Sample Lesson for Grades 5-6 from

How Might Life Evolve on Other Worlds?

SETI INSTITUTE

The **Life in the Universe Series** was created by
children, teachers, and scientists at the SETI Institute
for grades 3-9, with funding from
the National Science Foundation (NSF)
and the National Aeronautics and Space Administration (NASA).

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Mission 10
Inventing Life Forms

The Creation of an Imaginary Species

Overview

In Mission 9, the students applied their knowledge of biological concepts to determine the identity of several Earth plants and animals. In Mission 10, they will play a dice rolling game, "Inventing Life Forms", to simulate the creation of extraterrestrial life-forms. Then they will make illustrations of their life-forms.

Students will consider many of the important characteristics that distinguish different forms of animal life on the Earth, such as kind of skeleton, body size and shape, how it gets around, senses, method of reproduction, relationship to other forms of life, and so on, in an evolutionary context. All of these characteristics are the result of natural selection; they are all adaptations to their environments. The students also have an opportunity to be creative as they draw a picture and describe the creature they have invented. As they play the game, the students learn that biological concepts are expected to apply to all life, no matter where in the universe it may have evolved.

Concepts

• Scientists expect certain biological concepts to apply to all life, everywhere in the Universe.

• Natural selection operating in an extraterrestrial environment will produce extraterrestrial creatures that are adapted to that environment.

Skills

• Synthesize knowledge and creative imagination to visualize the evolution of life.
• Follow directions written as a flowchart.
• Understand the role of chance in events.

Mission 10

Materials

For Each Team:
› Crayons or markers
› 1 Die or number cube

For Each Student:
› SETI Academy Cadet Logbook
› pencil

Getting Ready

Before the Lesson:
1. (Optional) Create reusable “game rules” booklets in folders (the instructions for Inventing Life-Forms are eight pages long).

Classroom Action

1. **Mission Briefing.** Have the class refer to the “Mission Briefing” for mission 10 in their student logbooks while one student reads it aloud.

2. **What Do You Think?** Have students answer the pre-activity questions on the “Mission Briefing.” Invite them to share their answers in a class discussion.

3. **Lecture**. Emphasize that scientists who study the possibility of life on other planets have no actual extraterrestrial creatures to study, since none have been discovered yet. However, they can do simulations based on what they know of Earth life and how it evolved. For example, when Pangaea separated into the modern continents, each continent became a "little world" on which evolution proceeded independently: in Australia, marsupials evolved, while in North America, placental ("true") mammals evolved.

Biologists also know that any organism on any planet must have solved the same problems that all Earth organisms have, although there are many possible solutions to each problem. For example, any organism on any planet must have body openings so that solids and gasses can pass into and out of it in order to allow for life processes and growth. Also, any organism on any planet must have a method of getting nutrients into its body; the actual method depends on the organism’s size. Also, each animal must fit into some sort of food web as both predator and prey. The number of offspring may be related to the degree to which the parent animal cares for its young.

4. **Demonstration**. In this game, “Inventing Life Forms”, each student will use a combination of chance probabilities and creativity to imagine one extraterrestrial (Planet Y) creature. Explain to the students the rules of is game:

a. Each student rolls one die to find out one characteristic of their extraterrestrial creature, carefully following the instructions.
b. Each characteristic is written on the “Recording Sheet” in the logbook along with the name of an Earth creature that has that same characteristic. Explain that the purpose of listing the Earth creature is to help to think about how that characteristic affects the life and behavior of the Earth animal. The extraterrestrial animal may be similar!
c. After that step is finished, the student proceeds to the next step following the directions very closely. There are a few cases where they will have to roll the die twice, or skip a step.

As an example, roll a die for step 1—“Skin”— and show how to record the results of the roll. Point out the direction "Go To" that tells the student what to do next.

Ask the students to look at step 24 and the “My Extraterrestrial Species” logbook sheet, where they name, draw a picture of, and describe their creature. Students who finish early can ask you for drawing materials and go on to that step. You may wish to make completion of the last step a homework assignment.

4. **Activity**. Give the students the remainder of the class period to complete the game. Help as needed, and check to see that all of the students are recording their results. Small drawings of plant and animal forms used for food can be done on the back of the recording sheet when they draw their life form, or on a separate sheet of paper.

The students should have some fun with the simulation, and recognize that life on other worlds will follow the rules that have led to the development of life on Earth, though the outcomes will be different. This is like dealing a hand of cards. Following the rules of the game, a specific number of cards will be dealt. However, each actual hand is a different outcome.

Closure

1. **Discussion**. Post all of the students' drawings on the wall. Allow time for each student to describe their creature. Ask students to tell how intelligent they think their creature might be, but do not emphasize intelligence as it is a complex topic, and the subject of *The Rise of Intelligence and Culture* in the *SETI Academy Planet Project* volumes.

2. What Do You Think? Have student answer the post-activity questions on the log-book sheet "What Do You Think, Now?" Invite students to share their responses. Ask students ho their opinions have been changed by this mission. In response to these questions, students might recognize, for example, the many different life-forms could exist in different habitats on the same planet. They might also see that characteristics implying the amount of gravity or composition of the atmosphere might mean that the creatures must be from different planets. For example, on a planet with a thin atmosphere, land dwelling creatures might have huge lungs. On a massive planet with strong gravity, creatures might be flat and low to the ground. Encourage open discussion and alternative points. of view.

Going Further

ACTIVITY: CREATIVE WRITING

Invite the students to make up a story from the viewpoint of their creature. They might want to describe a day in the life of their creature, or what happens when their creatures meet a visitor from Earth.

ACTIVITY: ENCORE, MORE EXTRATERRESTRIALS!

Have the students invent another creature from the same planet, using their imagination (no dice rolling). They should still describe all of the characteristics of their creatures, and how their new invented animals or plants are related to the creature they evolved in the die-rolling game.

Mission 10
Inventing Life-Forms

Name _____ **Date** _____

Mission Briefing. "All living things took their present form through a very long series of chance variations. Most of the changed creatures died, but the few that were better adapted to their environment survived, passing on those changes to their offspring. This is natural selection. In this game, you are invited to create a form of animal life that might have evolved on a planet that is somewhat, but not exactly like, Earth. Rolling a die will simulate the role of chance in the evolution of your extraterrestrial creature. Each roll of the die represents a result of millions of years of chance variations that were successful in the extraterrestrial environment. At the end of the game, you will have a chance to be creative and draw a picture showing what your extraterrestrial looks like."

Dr. David Milne
Biologist on SETI Academy Team.

What do you think?

1. In what ways might an habitable extraterrestrial planet be different from Earth?

2. In what ways could extraterrestrial life-forms be different from Earth life-forms?

Mission 10
Inventing Life Forms

Name _____ **Date** _____

Student Recording Sheet

Table 10.1. Inventing Life Forms.

Adaptation	Adaptation of Your Extraterrestrial Organism	Earth Animal With Adaptation
1. Kind of skin		
2. Number of openings		
3. Long or other?		
4. Segments		
5. Appendages		
6. Hard parts		
7. Hard outside parts		
8. Size		
9. Feeding cells		
10. Moving around		
11. Sensing vibrations		
12. Chemical senses		
13. Number of eyes		
14. Eating		
15. Plant eater		
16. Predator		
17. Defensive structures		
18. Poison as a defense		
19. Defensive behaviors		
20. Reproduction		
21. Sexual reproduction		
22. Mating		
23. Babies		

Mission 10
Inventing Life Forms

Directions

On each roll, use one die. Record all of your adaptations on the recording sheet in the center column, and copy the Earth animal (in parentheses) with the same attribute in the column on the right.

1. SKIN. If you roll a ...
1,2, or 3 = you have scaly skin (*like a snake).*
4 or 5 = you have mucus-covered soft skin *(like a slug).*
6 = you have leathery skin *(like a cow).*
Record on your recording sheet.
GO TO 2. OPENINGS

2. OPENINGS. If you roll a ...
People have different openings or holes in their bodies to breathe, get rid of waste, and eat. Some animals, like anemones, use 1 hole for several of these purposes. How many holes does your organism have, and which does it use for what?
1 or 2 = 1 opening *(like a sea anemone).*
3 or 4 = 2 openings*(like an earthworm).*
5 or 6 = 3 openings *(like a frog).*
Record on your recording sheet.
GO TO 3. ROUND OR LONG

3. BODY SHAPE. If you roll a ...
1, 2, 3 or 4 = your organism's body is longer than it is wide *(like a worm)* .
5 or 6 = your organism has some other shape
Record on your recording sheet.
GO TO 4. SEGMENTS

4. SEGMENTS. If you roll a ...
1, 2 or 3 = your organism's body is divided into segments *(like a centipede).*
Record on your recording sheet.
GO TO 5.A. APPENDAGES FOR SEGMENTS

4,5 or 6 = your organism's body has no segments *(like a toad).*
Record on your recording sheet.
GO TO 5.B. APPENDAGES FOR NO SEGMENTS

5.A. APPENDAGES FOR SEGMENTS
Roll one die two times and add the numbers together to find the number of **segments** your organism has. Your organism has two appendages on every segment. (3 segments x 2 = 6 appendages)
Record on your recording sheet.
GO TO 6. HARD PARTS

5.B. APPENDAGES FOR NO SEGMENTS
People have four appendages: two arms and two legs. On Earth, most animals have an even number of appendages, but that may not be the case on all planets. Roll one die. This is the number of appendages your organism has.
Record on your recording sheet.
GO TO 6. HARD PARTS

6. HARD PARTS. If you roll a ...
1,2 or 3 = your organism has hard parts on the **outside** of its body. *(like a lobster)* .
Record on your recording sheet.
GO TO 7. OUTSIDE HARD PARTS

4 or 5 = your organism has hard parts on the **inside** of its body. *(bones -like you).*
Record on your recording sheet.
GO TO 8.B. LARGE SIZES

6 = your organism has **no hard parts**. It gets around by wiggling *(like a worm).*
p Record on your recording sheet.
GO TO 8.A. SMALL SIZES

7. OUTSIDE HARD PARTS. If you roll a ...
1 or 2 = your organism has a hard shell *(like a snail).*
Record on your recording sheet.
GO TO 8.A. SMALL SIZES

3 or 4 = your organism has a protein, armor-like covering *(like a beetle).* It must shed its armored skin to grow.
Record on your recording sheet.
GO TO 8.A. SMALL SIZES

5 or 6 = your organism has a protein, shell-like covering *(like an insect).* It doesn't need to shed to grow.
Record on your recording sheet.
GO TO 8.B. LARGE SIZES

8.A. SMALL SIZES.
Roll one die for the range of your organism's weight.
1 or 2 = 0-1 pounds *(like a mouse).*
3 or 4 = 1-2 pounds *(like a rat).*
5 or 6 = 2-5 pounds *(like a chicken).*
Record on your recording sheet.
GO TO 9.A. FEEDING CELLS OF SMALL ANIMALS

8.B. LARGE SIZES.
Roll one die for the range of your organism's weight.
1 = 6-9 pounds *(like a cat).*
2 = 10-49 pounds *(like a bobcat).*
3 = 50-99 pounds *(like a German shepherd).*
4 = 100-199 pounds *(like an alligator).*
5 = 200-999 pounds *(like a pig).*
6 = 1,000-100,000 pounds *(like a dinosaur).*
Record on your recording sheet.
GO TO 9.B. FEEDING CELLS OF LARGE ANIMALS

9.A. FEEDING THE CELLS OF SMALL ANIMALS
Like people, earthworms take in oxygen and food from their environment. The oxygen and food nutrients are absorbed by the worm's blood. Five small hearts pump the blood through the body to give oxygen and food nutrients to all the cells in the worm's body. Other small animals get food and oxygen to their cells in different ways. Roll 1 die to find out how your small animal gets oxygen and nutrients to its cells.
If you roll a ...
1 or 2 = oxygen and food are in blood, which is pumped to organs by one pump (heart) *(like a mouse)*
3 or 4 = oxygen and food are in blood, which is pumped to organs by more than one pump (several hearts) *(like an earthworm)*
5 = oxygen and food are in blood, which sloshes around inside your animal, bathing all cells. *(like a lobster)*
6 = Your organism is only a few cells thick. It absorbs oxygen and food through its skin, and has no blood. *(like a flatworm)*
Record on your recording sheet.
GO TO 10. MOVING AROUND

9.B. FEEDING THE CELLS OF LARGE ANIMALS
We take in air and food from our environment. Our blood absorbs oxygen from the air and nutrients from the food. Our hearts pump the blood through our bodies, carrying the oxygen and nutrients to every cell of our bodies. Roll 1 die to find how your animal gets oxygen and nutrients to its organs.
If you roll a ...
1,2,3 or 4 = oxygen and food are in blood, which is pumped to organs by one pump (heart) *(like you)*
5 or 6 = oxygen and food are in blood, which is pumped to organs by more than one pump (several hearts) *(like an octopus)*
Record on your recording sheet.
GO TO 10. MOVING AROUND

10. MOVING AROUND. If you roll a ...
1= crawls on land *(like a snail)*
2 = walks on land *(like a centipede, beetle, lizard, or ostrich)*
3 = swims in water *(like a fish)*
4 = drifts in water *(like a jellyfish)*
5 = jet propulsion in water (shoots out a burst of water through one of the holes in its back end, shooting the organism forward). *(like a squid)*
6 = flies in atmosphere (if larger than 100 lbs, roll again) *(like a bird or bat)*
Record on your recording sheet.
GO TO 11. SENSING VIBRATIONS

11. SENSING VIBRATIONS. If you roll a ...
People use their ears and sense of touch to feel vibrations in the air and the ground. What does your organism use to sense vibrations?
1 to 3 = your organism has organs (like ears) to sense vibrations in air *(like the whiskers on a mole)* or in water (sound). *(like you)*
4 to 6 = your organism uses small hairs scattered over its body to sense vibrations in the air, or water (sound). *(like some fishes or hairy tarantulas)*
Record on your recording sheet.
GO TO 12. CHEMICAL SENSES

12. CHEMICAL SENSES. If you roll a ...
People have sensors that sense chemicals in the air, food or water. They are in your nose and tongue, but chemical sensors are not always in noses or on tongues. Spiders have them on the soles of their feet. How many chemical sensors does your organism have, and where are they?
1,2 or 3 = one place *(like a spider)*
4,5 or 6 = two places *(like you)*
Record on your recording sheet.
GO TO 13. SENSING LIGHT

13. NUMBER OF EYES. If you roll a ...
1 or 2 = no eyes *(like blind cavefish)*
3 or 4 = 2 eyes *(like you)*
5 or 6 = more than two eyes *(like a spider)*
Record on your recording sheet.
GO TO 14. EATING

14. EATING. If you roll a ...
1,2,3 or 4 = plant-eater. Needs something to snip and grind plant parts with *(like a cow)*
Record on your recording sheet.
GO TO 15. PLANT-EATER

5= meat-eater. Needs to have meat tearers (like claws and sharp teeth) *(like a tiger)*
Record on your recording sheet.
GO TO 16. PREDATOR

6 = plant and meat-eater. Needs to have both plant grinders and meat tearers. *(like a bear)*
Record on your recording sheet.
GO TO 16. PREDATOR

15. PLANT-EATER
Your organism must protect itself against predators.
GO TO 17. PROTECTION - DEFENSIVE STRUCTURES

16. PREDATOR. If you roll a ...
How does your organism catch its prey? Roll one die twice add the numbers to get one adaptation. Repeat to get a second adaptation.
2 = chase it*(like a cheetah)*
3 = hit it *(like a hawk)*
4 = suffocate it *(like a python)*
5 = blind it *(like a spitting cobra)*
6 = spear it*(like a harpoon worm)*
7 = inject poison *(like a scorpion)*
8 = make a trap *(like a spider)*
9 = lure (trick it with a treat) *(like an angler fish)*
10 = electric shock *(like an electric eel)*
11 = stun it with vibrations *(like a dolphin)*
12 = work together with others of the same species *(like wolves)*
Record on your recording sheet.
GO TO 17. PROTECTION

17. PROTECTION - DEFENSIVE STRUCTURES
If you roll a ...
1 or 2 = spines *(like porcupine)*
3 or 4 = thick, protective covering *(like a turtle)*
5 or 6 = horns *(like a triceratops)*
Record on your recording sheet.
GO TO 18. PROTECTION - POISON

18. PROTECTION - POISON AS A DEFENSE. If you roll a ...
1,2,3,4 or 5 = No, your organism is not poisonous. It has camouflaged coloring, so it blends in with the planet's most common plant color *(like a grasshopper)*
6 = Yes, your organism is poisonous to eat, or has a venomous sting, and has coloring that warns other animals to leave it alone by standing out against the planets' plant color *(like poison arrow frogs)*
Record on your recording sheet.
GO TO 19. PROTECTION - DEFENSIVE BEHAVIORS

19. PROTECTION - DEFENSIVE BEHAVIORS. If you roll a ..
1 = run away *(like an antelope)*
2 = hide *(like a prairie dog)*
3 = freeze (stand very still) *(like a pheasant)*
4 = fight *(like cats and dogs)*
5 = pretend you're bigger than you really are*(like a scared cat)*
6 = work together with others of your species*(like a musk ox)*
Record on your recording sheet.
GO TO 20. REPRODUCTION

20. REPRODUCTION. If you roll a ...
1, 2 or 3 = Asexual: your organism reproduces without sex, by budding off a piece of itself, which grows into another identical organism *(like sea anemone)*
Record on your recording sheet.
GO TO 24. DESIGN YOUR ORGANISM

4, 5 or 6 = Sexual - your organism reproduces by sex (two organisms share their adaptations, and make babies a little different from themselves) *(like cats)*
Record on your recording sheet.
GO TO 21. SEXUAL REPRODUCTION

21. SEXUAL REPRODUCTION. If you roll a ...
1 or 2 = your species has two sexes: A &B. Every individual has only one sex *(like people and other mammals)*

3 or 4 = your species has two sexes: A & B. Every individual has both sexes, but two individuals are required to mate *(like earthworms)*.

5 or 6 = your species has three sexes: A, B & C. Every individual has one sex. Three individuals are required to mate. *(like no examples on Earth, but maybe this is true for your organism)*

Record on your recording sheet.
GO TO 22. MATING

22. MATING. If you roll a ...

Since your species has to get together all its sexes to mate, they need a way to find each other.
1 or 2 = mating call *(like a song sparrow)*
3 or 4 = bright colors *(like a male pheasant)*
5 = mating dance *(like a male peacock)*
6 = mating smell *(like big moths)*
Record on your recording sheet.
GO TO 23. BABIES

23. BABIES. If you roll a ...
1 = lay many eggs, but leave and don't take care of the babies *(like fish)*

2 = lay few eggs & take care of eggs & young. Whichever sex takes care of the eggs & young is camouflaged *(like birds)*

3 or 4 = live birth, care for young in some form of nest. Whichever sex(es) take care of the eggs, the young must be camouflaged *(like rabbits)*

5 or 6 = live birth, care for young in a pouch *(like a kangaroo).*
Record on your recording sheet.
GO TO 24. DESIGN YOUR ORGANISM

24. DESIGN YOUR ORGANISM
Using the attributes you now have for your extraterrestrial organism:

1) Draw what your organism and its extraterrestrial food source look like. Give the species a name.

2) Have a friend check your drawing to see that it has the attributes on your recording sheet.

3) Write a page about your creature, telling about all of the attributes not shown in the drawing, plus any other information you would like to add.

Mission 10
My Extraterrestrial Species

Name _____ **Date** _____

Name of Species: _____

Appearance of Species

Food For Species

Mission 10
Inventing Life Forms

Name _____ **Date** _____

What do you think, now?

After you have completed this activity, please answer the following questions:

1. In what ways do you think the planet where your extraterrestrial creature lives might be different from Earth?

2. Compare your extraterrestrial creature with others in the class. Could they all survive on the same planet? Why or why not?