Microbial Discovery Activity

What Microbe Are You?

An Activity Designed for Our Youngest Scientists

Authors

Michelle H. Hsia[1] – mhhsia@hawaii.edu
Kimberley A. Thomas[1,2]
Barbara C. Bruno[1]

[1]Center for Microbial Oceanography: Research and Education, University of Hawaii, Honolulu, HI
[2]Current affiliation: Rutgers University, New Brunswick, NJ

Intended Audience

K-4	X
5-8	X
9-12	

Activity Characteristics

Classroom setting	X
Requires special equipment	
Uses hands-on manipulatives	X
Requires mathematical skills	
Can be performed individually	X
Requires group work	
Requires more than one class period (45 minutes)	
Appropriate for students with special needs	X

American Society for Microbiology
Education Department
1752 N Street, NW
Washington, DC 20036
EducationResources@asmusa.org

An Educational Program of
AMERICAN SOCIETY FOR MICROBIOLOGY

Introduction

Description

In this fun, hands-on activity, students are matched with the marine microbes that most closely resemble their personalities based on the students' answers to a series of either/or statements. In the process, students learn about the vast diversity and critical importance of marine microbes.

Abstract

This online "personality quiz" helps young learners understand the unconventional concept that most micro-organisms are beneficial; only a fraction are harmful. This activity matches the quiz-taker with the microbe that most closely reflects his or her personality. At the end of the quiz, students are assigned to their microbial matches, and the microbes are given fun code names to circumvent the challenge of pronouncing the microbes' scientific names. Teachers can include this activity as a fun way to begin or end a unit on life sciences.

Core Themes Addressed

Microbial Cell Biology	
Microbial Genetics	
Microorganisms and Humans	X
Microorganisms and the Environment	X
Microbial Evolution and Diversity	X
Other -Common properties of life; Cellular components	

Keywords

Diversity, identification, marine bacteria, microbiology

Learning Objectives

At the completion of this activity, each learner will be able to:
1. Appreciate the vast abundance and diversity of marine microbes.
2. Understand that most microbes are not harmful.

National Science Education Standards Addressed

Science Standard A: Science as Inquiry (K–4 and 5–8, abilities necessary to do scientific inquiry) – Students take an online personality-matching quiz that uses either/or statements to help them identify and learn more about microscopic organisms.

Science Standard C: Life Sciences (K–4, the characteristics of organisms, organisms and environments; 5–8, diversity and adaptation of organisms) – Students will learn about the diversity of marine microbes, including the environments they inhabit, and the diverse adaptations and functions that allow them to survive in these environments.

Science Standard F: Science in Personal and Social Perspectives (5–8, risks and benefits) – Students will learn the importance of marine microbes and that only a small number of them are harmful.

Science Standard G: History and Nature of Science (5–8, nature of science) – Students will learn the process by which scientists gather data and analyze results.

Teacher Handout

What Microbe Are You?

An Activity Designed for Our Youngest Scientists

Student Prior Knowledge

This activity requires that students be comfortable using a computer and navigating through websites.

Teacher Background Information

Microbes are often viewed in a negative light. When most people think of microbes, they envision harmful bacteria and associated diseases, but the "bad guys" comprise only a fraction of all known bacteria. The vast majority of microbes are not only beneficial but also necessary for the existence of all other life on Earth [1]! The recent publication "What Microbe Are You?" [2] attempts to change the way students — and teachers — think about microbes through a "personality quiz" designed to match the quiz-taker with the microbe that she or he most closely resembles. Nineteen choices of microbes are provided, emphasizing the diversity of these remarkable organisms. To help students determine their microbial matches, a series of either/or statements are provided. For each pair of statements, students select the statement that most closely describes their personalities and, depending on their answer, are directed to a new pair of statements. These statements are linked to a dichotomous key that relates each student's personality traits to characteristics of a given microbe. For example, a student who chooses "My bedroom is messy, and only I know where to find anything"; "In a bunk bed, I prefer the upper bunk"; "I enjoy home-cooked meals"; and "During my free time, I prefer to hang out with my friends" will reach a page that reads:

> "Yipee! You are *Trichodesmium erythraeum*, a.k.a. *"Tricho"!* You and this microbe tend to be somewhat messy (its cell contents aren't well organized), and you both enjoy spending time with friends (*Tricho* forms colonies with other individual cells). Just as you like eating home-cooked meals, *Tricho* uses photosynthesis to make its own food. Under just the right conditions, cells can grow so rapidly that a bloom is formed that can be seen from space!"

This version of the quiz is designed for upper-middle-school students. Although the vocabulary is advanced for young children, the concepts are not. Numerous studies have shown that children as young as 3 understand a lot about the biological world and are very interested in how the natural world works [3]. In a Head Start program in Mount Vernon, Washington, 3- to 5-year-olds pretended to be doctors and scientists and learned about beneficial, immune-supporting bacteria, as well as the harmful bacteria that make people sick [4]. Through hands-on activities and books, the children started to use scientific vocabulary — for example, substituting the word "microbe" for "germ."

One of the Center for Microbial Oceanography: Research and Education's (C-MORE) objectives is to help young learners to understand the unconventional concept that most microscopic organisms are not harmful to humans. Therefore, we have used the original C-MORE quiz [2] as a model to develop a new online "What Microbe Are You?" activity for elementary school students. Development tasks involved simplifying the language, including more illustrations, and reducing the content to the bare essentials. We were conscious not to "dumb down" the quiz; instead, we simply translated it for a

younger audience. At the end of the quiz, when students are assigned their microbial matches, the microbes are given fun code names as alternatives for the challenging scientific names that can be difficult for young students to pronounce. In addition, to help students better understand how their personality traits relate to the lifestyles of particular microbes, we were more explicit in describing how the microbes and the students are similar to one another. For example, a student that chooses the responses described above will reach the profile in Figure 1. A complete list of either/or statements is given in Appendix 1.

Figure 1. *Trichodesmium erythraeum* (*Tricho*) microbe profile for elementary school students.

Class Time

Teachers can include this activity as a fun way to begin or end a unit on life sciences. Allow students 5 to 10 minutes to take the quiz and find their microbial matches. Then, have a class discussion about the students' matches and microbial diversity.

Teacher Preparation Time

This activity requires minimal teacher preparation time if computers are available. If computers are unavailable, allow at least an hour to print and assemble the flipbooks (see Possible Modifications below).

Materials and Equipment

Each pair of students will require a computer with Internet access or a printed flipbook if a computer is unavailable. The teacher can use the dichotomous key (Appendix 2) to lead a discussion at the end of the quiz.

Safety Precautions

None; classroom activity does not use microbes.

Methods

Introduction

1. Ask the students what they know about microbes (e.g., bacteria and viruses). Are microbes good or bad (most are good, very few are bad)? Where do microbes live (everywhere — in the ocean, the rivers, in the soil, etc.)? What do microbes do (e.g., some can "fix" nitrogen from the air for biological uses, some put oxygen into the atmosphere, and some can breakdown decaying material)?

2. Explain to the students that they will be taking a personality-matching quiz to match their habits and interests to the lifestyles of marine microbes.

3. Students work in pairs at a computer or with a flipbook. Access the Internet, and type the following URL into a web browser:
http://cmore.soest.hawaii.edu/education/kidskorner/elem_quiz/elem_ur_q1.htm.
Alternatively, each pair of students can type the address into a web browser themselves. Each student should answer the either/or statements individually. Students can answer the statements using the printed flipbooks if computers are unavailable (see Possible Modifications below).

Discussion/Questions
Ask students to compare their "microbial matches" with those of one another or the class. Discuss the vast diversity of marine microbes, the different (and in some cases, extreme) environments in which microbes live, their various adaptations, and the way scientists classify microbes [1].

Delivery
Students work in pairs and then compare their results with those of their partners or other classmates.

Technology Utilization
Students will require computers with Internet access.

Microorganisms
No microorganisms will be used in this activity.

Assessment and Evaluation of Activity
The classroom discussion can be used to assess student learning. Students can also be asked to write a reflection or draw a micro-organism as a pre- and/or post-assessment activity.

Possible Modifications
If a computer or Internet access is unavailable to the students, teachers can download and print (double-sided) the PDF microbe quiz flipbook found at *http://cmore.soest.hawaii.edu/education/kidskorner/microbe_quiz.htm*.

To assemble the flipbook, cut each page in half the short way, and then staple into a booklet. Students can share a flipbook with a partner, so that the teacher will only need to assemble one flipbook per pair of students. Alternatively, students can assemble the flipbooks themselves.

References

1. Center for Microbial Oceanography: Research and Education (C-MORE) (2008). Key Concepts in Microbial Oceanography. C-MORE, Honolulu, Hawaii. Retrieved from *http://cmore.soest.hawaii.edu/downloads/MO_key_concepts_hi-res.pdf*.

2. Gopnik, A. (2009). *The Philosophical Baby: What Children's Minds Tell Us about Truth, Love, and the Meaning of Life.* Farrar, Straus, and Gilroux, New York, NY.

3. Weersing, K., J. Padilla-Gamiño, and B. Bruno (2010). What Microbe Are You? *The Science Teacher* 77(6):40-44.

4. Youngquist, J. (2004). From Medicine to Microbes: A Project Investigation of Health. *Young Children* 59:28-32.

Appendix 1

Either/Or Statements
You'll be presented with a series of statements to help you discover which microbe is most like you. For each pair, click on the statement that best describes you.

Distinguish between prokaryotes and eukaryotes based on degree of internal cell organization.
1a. My room is neat and tidy. (Eukaryote - Link to question 14)
1b. My room is messy. (Prokaryote - Link to question 2)

Distinguish between bacteria and archaea on the basis of preferred water depth.
2a. In a bunk bed, I like the top bunk. (Bacteria - Link to question 3)
2b. In a bunk bed, I like to sleep on the bottom. (Archaea - Link to question 10)

Distinguish between autotrophic and heterotrophic bacteria.
3a. I enjoy cooking at home. (Autotroph - Link to question 4)
3b. I prefer to eat at restaurants. (Heterotroph - Link to question 6)

Distinguish between solitary and colonial cyanobacteria
4a. In my free time, I like playing alone. (Link to question 5)
4b. I like playing with my friends. (Link to *Trichodesmium erythraeum* profile)

Distinguish between *Prochlorococcus* and *Synechococcus* based on temperature tolerance
5a. I don't like cold weather. (Link to *Prochlorococcus marinus* profile)
5b. I like all sorts of weather. (Link to *Synechococcus WH 8102* profile)

Distinguish between aerobic and anaerobic heterotrophic bacteria.
6a. I can hold my breath for a long time. (Anaerobe - Link to question 9)
6b. I can't hold my breath for a long time. (Aerobe - Link to question 7)

Distinguish between aerobic heterotrophic bacteria based on gram stain.
7a. Purple is one of my favorite colors. (Link to *Salinispora tropica* profile)
7b. I don't like the color purple. (Gram negative - Link to question 8)

Distinguish between aerobic heterotrophic bacteria based on genome size.
8a. I stuff my backpack with a lot of things. (Link to *Ruegeria pomeroyi* profile)
8b. My bag is not full. (Link to *Pelagibacter ubique* profile)

Distinguish between anaerobic heterotrophic bacteria based on gas production.
9a. When I eat beans, I make a stinky gas. (Link to *Desulfovibrio desulfuricans* profile)
9b. I don't make a stinky gas after eating beans. (Link to *Rhodoferax ferrireducens* profile)

Distinguish between Euryarchaeota and Crenarchaeota based on range size.
10a. My aunts, uncles, and cousins live all around the world. (Crenarchaea - Link to question 11)
10b. My relatives live near each other. (Euryarchaea - Link to question 13)

Distinguish between thermophilic and symbiotic Crenarchaea based on degree of cooperation with other organisms.
11a. I like being part of a team. (Link to *Cenarchaeum symbiosum* profile)
11b. I like doing things on my own. (Thermophilic Crenarchaea - Link to question 12)

Distinguish between two thermophilic Crenarchaea based on pH tolerance.
12a. I like to drink milk. (Link to *Hyperthermus butylicus* profile)
12b. I prefer to drink lemonade. (Acidophile – Link to *Pyrodictium abyssi* profile)

Distinguish between methanogenic and halophilic Euryarchaea based on preferred salinity.
13a. I prefer swimming in pools. (Link to *Methanococcus jannischii* profile)
13b. Swimming in the ocean is the best. (Link to *Halobacterium salinariumis* profile)

Distinguish between heterotrophic (forams/radiolarians) and phototrophic (diatoms, coccolithophores, dinoflagellate) eukaryotes based on the time when most of the energy (sunlight versus feeding) is acquired.
14a. I stay up late. (Heterotrophic eukaryote - Link to question 15)
14b. I go to bed early. (Phototrophic eukaryote - Link to question 16)

Distinguish between foraminiferans and radiolarians based on skeleton shape.
15a. My hair is mostly straight. (Radiolarian - Link to *Lamprocyclas maritalis* profile)
15b. My hair is curly. (Foram - Link to *Elphidium crispum* profile)

Distinguish between obligate and facultative phototrophs based on metabolic flexibility.
16a. I like lots of different fruit. (Facultative phototroph - Link to question 17)
16b. I only like one or two kinds of fruit. (Obligate phototroph - Link to question 18)

Distinguish between facultative phototrophs (dinoflagellates) based on the ability to form red tides.
17a. I go with the flow and follow the rules. (Link to *Fragilidium subglobosum* profile)
17b. I'm a trouble-maker and don't follow the rules. (Forms harmful algal blooms - Link to *Akashiwo sanguineum* profile)

Distinguish between diatoms and coccolithophores based on presence/absence of silica.
18a. I don't wear glasses. (Coccolithophore - Link to *Emiliania huxleyi* profile)
18b. I wear glasses. (Diatom - Link to *Thalassiosira weissflogii* profile)

Appendix 2 (Weersing et al., 2010)

Dichotomous Key
What Microbe Are You? Microbe Relationship Tree
Trace the path on the tree as you go through the questions on the dichotomous key below. The number/letter combinations refer to the responses on the dichotomous key that would take you to that position on the tree.

Prokaryotes
(1b. disorganized/no organelles)

Bacteria Archaea
(2a. generally upper water column) (2b. generally lower water column)

Autotroph Heterotroph Crenarchaea Euryarchaeota
(3a. photosynthesis/home cooked meals) (3b. feeds org. matter/eats out) (10a. broad family range) (10b. narrow family range)

Trichodesmium Solitary Aerobic Anaerobic *Cenarchaeum* Asymbiotic *Methanococcus Halophilium*
(4b. colonial) (4a.) (6b. don't hold breath) (6a. hold breath) (11a. symbiotic w/sponge) (11b.) (13a. non-halophilic) (13b. halophilic)

Salinispora Gram Negative *Desulfovibrio Rhodoferax Hyperthermus Pyrodictium*
(7a. Gram positive) (7b.) (9a. makes gas) (9b. no gas) (12a. non-acidophilic) (12b. acidophilic)

Prochlorococcus Synechococcus
(5a. narrower temp. tolerance) (5b. more cold tolerant)

Pelagibacter Ruegeria
(8b. tiny genome) (8a. relatively large genome)

Eukaryotes
(1a. organized/organelles present)

Phototroph Heterotroph
(14b. photosynthesis during the day only) (14a. can feed during day and/or night)

Obligate phototroph Facultative phototroph *Lamprocyclas Elphidium*
(16b. fixed metabolism) (16a. flexible metabolism) (15a. straight extension from shell) (15b. curl shell)

Emiliania Thalassiosira
(18a. no silica) (18b. silicate test)

Fragilidium Akashiwo
(17a. non-bloom forming) (17b. forms toxic blooms)

Student Handout

What Microbe Are You?

An Activity Designed for Our Youngest Scientists

Introduction

There are a lot of tiny creatures called microbes on our planet. The cool thing about microbes is their small size. They are so small that we cannot see them with our eyes! Microbes are everywhere: in really hot places at the bottom of the ocean [1]; inside animals, such as clams; and in really cold places like ice [2].

There are a lot of microbes in the ocean [3]. There are more microbes in the ocean than grains of sand on a beach! We need these tiny creatures to stay alive. They make half of the oxygen that we breathe. They are also important because fish eat microbes and then we eat fish. Many different microbes have been found, and there are more being discovered everyday [4]!

Vocabulary

Microbe: an organism that is too small to be seen with our eyes. We need to use a microscope to see them. Examples of microbes are bacteria and viruses.

Materials Checklist

Each pair of students will need a computer with Internet access for the online quiz or a printed copy of the quiz that is provided by your teacher.

Procedures

1. Find a partner and work together. Using a computer, go to the website address that your teacher gave you. If a computer is not available, follow the teacher's instructions on using the printed copy of the microbe flipbook.

2. If your teacher already put the webpage on the computer, you and your partner will each take a turn to click on the statements that most closely match you. Both of you will be matched to a microbe at the end. If you are using the printed flipbook, take turns reading the statements.

3. Once you and your partner have finished, talk with each other about your microbe and with other students in the classroom, and discuss anything that is different.

References Cited

1. Miller, J.F., N.N. Shah, C.M. Nelson, J.M. Ludlow, and D.S. Clark (1988). Pressure and temperature effects on growth and methane production of the extreme thermophile *Methanococcus jannaschii*. *Applied and Environmental Microbiology* 54(12):3039-3042.

2. Pomeroy, L.R., P.J.I. Williams, F. Azam, and J.E. Hobbie (2007). The microbial loop. *Oceanography* 20(2):28-33.

3. Price, P.B. (1999) A habitat for psychrophiles in deep Antarctic ice. *Proceedings of the National Academy of Sciences* 97(3):1247-1251.

4. Sogin, M.L., H.G. Morrison, J.A. Huber, D.M. Welch, S.M. Huse, P.R. Neal, J.M. Arrieta, and G.J. Herndl (2006). Microbial diversity in the deep sea and the underexplored "rare biosphere." *Proceedings of the National Academy of Sciences* 103(32):12115-12120.

Acknowledgements

This project was funded by NSF-OIA award EF-0424599 (D. Karl, PI) and NSF-OEDG award 091431 (B. Bruno, PI). Field-testing occurred through C-MORE and Ocean FEST (NSF-OEDG award 091431). Many scientists and educators contributed to the development, evaluation, and field-testing of this activity, particularly Jacqueline Padilla-Gamiño, Jim Foley, Ryan Kagami, and Sara Thomas. Brooks Bays designed the online structure and layout of the personality quiz.