esponjas que estuvieron en las bolsas de papel encerado (instrucciones están en la tabla de datos).

18. Contesta las preguntas de Análisis y Discusión.

Hoja de Datos: Cacto de Esponja

	Peso del cacto de esponja de control	Peso del cacto de esponja en la bolsa de papel encerado
Peso inicial		
Peso final		
Peso total de agua perdida (peso inicial menos peso final)		
Peso total perdido <u>redondeado al gramo más cercano</u>		

Nombre: _____ Fecha: _____

Hoja de Resultados de la Clase

Número del grupo	Peso de agua perdida por el **Cacto de Esponja de Control**	Peso de agua perdida por el **Cacto de Esponja en Bolsa de Papel Encerado**
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
Suma (peso total perdido por todas las esponjas en la columna)		
Media (suma dividida por el número de esponjas en el grupo)		

Análisis y Discusión

1. ¿Cuál de tus dos esponjas perdió más agua? _____

2. Cuando examinaste los resultados de la clase, ¿cuál tipo de esponja perdió más agua?

_____

3. Compara tu respuesta a la #2 con tu hipótesis. ¿Estaba tu hipótesis correcta o incorrecta?

_____

4. Basado en los resultados de tu experimento, ¿por qué piensas que muchas plantas del desierto tienen una capa de cera en sus hojas? Usa otra hoja de papel si necesitas más espacio para explicar tu respuesta.

_____

_____

_____