

ActionBioscience.org lesson

To accompany the article by Abigail A. Salyers, Ph.D.:

"Looking for Life on Mars and Beyond" (Aug. 2004)

<http://www.actionbioscience.org/newfrontiers/salyers2.html>

Life on Mars? (March 2007)

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Grades & Levels:

- **Handout 1:** middle - high school (all levels)
- **Handout 2:** high school (all levels)
- **Handout 3:** high school (honors/AP) –undergraduate (year 1)

Time Recommendations:

- 1 class period and/or assignment for article review and discussion questions
- 1-4 class periods for activities or a combination of classroom and assignment work

NSES (USA) Content Standards, 9–12:

- NSES 1.2. Unifying Concepts and Processes: Evidence, models, and explanation
- NSES 2.1. Science as Inquiry: Abilities necessary to do scientific inquiry
- NSES 3.3. Physical Science: Chemical reactions
- NSES 5.2. Earth & Space Science: Geochemical cycles

Note: View the NSES content standards on this site to choose other curricular applications for additional activities at www.actionbioscience.org/educators/correlationcharts.html

Lesson Objectives: Students will...

- recognize that the idea of life on Mars is a hypothesis with differing scientific views
- explore the definition of "microbes"
- examine the similarities of landscapes and conditions between Earth and Mars
- consider evidence that there used to be water, and perhaps life, on Mars

Key Words Include:

Archaea, astrobiology, atmosphere, bacteria, cyanobacteria, eukaryotes, extremophiles, fungi, hydrothermal, microbes, microorganisms, microscopic, photosynthesis, protozoa, streamlets, stromatolies, UV radiation, virus

Preparation

Article Discussion: Several approaches are possible for the questions on page 2:

1. Have students read the article on their own, or distribute questions to groups.
2. Give students copies of the questions and have them do the reading and complete the content questions on their own, perhaps as a short-answer writing assignment. Have them discuss their answers and the more complex questions either as a large group or in small groups.
3. Some extension questions require research and may be more suitable as homework.

Lesson: *Life on Mars?* By Abigail A. Salyers

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Source: <http://www.actionbioscience.org/newfrontiers/salyers2.html>

Handouts: Refer students to “useful links for student research” in the “Educator Resources” section at the end of the Morse article. These links help students with their activities and provide a source for research information.

- **Handout 1:** These are introductory activities in the concept of microbes.
 - **Handouts 2 and 3:** Students will need to view images of space exploration on the Internet.
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For Educators: Article Discussion

About the article by Abigail A. Salyers, Ph.D.: "Looking for Life on Mars and Beyond"

<http://www.actionbioscience.org/newfrontiers/salyers2.html>

Article Content Questions

1. What life forms were present on Earth billions of years ago?
2. What did microbes do for the development of life on Earth?
3. What's the main difference between bacteria and eukaryotes?
4. What is binary fission?
5. How are fungi different from your average microbe?
6. How is Antarctica similar to Mars?
7. Why could the atmosphere on Mars be good for microbial life?
8. Why does the author think microbes would be less abundant on Mars than on Earth?
9. Can microbes leave a fossil record? Explain.
10. Why could Europa harbor life?
11. Why is photosynthesis important to life?
12. Why is it important that scientists reexamine the criteria for the definition of life?
13. Is it possible that samples of Mars microbes brought to Earth by space explorers could become hazardous to life on Earth? Explain.
14. Could Earthlings contaminate Mars? Explain.

Article Extension Questions

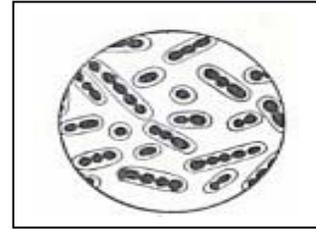
1. If you were an astronaut, what do you think you would experience on a walk on Mars?
2. Where would you look for water on Mars? For microbes? For signs of life?
3. If you could ask a scientist involved in space exploration, what would you like him or her to tell you about Mars?
4. What would you recommend to this scientist about what you think they should try to find out about the universe?
5. Do you think there is life somewhere in space? Why or why not?
6. Should humans set up a permanent base on Mars to conduct exploration? Why or why not?
7. Should nations spend their money to fund projects on Earth instead of projects in space? Why or why not?

Extension Activities

1. Mars is known as the "Red Planet." Do a search on the Internet to find out why it has this nickname.
2. Write a one-page fact sheet about the history of Mars exploration. Search for data on the Internet or in publications in the library.

Life on Mars?

Handout 1



A. Read the following description of "microbe."

What is a microbe?

To most scientists, and for purposes of this article, "Looking for Life on Mars and Beyond" <http://www.actionbioscience.org/newfrontiers/salyers2.html>, the term "microbe" means any creature capable of reproducing itself that is too small to be seen with the unaided eye. This would include viruses, bacteria, archaea, fungi, protozoans and algae. Archaea are microbes that look like bacteria but have now been found to form a separate domain of life, the other two domains consisting of the bacteria and the eukaryotes (e.g., fungi, protozoa, plants, animals). There are two caveats to this definition. Some scientists would place viruses in a separate category because they are parasitic on cells capable of reproducing themselves, such as bacteria, fungi, and mammalian cells. Other microbes, with a few exceptions, are capable of reproducing themselves without this type of aid. Many of these, but not all, reproduce by dividing (binary fission). A second caveat is that some microbes, including bacteria and fungi, are large enough to be seen without a microscope. These exceptions are included under the term "microbe" because they are closely related to other microbes that are not visible to the unaided eye.

It is difficult to come up with an airtight definition of microbe because, as scientists now know, microbes are an incredibly diverse collection of creatures. There is far more genetic diversity in the microbial world than in plants, insects or animals – a fact that is not surprising when you consider the fact that microbes had a 3 billion year evolutionary head start. The diversity of microbes also shows itself in the variety of environments (volcanoes, clouds, sulfuric acid mine drainage, hydrothermal vents, deep subsurface, hot springs) where microbes can live.

B. Definition Discussion

With a partner, discuss the following:

- Did you learn something new about microbes? Explain.
- How would some scientists qualify the general definition of microbes? Why?
- Why is it a problem to come up with a definition of microbes?

C. Meet the Relatives

For a small group project, choose one of the activities below (1) or (2). Your presentation will include a photo/illustration of a: virus, bacteria, archaea, fungi, protozoa, and algae.

1. Create an illustrated glossary of these organisms. Search the Internet for a photo or illustration of one organism in the each category above (download the photo/illustration or make a sketch). Write a very short description about each organism.
2. Make a poster of a family tree to show how these organisms are related. Add a photo or illustration of one example organism for each branch of your tree. Label the organisms.

Life on Mars?

Handout 2

1. Mars Documentary

With a partner or group of students, write an outline/draft for a short TV documentary (or create a PowerPoint or web page presentation) to describe the surface of Mars. Make sure you include information about:

- surface features such as volcanoes, valleys, canyons, dust storms, channels and impact craters
- unique planetary features such as chaotic terrain
- indications on the surface that suggest the presence of flowing water

Present your ideas for the documentary to the class. Ask for suggestions about ways to produce this documentary.

2. Mars Vehicle

What surface exploration vehicle would you design for a Mars mission? With some classmates as co-designers:

- Search the Internet for vehicles used in past and current missions, e.g., the Mars Rover. Examine their design and purpose.
- Discuss the engineering considerations, e.g., fuel source, weight, moving parts, maneuvering mechanism.
- Review the travel challenges of the planet's surface and consider the special features you would need to add to overcome these challenges.
- Using graph paper or a drafting/drawing software program, sketch a design.
- Write a short sales pitch about the benefits of the design. How about a name for your vehicle?

Present the design to the class and read your sales pitch. Compare your design with the designs created by other student groups.

3. Mars Quiz

What do your classmates and family know about Mars? Research data about Mars and create a quiz of 10 to 20 questions that will stun and amaze them. For example:

- What caused the craters on Mars?
- Why do impact craters stay in tact on Mars but become obliterated on Earth?
- Are any of the volcanoes on Mars still active?

You can find some data for the quiz in Abigail Salyer's article "Looking for Life on Mars and Beyond" <http://www.actionbioscience.org/newfrontiers/salyers2.html>. Also, there are many good web sites about Mars exploration.

4. Space Exploration in the Movies

Have you ever watched a sci-fi movie about exploration of Mars or other real or fictional planet? Some examples include Red Planet, Alien, Mission to Mars, Star Trek movies, Dune.



- Choose one of these movies and write a one-page "editorial" for a local paper about why you think the movie plot is or isn't plausible.
- Read the editorial in class and let other students debate you about your views.

Life on Mars?

Handout 3



Valles Marineris, Mars
Courtesy NASA/JPL-Caltech

1. Reports

Choose one of the following topics for a report:

- Look up the composition of the atmosphere and surface temperature of Venus. Could microbial life exist on Venus and, if so, what type of metabolism would it have?
- If previous space probes have contaminated Mars with Earth organisms, how will this complicate the search for life on Mars? How could scientists rule out this possibility? Or can they?

2. Mars to Earth

Some scientists dismiss the danger of bringing Mars samples to Earth because a number of meteors from Mars have landed on Earth with no obvious adverse consequences. With a partner find out:

- how scientists decide that a meteor comes from Mars
- why fragments of the planet would be hurtling through space
- whether a meteor is the same as a soil sample or rock collected from the Mars surface and brought back in a space ship

Present your findings to the class.

3. Science Fiction

Write a short story along the lines of the *Andromeda Strain*, from the Martian perspective. What damage, if any, could Earth microbes do to life on Mars if life exists on the red planet? (*Andromeda Strain* is a novel written by Michael Crichton in 1968, which was turned into a movie in 1971.)

4. Proof of Water on Mars?

Search for news stories on the Internet that appeared around December 7, 2006 (or more recent news). The news was about scientists discovering evidence that water flowed down gullies on Mars from pictures taken by NASA's Mars Global Surveyor, which has been orbiting the planet for ten years. Examine the pictures and news reports and write your own version of the news story.

Include the following information:

- Which areas of Mars suggest flowing water?
- Where would the water have come from?
- What is the most recent evidence for water flow?
- How does flowing water create features that can be interpreted as water flow?
- What other evidence do scientists have to support the idea of water on Mars?