

Lesson #5:

Life in the Extreme



Image: <http://www.nsf.gov/>. This image shows many habitable and extreme environments on Earth. Europa is a moon of Jupiter that scientists believe also has an ocean, like Earth. Perhaps it has life on it as well? Scientists are investigating this exciting question.

Lesson Summary

- **Grade Level:** 6th -8th
- **Prep time:** ~20 minutes
- **Lesson time:** ~ 10 minutes for videos. ~ 35 minutes total for both activities. Total: ~45 minutes
- **Learning Outcomes:** Goals of this lesson are to get students to understand characteristics of extraterrestrial life on earth or on other planets. This lesson will introduce students to the F₁ Drake term. This lesson aligns with relevant standards from the document, “A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas” written by the National Research Council.

What students do

In the N_e section we have seen how water is crucial for all life on Earth even for those organisms that live in extreme environments. Let's consider how extreme those environments can be.

The goal of this lesson is to introduce students to the possibility of extraterrestrial life and what might we find if we do find life in our solar system. We will also look at misconceptions associated with life and how it isn't necessarily the little green men depicted in Hollywood movies that astrobiologists expect to find. This lesson will help the students consider "who's out there" in our solar system in a more realistic way. Students will be introduced to extremophile organisms and the link that they provide to understanding what possibilities exist for extraterrestrial life.

At the end of this lesson, students will be able to:

- ✓ **Identify** fundamental criteria for life.



The following Next Generation Science Standards will be addressed in this lesson:

MS-LS1-1. Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells.

MS-LS1-5. Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.

MS-LS4-4. Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment;

MS-LS2-1. Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.

Resources needed:

- **Accompanying activity packet:** “LifeintheExtreme.pdf”

(found at the end of this document)

- **Internet access and projection capability for showing videos from the following website:**

<http://dsc.discovery.com>

Copyright/permission statement

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Science of the Topic:

Read the following:

From R^ , F_p , and N_e Drake Equation terms, now we understand that planets around special stars need to form special environments suitable for life. But what kind of life will form in those environments? And how extreme can that life get? That is the subject of this lesson, F_l .*

Hollywood has fed our society different images of what aliens look like and why they come to Earth. The images range from the popular little green men to blobs.

But, if we find extraterrestrial life on other planets in our solar system, what will they really look like? Will they look like humans or match any of the images we have seen in films or pictures? Do these images have any scientific validity?

Some scientists believe that if we find life in outer space it will be in the form of microorganisms and not alien creatures that we have seen in movies.

Imagine this scenario. One day, you are watching TV and breaking news from NASA takes over the screen claiming that one of the Mars Rovers has found the supposed existence of life on Mars. The world is amazed by the discovery but you are left to wonder what kind of organism was found. No more information is given by NASA yet until they have confirmation of the data. So you are left in suspense to wonder what kind of creature it may be.

Here, you will learn about some interesting possibilities for organisms that can survive in some extreme environments that you may not know were even inhabitable!



Teacher's Tip: Short discussion should now proceed about examples from popular movies such as Alien vs. predator, WALL-E, Star Wars, etc. Ask students to share with everyone what they think extraterrestrials will really look like and to hold on to their thoughts for this lesson because some students may be in for a surprise

More science is provided in the “**Background Information**” section of the accompanying Life in the activity packet. Teachers are encouraged to hand out this background to students.

Vocabulary list

List of terms that students will encounter during the lesson and activity are below. Teachers may want to distribute this to students.

1. Organism - An individual living thing that can react to stimuli, reproduce, grow, and maintain homeostasis. It can be a virus, bacterium, protist, fungus, plant or an animal. (www.biology-online.org)
2. Microorganism or microbe- An organism that is microscopic or submicroscopic, which means it is too small to be seen by the unaided human eye. (www.biology-online.org)
3. Habitable – an area capable of supporting life. Signs of long-lasting water and presence of organics are conditions associated with a habitable environment.
4. Extremophile — organism with the ability to thrive in extreme environments such as hydrothermal vents. Since they live in “extreme environments” (under high pressure and temperature), they can tell us under which range of conditions life is possible. (<http://oceanservice.noaa.gov/facts/extremophile.html>)



Teacher's Tip: More vocabulary terms relevant to this lesson are listed in the activity supplementary packet at the end of this document, in the section, “**Types of Extremophiles.**” Students can use both this sheet and the vocabulary in the packet together as a reference while doing this activity. For this reason, no stand-alone vocabulary sheet follows this.

Activity 1: Watch 6 Short videos to introduce extremophiles and finding extraterrestrial life in our solar system

Time: Each video is ~1- 3 min; All 6 will take <10 minutes to watch

Level: 6th -8th

About this activity: Here are 6 very short videos clips to introduce extremophiles and the possibility of extraterrestrial life. The videos will also go over common questions about extraterrestrial life and the possibility of finding life in the solar system. The videos not only explain what extremophiles are but also describes scientists' speculation about extraterrestrial life in our own solar system and what it may look like, getting rid of many popular misconceptions about 'little green men' or E.T.-like cute and cuddly visitors. After showing as many videos as the teacher wishes, he or she should do activity 2, which is a short discussion about whether students were surprised to learn what "aliens" might really look like and to discuss their preconceptions about what they thought other life forms would look like before this lesson was introduced. This can be done as a homework assignment.



Teacher's Tip: Before every video there may be a commercial that plays. Teachers can pre-load the videos before class starts passing the commercial to the beginning and pausing it until they are ready to show it to the class.



Teacher's Tip: None of the below videos rely on YouTube to be played since that site is blocked in some schools.

1. Jill Tarter: On Extremophiles: What is an extremophile? <http://dsc.discovery.com/tv-shows/curiosity/topics/jill-tarter-on-extremophiles.htm>
2. What can extremophiles teach us about extraterrestrial life? <http://curiosity.discovery.com/question/extremophiles-teach-us-about-extraterrestrial-life>
3. What scientific breakthroughs could tell us about extraterrestrial life? <http://curiosity.discovery.com/question/scientific-breakthroughs-extraterrestrial-life>
4. Are we likely to find extraterrestrial life in our solar system? <http://dsc.discovery.com/tv-shows/curiosity/topics/are-we-likely-to-find-extraterrestrial-life-in-our-solar-system.htm>

5. Where are we most likely to find life in space? <http://curiosity.discovery.com/question/where-find-life-space>

6. Will we find simple extraterrestrial life before intelligent life? <http://dsc.discovery.com/tv-shows/curiosity/topics/what-can-extremophiles-teach-us-about-extraterrestrial-life.htm>

Activity 2: Discussion on misconceptions affiliated with F₁ and extraterrestrial life

Time: ~10-20 minutes

Level: 6th -8th

Learning Outcomes:

The following taxonomy for learning is adapted from Anderson and Krathwohl's (2001) taxonomy. After this activity, students will:

Evaluate erroneous claims about what extraterrestrials may look like:

5.2 **By critiquing** erroneous conclusions about assumptions about extraterrestrial life

About this activity:

After watching the videos in Activity 1 of this lesson, teachers will begin a class discussion about misconceptions surrounding the perceptions of extraterrestrial life. Then, in the third activity of this lesson, students will do an activity involving categorizing extremophiles into categories based on information cards.

Preparation:

After watching the previous videos, teachers can begin a class discussion about misconceptions surrounding the perceptions of extraterrestrial life. Teachers should initiate this with stating or writing on the board the 3 misconceptions seen below. Students should be able to explain why these claims are actually false based on information they learned from the videos and activity. This can be done in groups or individually.

Misconceptions:

1. Earth is the only planet that is habited.
 - a. False, it is the only one we know of right now.
2. If we find extraterrestrial life they will look like the depictions we have been given by Hollywood.
 - a. False, most researchers believe that when we find life in the solar system they will come in the form of microorganisms.
3. A planet has to have the same conditions as we live in to sustain life.
 - a. False, extremophiles prove that organisms can survive in the most extreme conditions that are similar to those on other planets. Students should be able to give examples based on the activities and videos.

Assessment

None. This is intended to be an ungraded discussion.

Activity 3: “Life in the Extreme”¹

Time: ~15 minutes

Level: 6th -8th

About this activity: Participants are each given one of 14 examples of extremophiles – organisms found in some of the toughest conditions on Earth, at least tough to live in for us. Students sort themselves into groups according to the various preferences of their organisms. Finally, they discover that all known life on Earth requires liquid water to survive. For more information, see the activity packet.

Learning outcomes:

Objectives and outcomes aligning with the following relevant process areas in this activity are:

- ✓ **Understand** that extremophiles can live in various extreme conditions
 - 2.3 By categorizing** into different groups based on survival conditions
 - 2.6 By comparing** different organism living conditions
- ✓ **Recognize** that all living things need water to survive
 - 2.4 By summarizing** that all the extremophiles have one element in common needed for survival.

Preparation:

Follow instructions given in the packet found at the end of this document. See “**Leader’s Role**” for narration to students, a presentation tip that follows, and preparation instructions (“**What do I need to prepare?**”). Students should be in groups for this activity.

¹ See Copyright statement on first page and activity packet for details on educational distribution and permissions.

Assessment

For this activity, students can be graded on Activities 2 and 3 as one or two separate in-class assignments on the basis of engagement, participation, and discussion in their groups (as judged by the teacher). Activity 1 is not graded but the misconception discussion relies on students having comprehended the videos in Activity 1. The teacher can assign as many points as he/she wishes, guided by a stand-alone sheet with a rubric on the next page.

Rubric for “Life in the Extreme” Activity

	Learning Objective:	
	Understanding that extremophiles can live in various extreme conditions	Recognizing that all living things need water to survive
Expert	<ul style="list-style-type: none"> • Student successfully categorized extremophiles into different groups based on survival conditions • Student successfully compared different organism living conditions 	<ul style="list-style-type: none"> • Student successfully summarized that all the extremophiles have one element in common needed for survival
Proficient	<ul style="list-style-type: none"> • Student mostly successfully categorized extremophiles into different groups based on survival conditions • Student mostly successfully compared different organism living conditions 	<ul style="list-style-type: none"> • Student mostly summarized that all the extremophiles have one element in common needed for survival
Intermediate	<ul style="list-style-type: none"> • Student somewhat categorized extremophiles into different groups based on survival conditions • Student somewhat compared different organism living conditions 	<ul style="list-style-type: none"> • Student somewhat summarized that all the extremophiles have one element in common needed for survival
Novice	<ul style="list-style-type: none"> • Student did not categorize extremophiles into different groups based on survival conditions • Student did not compare different organism living conditions 	<ul style="list-style-type: none"> • Student did not summarize that all the extremophiles have one element in common needed for survival

Stay tuned for another activity!



Teacher's Tip: In future iterations of this lesson package, which seeks continuing improvement, there are plans to include more activities! These activities will align with the Next Generation Science standards and are sure to stretch your students' minds. Stay tuned!

Congratulations!

You've completed the F₁ lesson. Next, you will explore with your students the F_c lessons with an activity plus one or more science standards. The F_c lesson will focus on how we communicate as a civilization with each other, and we will explore ideas on communicating with other civilizations, too, if we might encounter them!