Lesson 18: Origin of Life

Summary
This module explores various hypotheses concerning the origins of life on planet Earth and their plausibility when applied to Mars.

Learning Goals

Students will be able to:

- Explain the conditions of the Miller-Urey Experiment.
- Define "life" and the requirements for life.
- Determine if the Miller-Urey Experiment has applicability on Mars.

Context for Use
This module is meant for adaptation in an Earth science course, particularly a segment discussing Pre-Cambrian/Hadean environmental conditions on Earth. Biology instructors are also encouraged to adapt this material.

Description and Teaching Materials

In-Class Activity 1: Miller-Urey Experiment
In-Class Activity 2: Mars Life through the Lens of MSL Curiosity

Teaching Notes and Tips

1. Encourage a discussion about the requirements for life and what "life" means in the In-Class Activity
2. Have students determine the viability of the Miller-Urey Experiment as a theory for the origin of life.

Assessment
Methods of assessment are within each individual *In-Class Activity* and *Homework*.

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References and Resources

Miller-Urey Experiment YouTube Video: http://www.youtube.com/watch?v=iahBQolXQH8

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In-Class Activity 1
The Origin of Life
Miller-Urey Experiment

Preparation
Have an Internet connection to view the associated video

Engage
Questions for students:

1. Have the students in their own words, define "life":

2. List some requirements for life?

Explain

1. Students can debate the different definitions of life. A general definition of life is as follows: an organismic state characterized by capacity for metabolism, growth, reaction to stimuli, and reproduction.
2. Requirements for life are: chemical building blocks, energy, and a liquid medium.
3. Most researchers would general agree that life requires water; hence NASA's campaign "Follow the Water".
4. Energy does not need to be sourced from photosynthesis (e.g. chemosynthesis).

Explore
View the following YouTube animation of the Miller-Urey Experiment:
http://www.youtube.com/watch?v=iahBQolXQH8

1. Describe at least 4 conditions of the experiment.

2. What was "applied" after the gases travelled through the horizontal tube?

3. Was O2 gas an important component of the experiment? Why or why not?

4. Did the experiment accurately represent a scale model of early Earth? Did they set up the conditions of early Earth properly?

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Elaborate

1. Would this experiment be applicable to early Mars?

2. How would the students modify the experiment to represent what might have occurred on Mars?

3. Visit NASA's NAI-Astrobiology website and explore the various "headlines." https://astrobiology.nasa.gov/nai/ List at least 2 ongoing investigations that have applicability to researching the "origin of life."

4. Read "About NAI" on the website. Are investigations into the origin of life a NAI focus? Why or why not?

Students could also consider exploring a planet in a habitable zone and compare it to Earth and Mars using data from the Kepler mission. See upcoming news featuring NASA's Kepler Mission.

Evaluate

1. When students consider the present and/or past environment of Mars, could they find all the requirements for life?

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In-Class Activity 2
Origin of Life?
Mars life: through the lens of Curiosity

Purpose: Students will become familiar with the mission of Curiosity as it pertains to finding life on other planets.

Preparation:

- Internet access in the classroom
- Students need to be somewhat familiar with the mineralogy of Mars to be successful in this activity (olivine, phyllosilicates, sulfates etc.).

Resources:

- Mars Curiosity Habitability Mission video: http://www.youtube.com/watch?v=oHLbXTOaw7w&feature=relmfu

Engage
Have students view the following video from NASA regarding the mission of MSL Curiosity: http://www.youtube.com/watch?v=oHLbXTOaw7w&feature=relmfu

Explore
As students watch the video have them be ready to answer and discuss the following questions:

1. What type of "life" are scientists looking for?
2. Can instruments on the MSL Rover Curiosity detect life?
3. What compound is associated with all life?
4. What element is necessary for life?
5. Why would the layering of rocks at Gale Crater be of interest? What might that layering imply?

Explain
Students should define habitability, extinct life, and extant life. They should understand that the "life" on Mars may be very small and primitive if scientists are lucky enough to find and detect it.

Here is a short recommended reading on habitability of Mars:
http://www.space.com/19928-mars-habitable-life-possible.html

Mars for Earthlings

Elaborate

Detecting Life: Ask the students the following question.

1. Does Curiosity have any instruments that can directly test for life?

Evaluate

Promote discussions about the challenges NASA faces now and in the future as they continue the search for life. To spark discussion use the following question:

1. What are some of the challenges related to directly testing for life?