ASTROBIOLOGY ALIVE!

Module 2: Life in Extreme Environments

1. Introduction

In this module we will talk about life in icy environments on Earth and its implications for life on icy worlds such as Enceladus, Titan, and Mars. In this activity, we will discuss what life requires to survive. Using Earth as an analog, we will take a look at life that is able to survive in some of our coldest environments. Students will be divided into groups, each provided with a microscope and the necessary tools to make a slide. Each group will be introduced to the parts of a microscope, and with the help of outreach volunteers, we will make our slides with snow algae and view the tiny life that may give us an insight to what life may look like if it existed on Mars.

Structurally, the module includes: 1) an introductory discussion and a guided discussion about the planned activity; 3) a hands-on activity; and 4) a discussion summarizing what the students learned.

Target Grades: K-6 (adapt discussions as appropriate for grade level)

2. Learning Objectives

- Critical thinking about what life requires to survive
  - Water
  - Energy source
  - Food (carbon) source
- General environmental conditions on Mars, Titan and Europa (Use the Astrobiology poster)
- Critical thinking about what factors might limit life – especially on other planets
  - Extreme cold and heat
  - No water
  - No food
  - Not enough sunlight
- Introduce the concept of Earth analog environments
- Develop the concept of micro-environments/niches
- Introduce parts of a microscope and how to handle equipment
- Introduce students to the type of life found in cold environments on Earth. Use the Life in Ice poster to discuss the types of life we find in snow and ice, and as a life identification tool.

3. Materials

- Astrobiology – water poster
- Life in the ice – glacier poster
- Parts of a microscope – poster
- Microspin Microscope (600 x)
    - With camera and computer connection ($ 78.99 at Fry's electronics)
- Glass slides
- Slide coverslips
- Eye droppers
- Samples
    - Snow algae sample
        - You can find snow algae on Mt Charleston in the spring! Look for red-pink, or yellow-orange snow along snowy trails after the snow begins melting.
    - Mineral/dust/sand samples
    - Natural water samples – e.g. from the wetlands park
    - Prepared slides of stained microbes
    - *Chloromonas brevispina* culture sample
    - Stuffed microbes (optional)
- Bookmarks or pencil (handout)
- Laser pointer (optional)

4. **In-Class Guide (~ 1 h)**

4.1. Introductory Discussion (5 m)

Poster – astrobiology. Introduce students to planets further from Sun (colder, covered in ice) in comparison to Earth (not too cold or hot, has liquid water):

1. Places like Mars, Titan, and Europa are very cold and covered in ice because they are far from the Sun.
2. Unlike these places, Earth is just close enough to the Sun to keep things warm and give us liquid water! BUT don't forget that we also have places covered in ice where life exists like Antarctica.
3. What kind of life do we think might live in snow and ice? How do we get life where there is ice? By turning the ice into water!

4.2 Activity Discussion (10 m)

1. *Poster – Life in the Ice*; Discuss where we find life in ice on Earth and what kind of life exists in these places.
    i. Think of Antarctica…what is it covered in? Glaciers, which are made out of…? Ice. Do we have life in Antarctica? Yes!
    ii. Introduce students to the type of microbial life that can survive in the ice – snow algae.
2. *Poster – Parts of a Microscope*; Introduce students to parts of a microscope.

4.3 Hands-on activity (30 m)

1. Set up the microscope before the activity – you may need to download the drivers for the microscope online – allow about 15-20 min to do this before the activity. Project the microscope image for the entire class to see.

2. The outreach volunteers will instruct students on how to make slides. Groups of 3 students will make each slide:
    a. Student 1: Hold the sample
    b. Student 2: Hold the slide (in a petri dish)
    c. Student 3: Suction out a drop of sample with the dropper – and place one drop on the middle of the slide
    d. Student 1: place the cover slip on top of the sample drop
    e. Student 2: place the slide on the microscope

3. Explore the life you see in the samples
    a. Why are they clumped together – or not? (biofilms and microbe "snot")
    b. Why are they green? (chlorophyll, photosynthesis, single cell "plants")
    c. Why are they red? (too much sun exposure makes them form red pigments that protect them from the sun)
    d. See any pollen grains? – these can look black to brown, and are relatively large 3-lobed shapes – look like mickey mouse heads.

4. Explore what minerals/dust/sand looks like. (Place grains on a slide under the microscope lens, may have to zoom out e.g. 10-30 x objective)
    a. Describe what you see.
    b. Change the light source from transmission to reflected light and discuss how it looks different under the two light sources.
    c. What shapes are the grains? Color?
    d. How are they similar or different from the life that you saw?
5. Microbe – or – mineral? Challenge
    a. Put an "unknown" sample on the slide
    b. As the students if it's a microbe or mineral
    c. How do they know?

4.4 Summary Discussion (10 m)

Review questions:

Q1: How cold is it on Europa? (-260 oF (-160 oC) at the equator surface)

Q2: Does Europa have liquid water? Where is it?

Q3: Name one type of snow algae we saw today.

Q4: Why are some microbes green? Why are some red?

Students may also be asked questions about how to use the microscopes such as the following:

i. What is the name of the part we use to look through? *Eyepiece*
ii. Which part is used to carry the microscope? *Arm*
iii. What is the name of the part that we place the slide on? *Stage*