

Red Planet:

Read, Write,
Explore!

Lesson 3: Going to Extremes

Description of Lesson: After reading aloud a text on life in extreme environments, students will discuss what life is and the requirements of life. Groups of students will conduct an experiment of their choosing on chia seeds to explore how extreme environments affect the growth of the plant. After conducting their experiments, they will write and illustrate a fictional story about an imaginary life form on Mars.

Background (See also “Background” from Lessons 1 and 2):

Life as we *know* it needs a source of nutrients, some kind of energy, and liquid water to survive. Life doesn’t even need sunlight to survive; it can get energy from geothermal sources or chemical reactions. Many argue that life doesn’t need water to survive and that other liquids would suffice.

Astrobiology is the study of life and the possibility that life could exist elsewhere in the Universe. Astrobiologists, in part, study life that lives, survives, and thrives in extreme environments of Earth. We find life pretty much everywhere we find water on Earth, even if the water is highly acidic or basic, very cold, or very hot (nearly boiling)! We find plant seeds that are thousands of years old frozen in permafrost, and they grow with a little laboratory coaxing. There are even microscopic creatures that love radiation! As long as there is a source for nutrients and energy, and water, life thrives.

Scientists wonder if life could have evolved anywhere in the Universe besides Earth, so they look for traces of water in the Solar System. Mars is intriguing because it likely had water flowing on it at some point in its history and it may even have liquid water underground, perhaps heated by geothermal processes. Maybe life briefly formed on Mars around the same time it first formed on Earth 3.5 billion years ago. Did it have enough time to form before the atmosphere was lost to space? If it did evolve, could it have survived after the atmosphere was lost? The MAVEN mission will help gather information about how much water Mars had and determine when Mars lost its atmosphere.

Most scientists agree it is unlikely that Mars harbors life today. The surface doesn’t have liquid; the thin atmosphere lacks a protective ozone layer, which means dangerous levels of ultraviolet radiation (UV) reach the ground; and Mars lacks a global magnetic field. On Earth, our magnetic field shields us from solar energetic particles that can damage organic tissue. On Mars, the particles directly impact the surface. Since the likelihood of finding living bacteria today is low due to the extreme environment, scientists instead think about finding fossils of bacteria that perhaps formed in the first billion years or so after the planet formed.

Recommended additional materials:

For Grade 5 (or advanced Grade 4), watch the *Science Friday* video, “Behold the Mighty Water Bear,” available on the accompanying CD, on the MAVEN website: <http://lasp.colorado.edu/home/maven/education-outreach/for-educators/red-planet/>, or directly from the *Science Friday* website:

<http://www.sciencefriday.com/video/01/23/2009/ behold-the-mighty-water-bear.html>

Benchmarks for Science Literacy, Project 2061 (Grades 3-5)**The Nature of Science**

Scientific Inquiry: Scientific investigations may take many different forms, including observing what things are like or what is happening somewhere, collecting specimens for analysis, and doing experiments. 1B/E1

The Living Environment

- *Interdependence of Life: For any particular environment, some kinds of plants and animals thrive, some do not live as well, and some do not survive at all. 5D/E1*
- *Flow of Matter and Energy: Some source of "fuel" is needed for all organisms to stay alive and grow. 5E/E2*

Common Core for English Language Arts**Writing**

- *W.3.3., 4.3, 5.3 Write narratives to develop real or imagined experiences or events using effective technique, descriptive details, and clear event sequences.*
- *W.3.7., 4.7, 5.7 Conduct short research projects that build knowledge about a topic.*
- *W.4.9., 5.9 Draw evidence from literary or informational texts to support analysis, reflection, and research.*

Speaking and Listening

- *SL.3.2. Determine the main ideas and supporting details of a text read aloud or information presented in diverse media and formats, including visually, quantitatively, and orally.*
- *SL.3.4., 4.4, 5.4 Report on a topic or text, tell a story, or recount an experience with appropriate facts and relevant, descriptive details, speaking clearly at an understandable pace.*

Lesson Time: Two 45-minute periods for the main lesson, and the one-week project, “Chia Seeds from Outer Space!” (included)

Choose one or more of the following books to read aloud:

- Breidahl, Harry. 2002. *Dark Secrets: Life Without Sunlight*. Broomall, Penn.: Chelsea House Publishers. (Grade 4)

- Ride, Sally and Tam O'Shaughnessy. *The Mystery of Mars*. San Diego: Sally Ride Science. (Grades 3 and up) pp 34-41

Choose one or more of the following books as a classroom resource:

- Breidahl, Harry. 2002. *Dark Secrets: Life Without Sunlight*. Broomall, Penn.: Chelsea House Publishers. (Grade 4)
- Kobasa, Paul ed. 2007. *Solar System and Space Exploration Library: Mars*. Chicago. (Grades 3 and up) p 60
- Murray, Stuart. 2004. *Eyewitness Mars*. London: DK Publishing, Inc. (Grade 3 and up) p 50
- Ride, Sally and Tam O'Shaughnessy. 2006. *The Mystery of Mars*. San Diego: Sally Ride Science. (Grades 2 and up)
- Vogt, Gregory L. 2007. *The Biosphere: Realm of Life*. Minneapolis: Twenty-First Century Books. (Grade 5) ch. 1-3

Materials:

- One or more of the books listed to read aloud
- One or more of the classroom resource books
- One small pebble
- One small package of chia seeds (eight grams)
- One roll of absorbent paper towels
- One box zip-to-seal sandwich bags
- One permanent marker
- One small plastic bowl per student
- One tray per student
- One pitcher for water

Notes on Materials:

Chia seeds can be purchased at most natural food stores as a dietary supplement, typically for around one dollar for eight grams. Before beginning the activity with students, make sure the seeds are able to sprout. See the procedure from "Chia Seeds from Outer Space," below.

Procedure:

- Read one of the recommended books to students, and based upon the reading, help students come up with a definition of life and what it means to be alive.
- Write the students' definition on the board after they discuss it as a class.
- Discuss: What makes Earth such a great place for life? What makes Mars inhospitable (not good for life)? Do you think Mars ever could have had life? What do you think life on Mars would have been like?
- Conduct the activity, "Chia Seeds from Outer Space," with students (included).
- Have students write and illustrate a fictional story about the life of an imaginary life form on Mars, including factual information, such as:
 - Timeframe the life form existed in, and what the Mars was like at the time (from Lesson 2)
 - How or if the life form survived
 - What characteristics of the life form enabled it to survive

- Where on the planet the life form lives
- What things the life form uses on Mars to survive (i.e. energy, water, nutrients)
- After students write their stories, have them share them with the class.
- Make sure to emphasize that we have never found evidence of life on Mars!

References used to create lesson:

Yashinaa, Svetlana et al. 2012. "Regeneration of whole fertile plants from 30,000-y-old fruit tissue buried in Siberian permafrost." *Proceedings of the National Academy of Sciences* 109(10): 4008-4013.

Science Friday website. Accessed March 18, 2012:
<http://www.sciencefriday.com/>.

Activity: Chia Seeds from Outer Space!

Teaching time: One-week, two 45-minute periods, three 15-minute periods

Motivation:

Most scientists agree it's unlikely Mars has life on its surface today. The surface lacks any kind of liquid and is exposed to solar radiation because of the thin atmosphere with no ozone layer. When scientists think about the potential for finding life on Mars, they are generally thinking about finding fossils of bacteria. Pretend, though, that they discovered an ancient seed on the surface of the planet, billions of years old. What kinds of things would the seed have survived over billions of years? Is it possible the seed could still grow after all of that?

Procedure:

- Bring out a pebble and a chia seed. Ask students what the difference is between these things. After some discussion, inform students what the objects are, if they have not guessed.
- Students will devise an experiment to conduct on their seeds and establish whether they are still able to grow.
- Before beginning, discuss reasonable experiments students could conduct, such as:
 - Putting seeds into the microwave to expose them to radiation (Note: seeds can survive for at least three minutes in the microwave. Students could choose different times to put the seeds in the microwave as long as they record the amount of time. Do not put them in water before microwaving.)
 - Freezing seeds overnight
 - Freezing seeds in water and letting them thaw
 - Trying to grow seeds in the dark
 - Exposing them to a weak acid, like soda water, citric acid, or hydrogen peroxide (it is thought that some surface conditions create a weak acid in the soil)
 - Exposing them to basic solutions, such as Epsom salt or table salt water

- Putting them in the sunlight for a day or more
 - Another reasonable experiment of their choosing
- Students should be given about a dash of seeds each, reserving a dash for the control.
- Help students with their experiments when needed. They may need additional supplies.
- Label the plastic bowls with the names of each student. Label one bowl “control.”
- After students conduct their experiments, pass out the labeled bowls.
- Instruct students to place their seeds into their bowls.
- Place a dash of the reserved seeds in the bowl labeled “control.”
- Fill the pitcher with lukewarm water and fill each bowl so that the seeds are covered.
- Allow seeds to soak for about 24 hours.
- Give each student a paper towel, a sandwich bag, and a tray.
- Have students fold the towel in fourths and then open them flat on the tray.
- Have students pour the contents of their bowls onto one of the quarter sections, fold the towel up, and place it into the plastic bag.
- Come around and pour a little extra water onto any paper towels that aren’t saturated.
- Partially zip each bag so that about ½ inch is left open.
- Have students place their bag in their bowl on the tray.
- Ideally, each tray should be placed in a sunny window, but barring that, each bag should have a small amount of extra water in the bottom so the towel does not dry out.
- Check the seeds each class day. For the control seeds, small sprouts should form within 48-72 hours.

Example Discussion Questions (allow for open discussion):

- Which experimental results surprised you the most in the whole class?
- What does this tell you about the chia seeds? Do you think this could apply to all life? A: *Chia seeds are pretty hardy and can withstand harsh conditions. The exterior is hard and protects the inside of the seed (the part that contains the embryo). Although a lot of seeds can withstand harsh conditions, something like an animal or human, plant, and certain bacteria could not. You could not microwave a plant, for example, and expect it to survive.*





Chia Seeds from Outer Space!

Part 1: Before the Experiment

My Name:

Directions: You will come up with an experiment to see if your seed could survive harsh conditions, similar to what a seed would experience on the surface of Mars.

My experiment:

Why I have chosen this experiment:

When I try to grow my seed, I predict:

Before my experiment, I observe that my seed is:

Part 2: The Experiment

Name:

Time after soaking	Observations
24 hours	
48 hours	
72 hours	
96 hours	

Draw a picture of the seed after 1 week here:

Part 3: Summary

Name:

I expected to find:

I actually found:

I was surprised that:

