GYSTC
GEORGIA YOUTH SCIENCE & TECHNOLOGY CENTERS

Title: Desert Microbe STEM Challenge Simulation

Estimated Time: 1-2 periods

Core Ideas (GSE Standard and elements):

S3L1. Obtain, evaluate, and communicate information about the similarities and differences between plants, animals, and habitats found within geographic regions (Blue Ridge Mountains, Piedmont, Coastal Plains, Valley and Ridge, and Appalachian Plateau) of Georgia.

b. Construct an explanation of how external features and adaptations (camouflage, hibernation, migration, mimicry) of animals allow them to survive in their habitat.

S7L5. Obtain, evaluate, and communicate information from multiple sources to explain the theory of evolution of living organisms through inherited characteristics.

b. Construct an explanation based on evidence that describes how genetic variation and environmental factors influence the probability of survival and reproduction of a species.

Literacy Connections: Books	Literacy Connections: Close Reads
Why Oh Why Are Deserts Dry, Tish Rabe Creatures of the Desert World, NatGeo	Amazing Adaptations Close Read
Science and Engineering Practices: **Developing and Using Models**: Develop and/or use a model to generate data to test ideas about phenomena in natural or designed systems, including those representing inputs and outputs, and those at unobservable scales. **Constructing Explanations and Designing Solutions:** Construct an explanation using models or representations.	**Crosscutting Concepts:** **Structure and Function:** Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the shapes, composition, and relationships among its parts; therefore, complex natural and designed structures/systems can be analyzed to determine how they function.

STEM Challenge Overview

It is likely that scientists have recently discovered and isolated a desert microbe that has an incredible ability to absorb water during the few and far between times when it rains in their natural environment. As a starting point, scientists want to know how much water the microbe can absorb relative to its body mass.

In this STEM Challenge, your job is to calculate how much water the desert microbe can ingest. As part of this challenge, you will also have to decide when the microbe has become saturated and can no longer absorb additional water. Please keep a very careful record of your measurements and calculations as they will all be essential to building an understanding of this new organism.

Since the microbe may be toxic, you are not to touch the microbe under any circumstances. Use the equipment available to handle it and wear safety goggles.

Ask	Allow the students to **ask** questions about adaptations and discuss their importance with respect to the survival of living things. Present a few interesting examples.

	Have them read the ***Amazing Adaptations*** article and discuss how desert plants and animals are uniquely adapted to their extreme environment.
Imagine/Brainstorm	Introduce the newly discovered desert microbe and have students **imagine** other ways it might be adapted for its extreme environment. Then, focus in on the water ingesting ability of the microbe and have students **brainstorm** how they plan to measure the water ingestion and how they will collect data and complete their calculations.
Plan/Design	Students **plan** and **create** a data table for your measurements and draw the table in the space provided below.
Create/Test	Students follow the procedure as they **test** the water absorbing ability of their microbe. Once the testing is complete, they use their data to calculate the total amount of water ingested by the microbe. Each group should put their data on the board so it can be compared and discussed. They also carefully sketch a picture of the saturated microbe.
Improve	After discussing and evaluating their results as a group, students suggest ways they could **improve** their procedure, measurements, and data collection. If time permits, they can test another sample.

Teacher Notes:

This is a super engaging modeling activity that incorporates adaptations, imaginations and measurement prowess. Here is an overview of the big ideas for this lesson. They are included in the student reading that I recommend for students before they do the STEM challenge.

Key ideas:

1) Both animals and plants are well suited to survive and reproduce because they can **adapt** or change in beneficial ways to new conditions and surroundings. They have been adapting and changing for millions of years.
2) Organisms can adjust, or adapt, to their environment in a variety of ways. Some of these adjustments are made in response to daily or cyclic changes that the organism may experience such as when:
   The color of a chameleon changes to blend in with the surroundings.
   A dog sheds its thick coat of fur at the start of spring.
3) In nature, when a genetic change occurs that helps a plant or animal to survive and reproduce, this change is called an **adaptation**.
4) The plants and animals with favorable traits (adaptations) are more likely to survive and have babies than animals who lack these traits (Natural Selection).
5) Adaptations may involve:
   a) a different an external feature of an animal such as **camouflage**, big ears, or thick fur
   b) a **behavior** such as hibernation for artic animals, or submissive behavior for a weaker wolf
   c) other protective improvements such as a more toxic venom for a snake or a harder shell for a turtle

After highlighting the importance of adaptation in general, you can focus in on the special ways that desert plants and animals have adapted to extremes of heat and dryness by using both physical and behavioral mechanisms. In particular, their ability to store and conserve water is quite impressive. Water can be stored by animals in fatty deposits in their tails and other tissues. In plants, water can be stored in the roots, stems, and/or leaves of plants. These organisms are also adapted to minimize water loss and from out of the skin, from urine and feces, and even from breathing.

When students calculate the amount of water absorbed they should obtain somewhere around 150 - 200 milliliters of water (this will vary quite a bit depending on what they considered as saturated). Since they started with .5 grams of microbe, this would represent an ability to absorb 300-400 times its own body weight (150ml/.5g microbe).

Unfortunately, we haven't actually discovered a super absorbing microbe in nature – that's why we call it a STEM Challenge Simulation. Rather, this simulated microbe is actually a chemical compound commonly known as Waterlock.

The scientific name for Waterlock is sodium polyacrylate and it is normally found in the form of small white crystals that resemble powdered sugar. It was invented by scientists about 40 years ago and it has the amazing ability to absorb hundreds of times its own weight in water. Waterlock is often used in situations where water and other liquids are undesirable. Plumbers use it to soak up standing pools of water when the water pipes break in a house. Emergency rooms use it to bind up the liquid blood from injured patients that drips on tables and floors. Its most common use, however, is in disposable diapers.

Sodium polyacrylate is a polymer – a long molecule made up of repeating chains of atoms. When these chains are surrounded by water molecules, each chain "unwinds" and exposes binding sites for the water molecules. These binding sites attach to the water molecule and bind them up in gel form so that the water is no longer able to flow freely. While Waterlock's ability to absorb water is amazing, it is not infinite and once all the binding spots for water are occupied, it cannot bind any additional water molecules. The sodium polyacrylate is effectively saturated and its capacity to absorb water is reached.

Sodium polyacrylate can absorb about 800 times its own weight in distilled water but only about 300 times in own weight in tap water since it contains other substances such fluoride, chlorine, and mineral salts. I would recommend doing the simulation with tap water but you can use distilled water for maximum results. While the directions suggest you start with .5 grams of Waterlock, you can tweak that amount depending on your supply of materials. In addition, make sure that students are very careful with their "microbe" throughout this experiment. While the Waterlock is non-toxic, it should be treated with caution since the powder (or gel) can get in their eyes and cause irritation. Make sure they wear goggles throughout the experiment, keep their hands off the microbe, and wash thoroughly at the end of the experiment. If students do get any powder or gel in their eyes, make sure they rinse them profusely in an eye wash for 10-15 minutes.

Extension:
As an extention (highly recommended) have students read the ***Wonderful Waterlock*** article. After doing so, discuss the amazing properties and uses of Waterlock. Finally, this experiment provides an excellent model of an engineered system where the function of the material (Waterlock) depends on the shape and composition of this polymer molecule. Have your students describe how the shape of the molecule helps it to effectively function as a super absorber (crosscutting concept). It truly is a most amazing molecule.

Materials Needed (per group:
.5 gram sample of microbe (sodium polyacrylate). www.steve.spangler.com (he calls it Water Gel)
Small container for microbe sample.
Plastic plate, petri dish, or similar dish.
Graduated cylinder or similar measuring device.
Plastic spoon.
Plastic gloves (optional).
Measuring scale or balance
Green food coloring (mix 2-3 drops of food coloring per gram of microbe that you mix up – this makes it look much more realistic).

Microbe Sample

Microbe Sample (partially saturated)

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Vocabulary Cards:

adapt

changing to new conditions or surrounding

adaptation

a genetic change that helps an organism to survive

Producing unpleasant smells can be a very useful adaptation

conserve

to use and preserve wisely

The waxy skin and thin needles of this cactus both help to conserve water

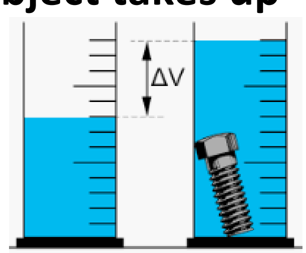
camouflage

to hide or disguise in order to promote survival

Camouflage helps predators and prey blend into their environment

volume

amount of space a substance or object takes up



engineer

to design, build, and improve things

Desert Microbe

Desert Microbe STEM Challenge Simulation:

Can you calculate how much water a desert microbe can ingest?

In this STEM Challenge, your job is to calculate how much water the newly discovered desert microbe can ingest. As part of this challenge, you will also have to decide when the microbe has become saturated and can no longer absorb additional water. Before beginning the challenge, read the article *Amazing Adaptations* to learn more about how organisms are adapted to extreme environments.

Criteria of the challenge:

- You will have one .5 gram sample of the microbe to test
- You will have a graduated cylinder to measure water, water, and plastic spoon.
- You must accurately record your data and calculate the total volume (amount) of water that microbe was able to absorb.

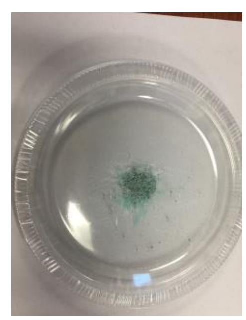
Microbe Sample

Constraints of the challenge:

- You are limited to the materials provided by the teacher.
- You can only have one sample of microbe to test.
- You must complete the challenge by the end of the class period.
- You must not touch the microbe as it may be dangerous.
- You must wear your safety goggles throughout the challenge.

Procedure:

1. With your partner, brainstorm ideas regarding how you plan to measure the water ingestion and how you will collect data and complete their calculations regarding how much water the microbe can ingest.
2. Plan and create a data table for your measurements and draw the table in the space provided below.
3. After completing your data table, place the sample of microbe in the center of a small plastic plate or plastic cup.
4. Begin to add water slowly about 10 ml at a time to the microbe. As needed, mix the water in with the microbe as needed with a plastic spoon.



Our data table:

Calculations of volume (amount) of water absorbed.

Sketch of saturated microbe:

Evaluating and Improving:

1. After completing your calculations, put your data on the board so you can compare your results with the other groups in the class. How did your results compare with other groups?

2. If you were able to repeat this experiment again, what steps would you take to improve your procedure and make it more accurate and precise?

3. Do you think that simulations like this are useful and helpful learning experience? Explain your answer.