LESSON 9: Are we alone?

PREVIOUS LESSON

We looked back at the DQB to identify a set of patterns about stars that we haven't explained. We figured out that we will need to model a different perspective at a larger scale in order to explain all the star patterns. We watched a video about seasonal constellations, and then in small groups we made a physical model to explain the patterns we see. We individually modeled these systems on paper as an assessment. Then we took stock of all the questions we have answered already and got ready to shift gears and talk about life in space.

THIS LESSON

PROBLEMATIZING

1.5 days

We return to the home learning to compare various pop culture references to life in space in concentric circles. We read about extremophiles on Earth to think about where we might find life in space. We add questions to the DQB about the possibility of life in space. We make a class barometer to show how much we agree or disagree with the idea that there is really life in space. Finally we make plans about what data we would need to find evidence for our arguments about life in space and where to go next to begin answering our questions about life in space. We decide to look more closely at our own solar system to investigate the potential for life.

NEXT LESSON

We will jigsaw a series of infographics to learn more about the diverse collection of objects in our solar system where we might look for life. We will argue that there is potential for life in our solar system, both past and present, but that it is unlikely that it was or is intelligent.

BUILDING TOWARD NGSS

MS-ESS1-1, MS-ESS1-2, MS-ESS1-3, MS-PS2-4, MS-PS4-2

WHAT STUDENTS WILL DO

9.A Ask questions to identify evidence that we could observe that will support or challenge a claim about if there is life in the vast universe.

WHAT STUDENTS WILL FIGURE OUT

- There are a lot of very different ideas out there about life in space (extraterrestrials).
- There is a lot we don't know about whether this popular idea from fiction could be a reality.

Lesson 9 • Learning Plan Snapshot

Part	Duration	Summary	Slide	Materials
1	12 min	**NAVIGATION** Return to the home learning to compare various pop culture references in concentric circles.	A-B	home learning (notes about a fictional life form in space)
2	18 min	**READ ABOUT EXTREMOPHILES** Read about life living in strange places on Earth, which informs the search for life in space.	D	*Obtaining Information from Scientific Text*, *Extremophiles*
3	13 min	**ADD TO THE DQB** Add new questions to the DQB now that we have begun to consider the possibility of life in space.	E	DQB (you may decide to add to the old DQB, or you may decide to create a new one)
4	2 min	**NAVIGATION AND EXIT TICKET** Review new questions from the DQB to choose which ones are the most interesting, as an exit ticket.	F	scrap of paper
				End of day 1
5	13 min	**MAKE AN INITIAL ARGUMENT** Vote with your feet about whether you agree or disagree that extraterrestrial life exists.	G	Agree and Disagree signs
6	10 min	**DATA TO ANSWER OUR QUESTION ABOUT LIFE** Make a list of data we would need to investigate our questions.	H	Data We Need about Life in Space poster
7	2 min	**NAVIGATION** Students consider where to look for life first, and we decide to investigate data from our solar system.	I	scrap paper
				End of day 2

Lesson 9 • Materials List

	per student	per group	per class
Lesson materials	• home learning (notes about a fictional life form in space) • *Obtaining Information from Scientific Text* • *Extremophiles* • scrap of paper • scrap paper		• DQB (you may decide to add to the old DQB • or you may decide to create a new one) • Agree and Disagree signs • Data We Need about Life in Space poster

Materials preparation (45 minutes)

Review teacher guide, slides, and teacher references or keys (if applicable).

Make copies of handouts and ensure sufficient copies of student references, readings, and procedures are available.

Before class, make sure you have identified a place in the classroom where students can stand in a line for the barometer activity. Tape a sheet of paper to one wall that says "Agree" and a sheet of paper that says "Disagree" on the wall at the opposite end of this line.

Make sure the DQB that the class made in Lesson 1 is posted and visible for all students. Prepare chart paper for new posters. The posters you will make in this lesson are as follows:

- What to Look for in Space if We Want to Find Life
- Extraterrestrial Life DQB (optional)
- Data We Need about Life in Space

Be sure you have materials ready to add the following words to the Word Wall and/or a personal glossary: *extremophiles*. Do not post these on the Wall until after your class has developed a shared understanding of their meaning.

Lesson 9 • Where We Are Going and NOT Going

Where We Are Going

This lesson is an OpenSciEd problematizing routine, designed to motivate the exploration of larger systems in space in the third and fourth lesson sets. The problematizing routine is not a true re-anchor, but it does motivate the need for a new line of investigation. In this way, the problematizing routine supports coherence between lesson sets that may address a very different set of science ideas. In this lesson, we will be moving from patterns in the sky that have been observed and recorded for thousands of years of human history, to the cutting edge of scientific exploration and the human imagination. A problematizing routine has three main elements: (1) The teacher seeds a question or new phenomenon for the class to consider that is designed to elicit disagreement or competing explanations (in this case, extremophiles), (2) students go public with their ideas and argue for competing ideas while trying to resolve the emerging controversy (the class barometer regarding life in space), and (3) students help articulate what the class might need to do next to resolve this question (return to the DQB and Data We Need poster).

If you are not teaching Lesson 9 directly after Lesson 8 for any reason, you may want to build this problematizing lesson into a full re-anchor, in which students explore the potential for life in our solar system before identifying related phenomena, and then develop questions and decide where to go next. In this case, we recommend the following:

1. Consider assigning the home learning in Lesson 8 ahead of time and spend time in this lesson re-defining the word "extraterrestrial," as described in Lesson 8.
2. Wait until the end of Lesson 10 to develop questions for the DQB and decide on the data needed. Allowing students to explore a new phenomenon to anchor the next two lesson sets will result in a more robust set of questions for the new DQB.

Where We Are NOT Going

In this lesson, students will learn about some of the biological requirements for life in order to motivate the investigations that follow. We will not be going into detail about the definition of life, or the organic compounds associated with life on Earth. The primary focus will be the search for water on other planets.

LEARNING PLAN for LESSON 9

1 · NAVIGATION

12 min

MATERIALS: home learning (notes about a fictional life form in space)

ADDITIONAL GUIDANCE

Connections to Me and My Community
This lesson begins with an opportunity for students to bring part of their authentic selves into the classroom with a conversation about representations of extraterrestrials in pop culture. This can be a powerful way to support students in forging connections between their identity outside of the classroom and the science ideas they engage with inside the classroom. For students who have no interest in science fiction, framing their families, friends, and communities as legitimate funds of knowledge can serve multiple purposes. It can (1) help students feel like they belong in the science classroom by situating their family and community knowledge as productive resources for science, (2) engage students' families in conversations about what is happening in the classroom, and (3) help students make connections between the science classroom and their everyday lives.

Share home learning in concentric circles. Divide the class into two equal groups. Have one group make a circle with each student facing out. Have the second half of the students form another circle around the first circle. Each student should have a partner in the inside circle or vice versa.

Present **slide A**. Tell students, *Share your answers to the questions on the slide, which were from your home learning.* Have the students in the inner circle go first, and then have the students in the outer circle share. After 1-2 minutes, the inner circle should move one position to the right and share their answers again. Continue this pattern until you run out of time (about 8 minutes).

The questions from the home learning were:

- Where are these extraterrestrial life forms from originally?
- How is the place they are from different from Earth?
- Do you think we would be able to live where they come from? Why or why not?

Say, *Wow there are a lot of very different ideas out there about life in space! I was overhearing some of your conversations, and some of these fictional extraterrestrials lived on planets with multiple stars, no oxygen, no land, or even on moons of planets. It makes me wonder--can any object in space potentially have life? What should we be looking for in these different places in space if we want to find extraterrestrials?*

Brainstorm places to look for life in space. Display **slide B**. Say, *We know a little bit about life from earlier units, so we may already have some ideas about what we want to look for. Let's make a public record of our ideas.* Title a piece of chart paper, "What to Look for in Space if We Want to Find Life."
Students may suggest things like:

- *cells*
- *food*
- *water*
- *air*
- *certain chemicals*
- *planets/moons to live on*
- *not too much or too little gravity*
- *energy*
- *light*
- *temperatures that aren't too hot/too cold*

✱ ATTENDING TO EQUITY

Concentric circles is a particularly effective strategy for emergent multilingual students because they will get a chance to say the same thing several times. This will give them additional practice listening and speaking in English.

Project **slide C**. Say, *Maybe we can use Earth as an example to test out some of our ideas we've listed here. Are there any places on Earth where you would predict we would not find life, because some or all of these things are missing? Take a minute to brainstorm with a partner: Are there any places on Earth that you wouldn't expect to find life, and why?*

After a minute, facilitate a brief share out. Look for students to suggest:

- *deserts*
- *deep under the ocean*
- *in the Earth's interior*
- *Antarctica*
- *volcanos*
- *in polluted rivers/lakes*
- *on top of mountains*

Look for justifications that include lack of air/water/food, extreme temperatures, or not enough sunlight. If students suggest a justification that is not on the "What to Look for in Space if We Want to Find Life" poster, add it now.

2 · READ ABOUT EXTREMOPHILES

18 min

MATERIALS: *Obtaining Information from Scientific Text*, *Extremophiles*

Frame the reading. Project **slide D** and say, *Scientists have also used life on Earth to help them think about where we might find life in space. And what they have found has been very surprising. Some of the places on Earth where scientists originally thought there definitely could not be life, they have found life.*

Hand out *Obtaining Information from Scientific Text* and *Extremophiles* and say, *I found a reading about how scientists are studying these extreme environments where life is found on Earth to guide our search for life in space. Use the text from Obtaining Information from Scientific Text to support you in obtaining information.*

ADDITIONAL GUIDANCE

This lesson builds off life science performance expectations built in earlier OpenSciEd units: Unit # 6.6, *OpenSciEd Unit 7.3: How do things inside our bodies work together to make us feel the way we do? (Inside Our Bodies Unit)* ,and *OpenSciEd Unit 7.4: Where does food come from, and where does it go next? (Maple Syrup Unit)*. Unit # 6.6 addressed MS-LS1-1, which states that "living things are made of cells." *Inside Our Bodies Unit* addressed MS-LS1-7, which covers " how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism." *Maple Syrup Unit* addressed MS-LS2-3, which states that students should "describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem." In that same unit, students developed ideas related to the LS1.C concept of "Plants, algae (including phytoplankton), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use." In this same unit, students also developed ideas related to PS3.D: "The chemical reaction by which plants produce complex food molecules (sugars) requires an energy input (i.e., from sunlight) to occur. In this reaction, carbon dioxide and water combine to form carbon-based organic molecules and release oxygen." These ideas will help students to think about what aspects of life to look for in space, with respect to the interactions inside of and between living things on Earth.

3 · ADD TO THE DQB

13 min

MATERIALS: DQB (you may decide to add to the old DQB, or you may decide to create a new one)

Develop new questions. Present **slide E.** Say, *In Lesson 1, we built our DQB around patterns in the sky. We had lots of clusters of questions about the sun, the moon, planets, stars, and a few other topics. What additional questions do you have about life in space, how we might find evidence of it, and where it might be most productive to look?*

Have students work in small groups to develop questions on sticky notes as they did in Lesson 1. Then have the class gather around the DQB. Depending on how much room you have on the old DQB, you may decide to add these new questions in a cluster on the old DQB, or you may decide to add a new piece of chart paper underneath the old one.

Some questions students might have include:

- Is there extraterrestrial life?
- Is there air on other planets?
- Are there plants on other planets?
- Is there water in space?
- Are there other planets going around other stars?
- Where have we looked for life so far?
- Does life need a certain temperature range to survive?
- Is there life in our solar system?
- How does life get intelligent?
- Have extraterrestrials been to Earth?
- Did extraterrestrials build the pyramids?
- How do we find places where there might be life?
- Can we send them messages?
- What do they eat?
- Could we survive on other planets?

There may have already been questions from Lesson 1 about life in space. If so, say, *We had some questions on our DQB that we clustered over here and have not yet addressed.* Read some of the questions in the cluster about extraterrestrial life and decide if any of them need to be moved to our new DQB (or into a new cluster).

ALTERNATE ACTIVITY

If you are not teaching Lesson Set 3 directly after Lesson Set 2, you may need to spend more time with the DQB here. Consider spending an additional day allowing students to brainstorm in groups, create a brand new DQB, and organize the questions into clusters. Example questions may include things like

- questions about what objects exist in space,
- questions about if life exists in space,
- questions about what life needs to survive, and
- questions about intelligent life.

4 · NAVIGATION AND EXIT TICKET

2 min

MATERIALS: scrap of paper

Exit ticket about our new questions. Display **slide F.** Say, *We just added many new questions to our DQB. What were the most compelling questions you heard from your classmates? Which question are you most motivated to investigate? Respond to this as an exit ticket.*

End of day 1

5 · MAKE AN INITIAL ARGUMENT

13 min

MATERIALS: Agree and Disagree signs

Remind students where we ended last time. Say, *We had a lot of questions about extraterrestrial life last time! I read through your exit tickets and I noticed a pattern. One of the questions that a lot of people found compelling was if there is any extraterrestrial life out there somewhere. Let's take some time to share our initial ideas about this question.*

Have students vote with their feet in a class barometer. Present **slide G.** Create a classroom barometer about how much students agree or disagree that extraterrestrial life exists. Before class, make sure you have identified a place in the classroom where students can stand in a line. Place "Agree" and "Disagree" signs at opposite ends of this line. Ask students to vote with their feet. Say, *If you definitely think there is extraterrestrial life, stand near the "Agree" sign. If you definitely think there is no extraterrestrial life, stand near the "Disagree" sign. You may stand anywhere between the two extremes, depending on how strongly you do or do not agree.*

Once students have lined themselves up, ask someone to explain why they have chosen to stand where they are standing. Encourage students to justify their claims. It is probably best to alternate from one end to the middle to the other end, rather than allowing too many voices from one stance to dominate. Encourage students to move if someone presents an argument that alters where they want to stand on the line. Run the activity until you think that most or all voices have been heard, making sure that no one person dominates. Unlike the barometer we created in Lesson 2, the class will not come to consensus here. Rather, expect students to have a range of ideas and very little evidence at this point to support or refute their claims.

ASSESSMENT OPPORTUNITY

Building towards: 9.A Ask questions to identify evidence that we could observe that will support or challenge a claim about if there is life in the vast universe.

What to look/listen for: Look for students to begin supporting their claims with evidence, for example:

- (Someone near agree): I think there is life in space because space is huge, and since there are extremophiles on Earth, life can live in weird places, so why not in space?
- (Someone near the middle): I think there is no intelligent life out there because we would have seen them by now, but maybe microbes exist.
- (Someone near disagree): I think Earth is special and it is the only place where life can exist in any form.

What to do: Use probing questions to push students to justify their claims with evidence, even if their evidence is weak right now. Use the words "claims" and "evidence" explicitly as you speak to students, in addition to any everyday language students are using. For example, you might say, *It sounds like your claim is that there is not any extraterrestrial life. What evidence do you have to support that claim?* The goal is to make sure students feel comfortable attaching claims to evidence, not to build strong arguments right now.

If a student makes a claim based on gut feeling or intuition and is unable to produce evidence (i.e., "I believe that there is extraterrestrial life out there; I just feel like there is stuff we can't explain."), say, *I wonder if there is scientific evidence out there that we could find that could support your claim*? You can use this lack of evidence as navigation into the next activity.

Highlight students who use the size or scale of the universe as evidence by revoicing these aspects, asking another student to revoice them, or asking for agreement/disagreement from other students.

6 · DATA TO ANSWER OUR QUESTION ABOUT LIFE

10 min

MATERIALS: Data We Need about Life in Space poster

Present slide H. Say, *We didn't have a lot of evidence to defend our initial arguments. This is understandable, as there is still a lot that scientists don't know about what is out there. If we could collect more evidence from things that scientists do know, that might help us make a stronger argument.* Then pose the question on the slide as a Stop and Jot:

- *What data do we need to get evidence to support your position?*
- *What data do we need to get evidence that will challenge the opposing position?*
- *What other data do you think scientists have collected that we could look at to find out what else is out there in space?*

Elicit student ideas. Some data students might suggest:

- photos of aliens
- information about what life needs to survive
- information about other planets
- what the air is made out of on other planets compared to Earth
- if there is water on other planets
- photos of other planets
- planets around other stars
- spacecraft we've sent to other planets
- spacecraft/probes we've sent to take pictures of things as they fly by them in space
- telescopes

Record students' ideas at the front of the room, either by adding onto the "Ideas for Future Investigations and Data We Need" poster from Lesson 1, or by creating a new poster titled "Data We Need about Life in Space."

ADDITIONAL GUIDANCE	Students will most likely suggest some evidence that we do not have, such as photos of aliens. If this happens, say, Whoa those would be incredible data! If we can't get those photos, what are some sources of data that we could look at more closely to see if there is evidence for or against there being life in space?

7 · NAVIGATION

2 min

MATERIALS: scrap paper

Navigate to the next lesson. Present **slide I.** Say, *There are a lot of data that we want to investigate. Some of it seems like it is from our own solar system, while some of it is from beyond our solar system. Let's look at both. Where would it make sense to start? Where do you think we have more complete data sets from? Why?*

Students are likely to suggest our solar system because

- the stuff in it is closer,
- we've sent spacecraft to or closer to stuff in the solar system than we have other places beyond, and
- it's easier to see details in things in telescopes, like planets that are closer, than things that are further away, like stars.

Say, *Let's plan to look more closely at the moons and planets in our solar system next time, using some of the data you suggested and see if we find water, energy, and some of the other things we are looking for that might support or refute the potential for life there.*