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the science of MICROBES

Activity: Observing Different 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.

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.

> 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.

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.

Giardia lamblia protist. CDC\8698 J. Carr.

TIME

Setup: 20 minutes
Activity: 45–60 minutes

SCIENCE EDUCATION CONTENT STANDARDS

Grades 5–8

Inquiry

- Communicate scientific procedures and explanations.
- Use mathematics in all aspects of scientific inquiry.
- Develop descriptions, explanations, predictions, and models using evidence.
- Use appropriate tools and techniques to gather, analyze, and interpret data.

Life Science

- Living systems at all levels of organization demonstrate the complementary nature of structure and function.
- All organisms are composed of cells—the fundamental unit of life. Most organisms are single cells; other organisms, including humans, are multicellular.
- Cells carry on many functions needed to sustain life.

ACCESS TO COLOR IMAGES

If students do not have access to microscopes, color images of the cells used in this activity can be viewed online or downloaded from the BioEd Online website at www.bioedonline.org/.

Overview

Students will use a microscope to examine three different microbes: bacteria, yeast and paramecia.

OBSERVING DIFFERENT

Microbes

Microbes are organisms too small to be seen with the naked eye. There are enormous variations in the kinds and sizes of microbes. This activity allows students to observe representatives of three different groups of microbes—bacteria, fungi and protists—first hand.

First, students will observe bacterial cells in yogurt, which will be visible only as tiny rods. (Rod-shaped bacteria are called bacilli.) Yogurt is created when milk is fermented by *Lactobacillus* and other kinds of bacteria. It has a slightly sour taste, is acidic, and stays fresh longer than milk. A yogurt recipe is included as an extension to this activity.

SACCHAROMYCES CEREVISIAE is more commonly known as baker's yeast. Members of this group of fungi are used in making wine, bread, beer, and medicines.

Students also will observe yeast, which are single-celled fungi. This group also includes organisms like mushrooms and molds. Fungi are not able to trap energy through photosynthesis and must feed on other organisms. Many fungi are important decomposers within ecosystems. Yeasts have numerous applications in food production, such as leavening in bread and fermentation for alcoholic beverages. Some kinds of yeast also cause diseases, such as diaper rash or thrush (a painful infection of the mouth and throat).

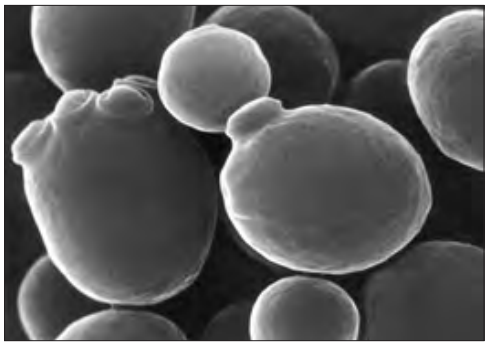
A light microscope image reveals the inner structure of a paramecium. Ron Neumeyer © MicroImaging Services.

Finally, students will observe a paramecium. "Slipper-shaped" paramecia are among the largest microorganisms in the protozoan group, which are considered to be protists. Most of the 40,000 species of protozoa are found in aquatic environments or in moist soil. A few are parasites. Protozoa do not have rigid cell walls (such as those in the onion skin cells). Paramecia take in particles of food through an "oral groove" located on one side of the organism, and they use tiny hairs, called cilia, to propel themselves through water.

MATERIALS

Teacher (See Setup)

- For paramecia, order a culture in advance, collect pond water, or make your own (see sidebar, p. 2).
- For yeast mixture (prepare one day in advance):
  - 250-mL container
  - 150 mL of warm water



Advances in technology allow us to see microbes with more clarity. A scanning electronic microscope (SEM) image shows the detail of the outer surface of common baker's yeast, *Saccharomyces cerevisiae*. Alan E. Wheals, Ph.D. © University of Bath.

  - Package of dry baker's yeast
  - Teaspoon of sugar
- 6–8 oz of plain, unflavored yogurt
- 6 sheets of cardstock (to make *Slide Preparation* cards)
- Small dropper bottle of glycerin (one drop per slide will slow paramecia if they are overly active)
- Permanent marker to label droppers

Per Group of Students

- Microscope (one or more per group)
- Samples of microorganisms in three small containers
  - 50 mL of pond water
  - 20 mL of yeast mixture
  - 20 mL of enriched yogurt
- 20 mL of tap water in a cup
- 3 plastic cover slips
- 3 plastic slides
- 3 droppers (one each for yeast mixture, pond water or paramecia, and tap water)
- Toothpick (for yogurt)
- Plastic tray (to hold materials)
- Set of colored pencils or markers
- Set of *Slide Preparation* cards
- Science notebooks
- Group concept map (ongoing)

SETUP

Order pond water, make your own (see Making Pond Water, right sidebar), or collect 500 mL of fresh pond water from a ditch or pond. (Look for standing water that has a greenish color; collect some of the algae and sediment.)

On the day before class, mix one teaspoon of yeast and one teaspoon of sugar into a cup containing 250 mL of warm water.

To enrich the microbe count in yogurt, use an individual-sized container of plain, unflavored yogurt that is past the expiration date, or let it sit unrefrigerated overnight.

Make six copies of the *Slide Preparation Cards* student sheet on cardstock. Cut out cards.

Place materials for each group on trays, which will be picked up by each group's materials manager. Leave the containers with pond water and yeast mixture on the distribution table until needed. For each group, label one dropper or pipette for the yeast mixture, one for pond water or paramecia, and one for tap water. At least one microscope should be placed on each group's table before class begins.

Optional: As an alternative to science notebooks, make and distribute clean copies of the *Magnification Observations* student sheet (see p. 8).

SAFETY ISSUES

See sidebar, right.

PROCEDURE

1. Ask students, *Have you ever seen a microbe? What do you think different kinds of microbes might look like?* Tell students that they will have opportunities to observe and compare different kinds of microbes: bacteria in yogurt, yeast cultures, and paramecia (or other pond organisms).

Continued

SAFETY ISSUES

Have students wash their hands before (to avoid contaminating the cultures) and after any lab activity. Hand washing is critical when handling microorganisms. Long hair should be pulled back. If students are immunocompromised, they should wear gloves when handling pond water. No food or drink should be allowed in the lab.

MAKING POND WATER

To create your own pond water culture, boil water, then let it cool. Add the cooled water to straw or dried grass. Cover it with a cloth or paper towel, and place the mixture in a warm, sunny spot for several days. When it turns cloudy or green, it's ready!

TEACHING RESOURCES

For more examples of pond life, visit the Microscopy-UK website at www.microscopy-uk.org.uk/.

- The Pond Life ID Kit offers a table with pages linked to some common groups of small and microscopic pond life.
- The Virtual Pond Dip presents information using a graphic interface that is fun for beginners of any age.

EXTENSION

It's easy to make yogurt using the following ingredients.

- 2 quarts of whole milk
- 1 cup of plain yogurt
- 1 cup of half-and-half

Bring milk to a boil in a very clean pot. (Greasy or dirty pots and utensils won't produce the desired results.) Remove from heat and let stand until cool. Pour the cooled milk into a glass or pottery jar, bowl or other glass container.

Measure one cup of the milk and pour it into a medium-sized bowl. Mix in the yogurt and half-and-half. Slowly add the remaining milk, stirring gently. Place a lid on the container or cover it with plastic wrap.

Wrap the container in a blanket or heavy towel. Place it in a corner of the room where it will stay warm and undisturbed for about six hours. Then refrigerate for 10 hours.

If you prefer a more tart flavor, leave the container wrapped for eight or nine hours. For a sweeter, softer yogurt, leave the container out for about four hours.

Always keep one cup of yogurt from the previous batch to use as a starter for the next batch.

2. First, students will prepare and examine a slide to observe bacteria in yogurt. If necessary, demonstrate how to make a slide before having groups of students make their own. Students should follow the instructions on the Bacteria card to prepare and observe their slides. Have students draw what they observe. (Students will not be able to see any parts inside the bacterial cells, which will appear as tiny rods.) Be sure students record on their drawings the magnification at which they made their observations.
3. Ask, *Were you able to see cells or groups of cells?* Explain that students observed tiny rod-shaped bacteria, called *Lactobacillus,* that live on milk sugar (lactose).
4. Have students follow the procedures on the Yeast card to observe and draw yeast cells. Students will be able to observe many round yeast cells, some of which may be reproducing by budding. Ask, *Were the yeast cells larger or smaller than the bacteria?* (larger) *What other differences did you notice?*
5. Finally, have students observe the paramecium culture (or pond water, which may or may not contain paramecia).

   If you are using pond water that includes a variety of organisms, you may want students to examine the water with a hand lens before using a microscope. Students should follow the directions on the Paramecia card to prepare their slides.

   Have students draw one paramecium (or other pond organism). These organisms may be large enough for students to observe and label the cell nucleus and cell membrane. Students also may be able to see the cilia around the edge of each paramecium.

   Note: A tiny drop of glycerin on slides with pond water will slow the movement of microorganisms so that they are easier to observe.
6. Conduct a class discussion or have each student group create a table that summarizes the similarities and differences observed among the three kinds of microorganisms. Allow time for groups to add new information to their concept maps.
7. Have students research or discuss other types of bacteria, fungi, and protists. For descriptions of major groups of living things that have microscopic members, see Activity 5 (p. 18).

Giardia lamblia protist. CDC\8698 J. Carr.

Slide Preparation Cards

Bacteria

These shapes are typical of bacteria in yogurt. Keep in mind that the actual microbes will appear smaller or larger, depending on the magnification.

A. Follow steps 1–3 below to prepare the slide for viewing.
   1. Using a toothpick, place a small amount of yogurt in the center of a slide.
   2. Use a pipette or dropper to add one drop of water to the yogurt. Stir to mix.
   3. Carefully place a cover slip over the mixture.

B. To examine the yogurt with a compound microscope, follow the steps below.
   1. First, focus the low-power objective and find an area of the slide that has some of your sample. Avoid bubbles (clear circles with heavy black borders).
   2. Once you have found a section with yogurt, center the sample in your field of view and rotate the objectives to medium-power or high-power, as directed by your teacher.
   3. Refocus the microscope using only the fine focus knob.

C. Draw what you observe, and label any parts you recognize.

Yeast

These shapes are typical of yeast. Keep in mind that the actual microbes will appear smaller or larger, depending on the magnification.

A. Follow steps 1–2 below to prepare the slide for viewing.
   1. Using a pipette or dropper, place a small amount of yeast mixture in the center of a slide.
   2. Carefully place the cover slip over the liquid.

B. To examine the yeast with a compound microscope, follow the steps below.
   1. First, focus the low-power objective and find an area of the slide that has some of your sample. Avoid bubbles (clear circles with heavy black borders).
   2. Once you have found a section with yeast, center the sample in your field of view and rotate the objectives to medium-power or high-power, as directed by your teacher.
   3. Refocus the microscope using only the fine focus knob.

C. Draw what you observe, and label any parts you recognize. You may notice that some cells have buds.

Paramecia

These shapes are typical of paramecia. Keep in mind that the actual microbes will appear smaller or larger, depending on the magnification.

A. Follow steps 1–2 below to prepare the slide for viewing.
   1. Using a pipette or dropper, place a small amount of pond water in the center of a slide.
   2. Carefully place the cover slip over the liquid.

B. To examine the microbes in pond water with a compound microscope, follow the steps below.
   1. First, focus the low-power objective and find an area of the slide that has some of your sample. Avoid bubbles (clear circles with heavy black borders).
   2. Once you have found a section with organisms, center the sample in your field of view and rotate the objectives to medium-power or high-power, as directed by your teacher. Paramecia are slipper-shaped microbes.
   3. Refocus the microscope using only the fine focus knob.

C. Draw what you observe, and label any parts you recognize. If your sample does not have any paramecia, select another microorganism to observe and draw what you see.