Lesson 19: Extremophiles

Summary
This learning module and related laboratory exercise exposes students to extremophiles, their habitats, and the potential to find habitable environments on Mars.

Learning Goals

Students will be able to:

- Understand the environment in which the *Tardigrade* can survive.
- Explore hydrothermal environments on Earth and Mars.

Context for Use
This learning module is meant for adaptation in an introductory earth science course and/or planetary science course.

Description and Teaching Materials
In-Class Activity
In-Class Activity 1: *Tardigrades: Living extremely*
Homework
Homework 1: *Sea Monkey Experiment*
Homework 2: *The Color of Temperature*

Teaching Notes and Tips

1. Students must be familiar with Mars environments of deposition, surface processes and climate.
2. To be successful in Homework 2 students need to have exposure and instruction in making contour maps.

Assessment
Each *In-Class Activity* and *Homework* has its own measure of Assessment.

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References and Resources

1. Image File: Extremophiles
2. Gale Crater Habitability via Curiosity: http://www.youtube.com/watch?v=oHLbXTOaw7w&feature=relmfu
3. Tardigrades video from SciShow on YouTube: http://www.youtube.com/watch?v=6H0E77TdYnY&continue_action=r7OE3bLJMHT8fAwevwnX9Oh_0zzl6Ajt2P3129QN588gcYR6MkEN_obkOAtaq5MUvFV4Yiq09ljbJDp8wedzPE1U417RionrJuPdT2CAALc=
4. Additional Tardigrade link: http://serc.carleton.edu/microbelife/topics/tardigrade/index.html

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In-Class Activity 1
Extremophiles 1_MFE
Tardigrades: Living extremely

Purpose: Become acquainted with the Tardigrade ("water bear") extremophile, its living conditions, and importance of its scientific study.

Preparation:
Have Internet access in your classroom.

Resources:
1. Tardigrade YouTube video: http://www.youtube.com/watch?v=6H0E77TdYnY&continue_action=r7OE3bLJMHT8fAwevwnX9Oh_0zzl6Ajt2P3129QN588gcYR6MkEN_obkOAtaq5MUvFV4Yiq09ljbJDp8wedzPE1U417RionrJuPdT2CAALc=
2. SERC definition of Extremophiles: http://serc.carleton.edu/microbelife/extreme/extremophiles.html

Engage
Watch the following You Tube Tardigrade video from the SciShow:
http://www.youtube.com/watch?v=6H0E77TdYnY&continue_action=r7OE3bLJMHT8fAwevwnX9Oh_0zzl6Ajt2P3129QN588gcYR6MkEN_obkOAtaq5MUvFV4Yiq09ljbJDp8wedzPE1U417RionrJuPdT2CAALc=

As students watch the video have them answer the following questions:
1. What is a *Tardigrade*?
2. What type of environments can *Tardigrade* live in?
3. What is its importance to science?

Explore
Have students briefly "explore" other extremophiles and answer a few questions about their characteristics and report back to the class.

Explain
As students discuss *Tardigrade* and the type of environment in which it can survive, share the following terms related to types of extremophiles. Ask students to classify *Tardigrade in one of these groups:*
1. Acidophile- high pH
2. Alkaliphile- low pH
3. Anaerobe- no need for oxygen
4. Endolith- lives inside rocks
5. Halophile- requires salt
6. Piezophile/Barophile- requires high pressures
7. Thermophile- lives in 40°C or higher
8. Xerophile- limited water supply
9. Psychrophile- lives in 15°C or lower

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Elaborate

Where could Tardigrade live on Mars?

1. Display a global Map of Mars so that all regions can be viewed (see Image File: Extremophiles)
2. Where could *Tardigrade* potentially live on Mars?
3. Is studying *Tardigrade*, and other organisms like it useful to space research? Why or why not?

Have students identify which extremophiles could live on Mars.

Also, possibly consider where they live on Earth for comparison.

Evaluate

Ask students what other Extremophiles classifications (see above) could be present on Mars and give a short presentation on a type of extremophile other than Tardigrade.

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