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the science of MICROBES

Pre-assessment Activity: What Do You Know About Microbes?

from *The Science of Microbes Teacher's Guide*

by Nancy P. Moreno, Ph.D., Barbara Z. Tharp, M.S., Deanne B. Erdmann, M.S., Sonia Rahmati Clayton, Ph.D., and James P. Denk, M.A.

RESOURCES

Free, online presentations of each activity, downloadable activities in PDF format, and annotated slide sets for classroom use are available at www.bioedonline.org/ or www.k8science.org/.

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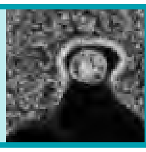


HIV virus particle. L. Howard, C. Daghlian, Dartmouth College.

INTRODUCTION

Microbial Challenges

Infectious diseases have plagued humans throughout history. Sometimes, they even have shaped history. Ancient plagues, the Black Death of the Middle Ages, and the "Spanish flu" pandemic of 1918 are but a few examples.

Epidemics and pandemics always have had major social and economic impacts on affected populations, but in our current interconnected world, the outcomes can be truly global. Consider the SARS outbreak of early 2003. This epidemic demonstrated that new infectious diseases are just a plane trip away, as the disease was spread rapidly to Canada, the U.S. and Europe by air travelers. Even though the SARS outbreak was relatively short-lived and geographically contained, fear inspired by the epidemic led to travel restrictions and the closing of schools, stores, factories and airports. The economic loss to Asian countries was estimated at $18 billion.

> For an emerging disease to become established, at least two events must occur: 1) the infectious agent has to be introduced into a vulnerable population, and 2) the agent has to have the ability to spread readily from person to person and cause disease. The infection also must be able to sustain itself within the population and continue to infect more people.

The HIV/AIDS viral epidemic, particularly in Africa, illustrates the economic and social effects of a prolonged and widespread infection. The disproportionate loss of the most economically productive individuals within the population has reduced workforces and economic growth in many countries, especially those with high infection rates. This affects the health care, education, and political stability of these nations. In the southern regions of Africa, where the infection rate is highest, life expectancy has plummeted in a single decade, from 62 years in 1990–95 to 48 years in 2000–05. By 2003, 12 million children under the age of 18 were orphaned by HIV/AIDS in this region.

Despite significant advances in infectious disease research and treatment, control and eradication of diseases are slowed by the following challenges.

- The emergence of new infectious diseases
- An increase in the incidence or geographical distribution of old infectious diseases
- The re-emergence of old infectious diseases
- The potential for intentional introduction of infectious agents by bioterrorists
- The increasing resistance of pathogens to current antimicrobial drugs
- Breakdowns in public health systems

Baylor College of Medicine, Department of Molecular Virology and Microbiology, www.bcm.edu/molvir/.

Using Cooperative Groups In The Classroom

Cooperative learning is a systematic way for students to work together in groups of two to four. It provides organized group interaction and enables students to share ideas and to learn from one another. Students in such an environment are more likely to take responsibility for their own learning. Cooperative groups enable the teacher to conduct hands-on investigations with fewer materials.

Organization is essential for cooperative learning to occur in a hands-on science classroom. Materials must be managed, investigations conducted, results recorded, and clean-up directed and carried out. Each student must have a specific role, or chaos may result.

The Teaming Up! model* provides an efficient system for cooperative learning. Four "jobs" entail specific duties. Students wear job badges that describe their duties. Tasks are rotated within each group for different activities so that each student has a chance to experience all roles. For groups with fewer than four students, job assignments can be combined.

Once a model for learning is established in the classroom, students are able to conduct science activities in an organized and effective manner. Suggested job titles and duties follow.

Principal Investigator
- Reads the directions
- Asks the questions
- Checks the work

Maintenance Director
- Follows the safety rules
- Directs the cleanup
- Asks others to help

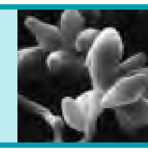
Reporter
- Records observations and results
- Explains the results
- Tells the teacher when the group is finished

Materials Manager
- Picks up the materials
- Uses the equipment
- Returns the materials

* Jones, R.M. 1990. *Teaming Up!* LaPorte, Texas: ITGROUP.

Overview: Pre-Assessment

To evaluate their current understanding of microbes, students will complete a pre-assessment, estimate the mass of microbes in the human body, and then begin group concept maps. Completed preassessments will be used again at the conclusion of the unit as part of the post-assessment (see Answer Key, right sidebar). Groups will add to their concept maps regularly throughout the unit.



Curvularia geniculata fungus. CDC\203 J. Carr, R. Simmons.

TIME

Setup: 10 minutes
Activity: 45 minutes

W H A T D O Y O U K N O W

About Microbes?

Microbiologists study organisms consisting of a single cell or a cluster of a few similar cells. Known as microbes or microorganisms, these organisms usually cannot be observed with the naked eye. The term "microbe" was coined by Charles Sedillot, a French scientist. It means any living thing that must be magnified to be visible.

MICROSCOPIC refers to something that is too small to be seen with the naked eye. The prefix "micro" is derived from the Greek micros, which means "small."

MACROSCOPIC refers to something that is large enough to be visible to the naked eye. The prefix "macro" comes from the Greek for "long" or "large" and "to look at."

Microbes are the most prevalent organisms on our planet, both in mass and number. They comprise a diverse group and include bacteria, microscopic algae, yeast cells, and even protozoa. Most biologists also consider viruses to be microbes, even though according to many definitions, viruses are not true "living" organisms. In this guide, we focus primarily on microbes directly related to health: bacteria, fungi, protists and viruses.

Microbes produce most of the Earth's oxygen and are essential parts of all ecosystems. Although some microbes cause illness, others play a role in digestion, disease resistance and other vital human functions. Microbes also are involved in the production of common foods, including sandwich bread and yogurt.

This activity allows students to share their knowledge about microbes. It also allows you, the teacher, to assess student knowledge before beginning the unit.

MATERIALS

Teacher (See Setup)

- Glo Germ™ kit (includes a black light) available for purchase online at www.glogerm.com or www.sciencekit.com
- Graduated cylinder, beaker or other means to measure one liter of water accurately
- Sturdy plastic bag large enough to hold a one-liter size bottle

Per Group of Students

- 8 small sticky notes (2 per student)
- 4 hand lenses
- 4 pairs of safety goggles
- 4 small paper clips
- Access to a balance or spring scale (2,000 gm capacity)
- Capped plastic bottle, pre-filled with one liter (measured) of water
- Markers

Continued

SCIENCE EDUCATION CONTENT STANDARDS

Grades 5–8

Inquiry

- Identify questions that can be answered through scientific investigations.
- Think critically and logically to make the relationships between evidence and explanations.
- Recognize and analyze alternative explanations and predictions.
- Communicate scientific procedures and explanations.

Life Science

- Some diseases are the result of damage by infection or by other organisms.
- Populations of organisms can be categorized by the function they serve in an ecosystem.

ANSWER KEY

Answers to the Pre- and Post-Assessments are as follow.

1. d	11. a
2. c	12. a
3. a	13. a
4. d	14. b
5. a	15. d
6. b	16. c
7. d	17. d
8. a	18. a
9. b	19. d
10. a	20. d

CITATIONS

Image citations, including source URLs, are available at the front of this guide.

BLACK LIGHTS

A black light gives off light (electromagnetic radiation) in the near ultraviolet range (close to 370 nm). To the human eye, light from a black light looks violet.

EXTENSION

Ask students, *How long do you need to wash your hands to make sure they are clean and free of harmful microbes?* Write students' estimates on the board. OR give each student a sticky note on which to write the number of seconds he or she thinks people must wash their hands to be sure they are clean. Have students create another class bar graph with their estimates.

Then, allow students to develop their own experiments to investigate the effectiveness of hand washing techniques or times. Students should examine their hands under the black light before beginning their experiments. Have students devise a uniform strategy for dipping their hands in the Glow Germ™ powder, and then examining their hands under the black lights after washing. Students also should think about other variables, such as water temperature and type of soap used (antibacterial, for example).

- Large sheet of poster board or large sheet of paper
- Stopwatch or clock with second hand (for Extension, left sidebar)

Per Student

- Copy of *What About Microbes?* student sheet (see Answer Key, p. 1, sidebar)

SETUP

Make copies of the student sheet (one per student).

Fill water bottles with one liter of water (measure) and replace the caps. Dry any excess water from the outside of the bottles.

Place 1 cup Glo Germ™ powder in the plastic bag. Coat the outside of each bottle with powder by placing it in the bag and shaking gently. The bottles will look dusty, but the powder will glow only under a black light. The specks of powder represent microbes in this activity.

After each student has completed the pre-assessment questionnaire, have students work in groups of four.

SAFETY ISSUES

Have students wash hands with soap and water after handling Glo Germ™ powder. Students should avoid contact with eyes and mouth while handling the powder. Students also may wear safety goggles.

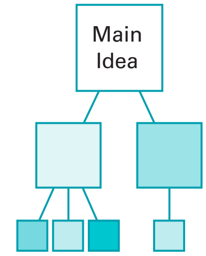
PROCEDURE

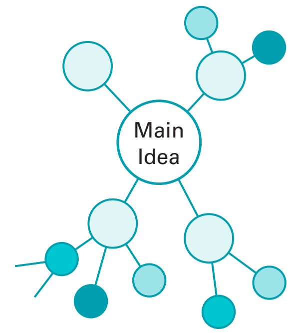
1. Explain to students that they will be learning about the most numerous organisms on Earth—microbes. However, before starting the unit, they will complete a pre-assessment activity. The pre-assessment questions will require students to reflect upon what they already know about microbes. At the end of the unit, students will answer the same questions on the post-assessment.
2. Distribute copies of *What About Microbes?* Have students complete the questions on their own. Tell students to answer each question using their existing knowledge and experiences.
3. Collect the student sheets. Ask, *Does anyone think he or she knew all the answers? Does anyone have questions or observations?* Record questions on chart paper to revisit at the end of the unit. Do not discuss answers to the preassessment questions. Students will have an opportunity to review their answers as part of the last activity of this guide.
4. Give each student a paper clip. Tell students that the mass (weight) of the clip is approximately one gram (gm). If time allows, have students estimate the mass (weight) of different objects in grams. Have students use a balance or scale to compare their estimates to actual measurements.
5. Next, have the materials manager of each group pick up a water bottle that you have treated with Glo Germ™ powder. Ask, *What is the mass of the bottle and its contents, in grams?* Each member of the group should hold the bottle and estimate (predict) the total mass of the bottle (weight of contents plus weight of the container), in grams.

A kilogram (kg) is a measure of mass that represents one liter of water under standard conditions. One kilogram is equivalent to 35.3 ounces, or 2.2 pounds.

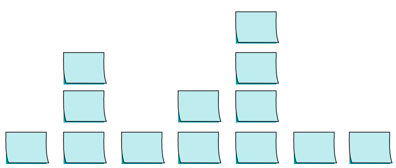
CONCEPT MAPS are web-like representations of knowledge, concepts and ideas. Concepts are expressed as words or phrases, and are connected by lines or arrows, and by linking words that describe relationships between two concepts.

Shown to the right are two different approaches to creating concept maps. Students may use sticky notes to position and reposition concepts on their maps as they learn. Computer-based graphics software also may be used to create concept maps.





6. After everyone has held the bottle, ask students to write their estimates on sticky notes. Create a class bar graph by lining up the notes according to increasing weight in a row across the wall or chalkboard. Stack notes with about the same weights above or below each other in vertical columns.



7. Tell students the bottle weighs about as much as the microbes in a person's body—slightly more than 1,000 grams (gm), or 1 kilogram (kg).
8. Review the graph and discuss students' estimates. Ask, *Was anyone close to the correct weight? Why was it difficult to estimate?* At this time, you may want to discuss metric measures and standard equivalents.
9. Next, ask students to examine their hands, first with the naked eye and then with the hand lens. Ask, *Can you see anything?*
10. Bring out the black light(s) and have students examine their hands again under the light. Ask, *What do you see? Was it there before? Why couldn't it be seen?* Explain that the glowing material on their hands is a harmless powder that spreads by contact, just as many microbes spread. The powder, however, becomes visible under special lighting conditions. Microbes cannot be observed in the same way.
11. Ask, *What do you know about microbes or microorganisms? Why do you think they are important?* (Microbes are organisms too small to be seen without magnification. They are the most prevalent life forms on Earth, both in mass and number. Most cannot be seen without a microscope, yet microbes influence every person's life. Some students may be able to name a few examples, such as bacteria. Students may think all microbes are harmful, but this is not true.)

    Ask, *Why do you think you were taught always to wash your hands before eating and after using the restroom?* OR *Have you noticed signs in almost all public restrooms stating that all employees must wash their hands before returning to work? Why might this be?* Allow students to discuss their ideas.
12. Finally, have students discuss what they know about microbes or microorganisms, and ask each group to begin a concept map (see illustrations, upper right), that demonstrates its collective knowledge of microbes. Tell students that while they may not have much information now, they will be adding to their concept maps throughout the unit. Display the concept maps around the room.

TEACHING RESOURCES

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Curvularia geniculata fungus. CDC\203 J. Carr, R. Simmons.

PRE-ASSESSMENT

What About Microbes?

Name

Circle the best response to each question.

1. Microbes usually are
   a. germs.
   b. bad.
   c. good.
   d. microscopic.

2. A microbe does NOT cause
   a. polio.
   b. HIV/AIDS.
   c. asthma.
   d. malaria.

3. One way to prevent the spread of disease is to
   a. wash your hands with soap and water.
   b. not ever get sick.
   c. wear a jacket.
   d. take aspirin.

4. Diseases caused by viruses can be cured with
   a. antibiotics.
   b. anesthetics.
   c. vitamin C.
   d. none of the above.

5. Flu is caused by a
   a. virus.
   b. bacterium.
   c. fungus.
   d. protist.

6. Most bacteria are
   a. harmful.
   b. helpful.
   c. viral.
   d. disease-causing.

7. A paramecium is an example of a
   a. virus.
   b. bacterium.
   c. fungus.
   d. protist.

8. Microbes are an important part of the environment because they
   a. break down waste.
   b. cause the water cycle.
   c. protect the ozone layer.
   d. block global warming.

9. The incubation period of a disease is the length of time
   a. it takes to get over a disease.
   b. between being exposed and showing the symptoms of a disease.
   c. it takes for the eggs to hatch.
   d. between showing the symptoms of a disease and getting well.

10. In order for bacteria to grow, they need
   a. a source of energy.
   b. a source of young viruses.
   c. specialized equipment.
   d. someone to cough or sneeze.

11 Infectious diseases can spread
   a. from one person to another.
   b. by eating only fresh fruit.
   c. from washing your hands.
   d. by inheritance.

12. Most diseases caused by bacteria can be cured with
   a. antibiotics.
   b. anesthetics.
   c. vitamin C.
   d. none of the above.

13. One of the most common microbes used in food production is a
   a. fungus.
   b. protist.
   c. virus.
   d. micron.

14. Scientific advances depend on all of the following, EXCEPT
   a. being curious about what is observed.
   b. always being successful.
   c. appropriate tools and methods.
   d. work by other scientists.

15. The large structure you can often see inside of a cell is called
   a. protein.
   b. flagella.
   c. the cell wall.
   d. the nucleus.

16. Antibiotic resistance is
   a. beneficial for most humans.
   b. caused, in part, by lack of antibiotics.
   c. caused, in part, by overuse of antibiotics.
   d. caused, in part, by overuse of vaccines.

17. A worldwide spread of infectious disease is called a/an
   a. anemic.
   b. epidemic.
   c. systemic.
   d. pandemic.

18. It is possible to catch HIV/AIDS from
   a. body piercing.
   b. saliva.
   c. sweat.
   d. mosquito bites.

19. A way to protect yourself from some diseases is called
   a. polarization.
   b. fertilization.
   c. constipation.
   d. vaccination.

20. Microorganisms often are measured in
   a. decimeters.
   b. centimeters.
   c. millimeters.
   d. micrometers.