

Extra, Extra, Read All About It: Microbes Create Earth's Atmosphere

An Astrobiology Web Quest created by Robin Bucaria, Dartmouth Middle School in cooperation with Dr. Brad Bebout, NASA Ames Research Center

Introduction

You have been selected as a member of a group to interest fourth and fifth grade students in current science issues. As you searched for science topics to capture their attention, you came across this headline: *Microbes Create Earth's Atmosphere*. Although this seems like a tabloid heading, it is not. NASA researchers are studying bacteria, other microbes, and the gases they produce in microbial mat ecosystems to see how life formed on Earth. Early microbial ecosystems are also studied to help scientists discover life on other planets. This research is even being used in the quest for life on Mars. You wonder, how do you use earth's microbial ecosystems to look for life on other planets?



Oxygen bubbles being produced by cyanobacteria in a microbial mat. Photo Credit: Bruce Russell, Biomedica Associates

Mock Article for Web Quest

Microbes Create Earth's Atmosphere

Over three billion years ago, microbial mats covered the earth. These mats were composed of layers of microorganisms similar to microbial mats that exist today. Microbes living within the mats produce different gases, sugars and organic matter as they harvest energy. For example, cyanobacteria living at the top of the mat conduct photosynthesis and release oxygen as a by-product. Aerobic heterotrophs, found in the next layer, break down sugar with oxygen and produce carbon dioxide and water. Other microbes produce different by-products. Scientists at NASA Ames Research Center probe the mysteries of modern microbial mats, and the products of the microbes living within the mats, to gain an understanding of how Earth's early atmosphere formed. Dr. Brad Bebout explains, "We think that modern microbial mats are examples of Earth's earliest biological communities. They may contain the same kinds of organisms that were present 3.5 billion years ago."

Task

Your group has been selected to give an interactive lesson on microbial mats to a fourth or fifth grade class. The lesson will capture the attention of the students, excite them about science, and answer the following questions:

- *What are microbes?*
- *What are microbial mats?*
- *How do mats function as ecosystems?*
- *What do microbial mats tell us about life on early earth?*
- *What do microbial mats tell us about the search for life on other planets?*

Your group may choose to present a skit, activity, PowerPoint presentation, movie, or other idea. Be creative and engage your audience.

Process

Write the problem statement: As a team, what do you consider your task and problem to be? Write a question to address for your task.

Sample: *How can we create an interactive lesson, which shows how Earth's Earliest? Ecosystems can be used to look for life on other planets?*

Determine Learning Issues

Know Want to know Learned format

Step One: In your team, complete the KWL chart, answering the questions as follows:

In the *Know* section of the chart: **What do you know about microbes, microbial mats, astrobiology, slime, or space exploration using mats to find life on other planets?**

In the *Want to know* section of the chart: **What do you need to need to learn about microbes, astrobiology, microbial mats, the search for life on other planets, etc. in order to create your presentation to the elementary school students?**

Remember, if you do not know anything about the topic, you will need to learn a little bit about the topic, determine new learning issues, and then research other items.

The *Learned* section of the chart will be completed as you do research.

Step Two: Decide as a team how to group your learning issues from the *Want to Know* section of the chart into four categories to research. Make group research assignments. In your learning log, list your research category and key words for research.

Conduct Research

Step One: In One class period will be given for the initial research. When researching, take notes on 4 x 6 index cards. Make certain that you write only one idea per card. Also, complete a bibliography card with all necessary information on a 3 X 5 index card for each new source of information. All research information will have to be documented in a bibliography for your project. The Research Guidelines handout provides assistance on note taking and documenting bibliographic information.

Web Sites where you can begin research:

Astrobiology. N/A. NASA. 12 January 2005. <http://www-space.arc.nasa.gov/branches_EB.htm>

Astrobiology micro*scope. The Astrobiology Institute. N/A. Marine Biological Laboratory, Woods Hole, MA. 12 January 2005 <<http://www.mbl.edu/microscope>>

Bebout, Brad. *Microbes at NASA*. NASA Ames Research Center. 15 August 2005. Web Page. 17 August 2005. <<http://microbes.arc.nasa.gov>>

Cyanobacterial Image Gallery. Dr. Mark A. Schneegurt. N/A. Department of Biological Sciences, Purdue University. 12 January 2005. <<http://www-cyanosite.bio.purdue.edu/images/images.html>>

Dyer, Betsey Dexter. [A Field Guide to Bacteria](#). Cornell University: Ithaca, NY, 2003. (pp. 32-33 for guide on using microbes to seek life on other planets, pp. 232-275--cyanobacteria)

"Introduction to the Cyanobacteria: Architects of earth's atmosphere," Brian Speer. 17 October 1995. University of California, Berkeley. 12 January 2005. <<http://www.ucmp.berkeley.edu/bacteria/cyanointro.html>>

Microbe World. 24 February 2003. American Society for Microbiology. 12 January 2005. <<http://www.microbeworld.org/home.htm>>(General Information on microbiology Activities for Microbiology Education)

Microbe Zoo. N/A. N/A. Communication Technology Laboratory Center for Microbial Ecology, Michigan State University. 12 January 2005. <<http://commtechlab.msu.edu/sites/dlc-me/zoo/index.html>>

nai.arc.nasa.gov. NASA Astrobiology Institute. Rosalind Grymes, Responsible Official. N/A. 12 January 2005. <<http://nai.arc.nasa.gov>>

NASA's Mars Exploration Program. 12 January 2005. 12 January 2005. <<http://mars.jpl.nasa.gov/>> (Search Mars for microbes and other related key words)

"Stalking the mysterious Microbe!" Microbe World.org. 1999. American Society of Microbiology. 12 January 2005 <<http://www.microbe.org/index.html>>

Weingarten, Tara. "Hello, Out There! The New Science of Astrobiology," 2000 The Millennium Note Book, pg. 12. Newsweek. 21 September 1998. Online. <<http://marple.as.utexas.edu/~hillstar/press/NEX98/Newsweek.9-21.html>>

"What is Microbial Ecology?" Communication Technology Laboratory Center for Microbial Ecology, N/A. 2000. Michigan State University. 12 January 2005. <<http://commtechlab.msu.edu/sites/dlc-me/zoo/ziwime.html>>

Step Two: Meet with students from other groups who are researching the same topic to share learning about the topic before meeting with original teams. Add any notes on new information in your learning log. (20 minutes)

Step Three: Meet with your team to share information that you learned about your research categories. Add new information to the Learned section of the KWL chart.

Step Four: As a team, decide if there are any additional learning issues that need to be added to the *Want to know* Section of the KWL chart. Divide these learning issues up between team members.

Step Five: Return to the computer or other resources to determine the answers to the new questions.

Step Six: Meet with your team to report the new research findings, and add this information to the Learned section of your KWL chart.

Plan Your Presentation

Step One: Review your information as a team. Decide what information best answers your problem statement. Highlight this information on your KWL chart.

Step Two: As a team, decide how you will present this information to a fourth or fifth grade class. Your group may choose to present a skit, activity, PowerPoint presentation, movie, or other idea. Be creative and engage your audience. Start planning and writing your presentation. Take notes in your learning log on presentation ideas. If you can, divide your task into parts and have each group member work on a different part.

As you design your interactive lesson, remember the following:

1. Your presentation must be appropriate for a 4th or 5th grade audience.
2. Your final presentation must involve the learners, but contain accurate science facts.
3. Your presentation must be a minimum of 15 minutes, and a maximum of 25 minutes.
4. Your presentation must include a way to check that students understand the material that they learned.

Step Three: Practice presentation and give it to your class for evaluation. What do you need to change before you go to the fifth grade class? Make any revisions and produce a final product. Use the Report of Research Group Presentation Rubric to make certain that you include all required material and techniques in your presentation.

Conduct Research

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Evaluation

Work will be evaluated individually and with a common grade for group work. Therefore, it is important to complete all of your individual tasks on time, so you can work cohesively as a team to finish the group project. Save all the materials that you use to complete the Web Quest. All bibliography cards, note cards, KWL charts, Learning Logs and other supporting information will be collected at the end of the Web Quest. The **Web Quest Process Rubric** will be used to evaluate individual and group effort to complete the task. The **Report of Research Group Presentation Rubric** will be the tool used to evaluate group microbial mat presentations to 5th graders. Notice that both rubrics contain sections where students are evaluated individually and also sections where teamwork is evaluated.

Conclusion

Your research has given you greater understanding about how Earth's microbial ecosystems assist in the search for life on other planets. In turn, your presentation helped 5th graders grasp the idea that life on other planets may be microbial and created an interest in space science. Whether you expand your knowledge to become an astrobiologist, or continue with a general interest in microbial ecology and space science, you certainly would not be surprised to someday discover a headline such as this, "Alien Microbes Create Planet's Atmosphere."

Make certain that you submit all of the parts of your research to your teacher for evaluation, including note cards, bibliography cards, learning logs, the KWL chart and presentation plan.

Teacher Resources

Background

Extra, Extra, Read All About It: Microbes Create Earth's Atmosphere is an astrobiology web quest created by Robin Bucaria, Dartmouth Middle School in cooperation with Dr. Brad Bebout, NASA Ames Research Center. In this web quest, students are selected as a member of a group to interest fourth and fifth grade students in current science issues. Students read an article titled, *Microbes Create Earth's Atmosphere* written for the web quest and then explore how researchers are studying bacteria, other microbes, and the gases they produce in microbial mat ecosystems to see how life formed on Earth. Students also discover, through research, how early microbial ecosystems are studied to help scientists discover life on other planets. Science and language arts standards are met through the web quest.

Main Concept

Microbial mats conduct processes that control our planet.

Question

What are microbial mats and why are they important?

Objectives

1. The student will identify topics, ask and evaluate questions; and develop ideas leading to inquiry, investigation, and research.
2. The student will use technology research tools to locate, evaluate, and collect information from a variety of sources.
3. The student will summarize or paraphrase reading materials by taking notes that include main ideas, most significant details, and reflect the underlying meaning of the material.
4. The student will deliver research presentations.
5. The student will discover how living organisms affect the composition of the atmosphere.
6. The student will learn how organisms in microbial mats function as ecosystems exchanging energy and nutrients among themselves and with the environment

Abstract

During this student web quest, students will utilize the internet as a source of information on microbial mats, practice summarizing, and present a report of research.

Prerequisite Concepts

1. Familiarity with internet search engines.
2. A basic understanding of photosynthesis.

Major Concepts

Misconceptions

National Education Standards:

IRA/NCTC Standards for the English Language

National Science Education Standards (NSES)

Project 2061 Benchmarks for Science Literacy (2061)

National Education Standards:

Fully Met	Partially Met	Addressed
<p>NLAS #7: Conduct research by generating ideas and questions; gather, evaluate and synthesize data from a variety of sources.</p> <p>NLAS #8: Use technological and information resources to gather and synthesize information and create and communicate knowledge</p>	<p>NLAS #1: Read range of print and non-print texts</p> <p>NLAS #4: Adjust use of language to communicate effectively</p> <p>NSES C4(5-8): Structure and Function in Living Systems a</p> <p>NSES C6(5-8): Regulation and Behavior a, d</p> <p>NSES C7(5-8): Populations and Ecosystems a, b, c</p> <p>NSES D4(5-8): Structure of the Earth System h, k</p> <p>NSES D5(5-8): Earth in the Solar System d</p>	<p>NLAS #5: Employ a range of strategies when writing; communicate with different audiences for a specific purpose.</p> <p>NLAS #12: Use spoken, written and visual language to exchange information.</p> <p>NSES B6(5-8): Transfer of Energy a, f</p> <p>NSES C7(5-8): Populations & Ecosystems d</p> <p>NSES G2(5-8): Nature of Science b</p>
<p>2061: 12D (6-8) #3</p>	<p>2061: 5A (6-8) #1</p> <p>2061: 5D (6-8) #2</p> <p>2061: 5E (6-8) #2, #3</p> <p>2061: 11A (6-8) #1,</p> <p>2061: 12D(6-8) #2, #4</p>	<p>2061: 1A (6-8) #2</p> <p>2061: 4E (6-8) #2</p> <p>2061: 5A (6-8) #3, #5</p> <p>2061: 5D (6-8) #1</p> <p>2061: 5E (6-8) #1</p> <p>2061: 11C (6-8) #1, #2</p>

California Science Standards

Fully Met	Partially Met	Addressed
<p>LA Grade 6: Reading 2.3, 2.4</p> <p>LA Grade 6: Writing 1.4</p> <p>LA Grade 6: Listening and Speaking 1.4, 1.5, 1.6, 1.7, 2.2 a, b</p> <p>LA Grade 7: Writing 1.4, 1.5</p> <p>LA Grade 7: Listening and Speaking 1.4, 1.5, 1.6, 2.3 a, b, c, d</p> <p>LA Grade 8: Writing 1.4, 1.5</p> <p>LA Grade 8: Listening and Speaking 1.3, 1.4, 2.3 b</p>	<p>LA Grade 8: Reading 2.3</p> <p>Science Grade 6: Ecology (Life Science) 5 a, b, c, e</p> <p>Science Grade 7: Structure and Function in Living Systems 5a</p>	<p>LA Grade 7: Reading 2.2</p> <p>LA Grade 7: Writing 2.5 a, b, c</p> <p>LA Grade 8: Listening and Speaking 2.3 d</p> <p>Science Grade 7: Evolution 3 a, c, d</p> <p>Science Grade 7: Earth and Life History a, d, e</p> <p>Science Grade 8: Chemistry of Living Systems 6 a, b</p>

Reading on Topic Related to Study

Microbial Mat information

Bebout, Brad. *Microbes at NASA*. NASA Ames Research Center. 15 August 2005. Web Page. 17 August 2005.
<<http://microbes.arc.nasa.gov>>

Student Resources

Astrobiology. N/A. NASA. 12 January 2005. <http://www-space.arc.nasa.gov/branches_EB.htm>

Astrobiology micro*scope. The Astrobiology Institute. N/A. Marine Biological Laboratory, Woods Hole, MA. 12 January 2005 <<http://www.mbl.edu/microscope>>

Bebout, Brad. *Microbes at NASA*. NASA Ames Research Center. 15 August 2005. Web Page. 17 August 2005.
<<http://microbes.arc.nasa.gov>>

Cyanobacterial Image Gallery. Dr. Mark A. Schneegurt. N/A. Department of Biological Sciences, Purdue University. 12 January 2005. <<http://www-cyanosite.bio.purdue.edu/images/images.html>>

Dyer, Betsey Dexter. *A Field Guide to Bacteria*. Cornell University: Ithaca, NY, 2003. (pp. 32-33 for guide on using microbes to seek life on other planets, pp. 232-275--cyanobacteria)

"Introduction to the Cyanobacteria: Architects of earth's atmosphere," Brian Speer. 17 October 1995. University of California, Berkeley. 12 January 2005. <<http://www.ucmp.berkeley.edu/bacteria/cyanointro.html>>

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<<http://www.microbeworld.org/home.htm>> (General Information on microbiology Activities for Microbiology Education)

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nai.arc.nasa.gov. NASA Astrobiology Institute. Rosalind Grymes, Responsible Official. N/A. 12 January 2005.
<<http://nai.arc.nasa.gov>>

NASA's Mars Exploration Program. 12 January 2005. 12 January 2005. <<http://mars.jpl.nasa.gov/>> (Search Mars for microbes and other related key words)

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<<http://www.microbe.org/index.html>>

Weingarten, Tara. "Hello, Out There! The New Science of Astrobiology," 2000 The Millennium Note Book, pg. 12. Newsweek. 21 September 1998. Online. <<http://marple.as.utexas.edu/~hillstar/press/NEX98/Newsweek.9-21.html>>

"What is Microbial Ecology?" Communication Technology Laboratory Center for Microbial Ecology, N/A. 2000. Michigan State University. 12 January 2005. <<http://commtechlab.msu.edu/sites/dlc-me/zoo/ziwime.html>>

Additional Resources

Blake, Dr. David F. Exobiology. 27 July 2004. <http://exobiology.arc.nasa.gov/> (NASA's interest in microbes, links to lab pages)

Ewald, Heather T. James H. Brashears III, Christine N. Huynh, Eric B. Freeman, Micahael V. Corvini, Meghan F. Davis, Elizabeth M. Femenia, Billie R. Hart and Carl W. Vermeulen, "Micro-Organisms for Education," Department of Biology, The College of William & Mary:1997, 12 <<http://www.science-projects.com/safemicrobes.htm#xlist>>

Noever, David. "Earth Microbes on the Moon," 1 September 1998. Science@NASA. 12 January 2005.
<http://science.nasa.gov/newhome/headlines/ast01sep98_1.htm>

"Production and Consumption of Trace Gases in Microbial Mats," N/A. NASA Ames Research Center. 12 January 2005.
<http://exobiology.arc.nasa.gov/ssx/microecobiogeo/html_documents/trace_gases.htm>

Schneegurt, Dr. Mark A., Cyanosite, Department of Biological Sciences, Purdue University, <http://www.cyanocite.bio.purdue.edu/> (Source of images and heavy research articles, may not be that good for kids)

seti.org. 2005. The SETI Institute. 12 January 2005. <<http://seti.org>>

Visionlearning. 2000-2005. The National Science Foundation. 12 January 2005. <<http://www.visionlearning.com/index.php>>

Materials List

1. Supplies

- a. Internet access
- b. 3 X 5 and 4 x 6 inch Note cards

2. Handouts

- a. Research Guidelines
- b. KWL Chart

3. Rubrics

- a. Web Quest Process Rubric
- b. Report of Research Group Presentation Rubric

4. Video

- a. Stromatolite Explorer downloadable from the Microbes @ NASA website <<http://microbes.arc.nasa.gov/>>

Differentiation

Structure student teams to compensate for differences in abilities. Student teams should be balanced, containing high, medium, and low ability students as well as a balance of students with learning disabilities and English language learning needs.

Preparation

1. Obtain access to computers with internet access for each student.
2. Review materials on the Microbes @ NASA website <<http://microbes.arc.nasa.gov/>>
3. Make classroom set(s) of copies of all handouts and Rubrics.
4. If the Stromatolite Explorer video has not been shown in other classes, it can be downloaded from the Microbes @ NASA website <<http://microbes.arc.nasa.gov/>> and viewed after student groups are assigned.

Procedure

Engage, Explore

1. Students will be assigned to cooperative groups of 4-5 to research different aspects of astrobiology and microbial mats using a web quest. A jigsaw format will be used with each student researching a different question, so the students can combine to answer a larger question: How does one use Earth's microbial ecosystems to look for life on other planets? The larger question will be answered at the end of the unit, after students have completed all science, math, and other English activities.

Smaller questions may include:

- *What are microbes?*
- *What are microbial mats?*
- *Why are microbial mats important?*
- *What is astrobiology?*
- *What does NASA want to learn from studying microbial mats? pl*

- *What is included in the study of astrobiology?*
- *What kind of gases, liquids, and solids are in microbial mats?*
- *What biological processes can be seen in microbial mats?*
- *For life to exist, what do scientists think is required?*

2. All students will be taught to summarize and research using the Research Guidelines handout.

3. Next, students will go to the web with their question. Some websites will be given for initial research, other websites students will have to search to find. (Review use of search engines and quality web sites.)

Explain

4. Students who have researched the same question will share ideas with others who have completed the same research to see if they need to add or change anything in their research before they share the information with the members of their group who have researched different topics.

5. Material is presented to the group in some format: movie, speech, PowerPoint, etc. before it is presented to a 5th grade class. All students need to take notes on the information from each presentation, for the information is needed in other classes to understand the material in the unit. They will also need the information at the end to answer the big question: How does one use Earth's microbial ecosystems to look for life on other planets?

Extend

6. Select the best presentation(s) to present to the 5th grade class(s).

Evaluate

7. Use the Web Quest Process Rubric and Report of Research Group Presentation Rubric to evaluate student work. Rubrics should be given to students during the web quest so they understand evaluation expectations.

Follow Up

Additional lesson plans on microbial mats are available at the **Microbes @ NASA** website <<http://microbes.arc.nasa.gov/>> in the **For Educators** section under **Microbial Mat Investigations**. This web quest is one in a series of interdisciplinary lessons titled **Microbial Mat Investigations**. Lessons in math, science, language arts and technology clarify the science of microbial mats and can be taught by one teacher in a single classroom, or by a team of content area teachers.