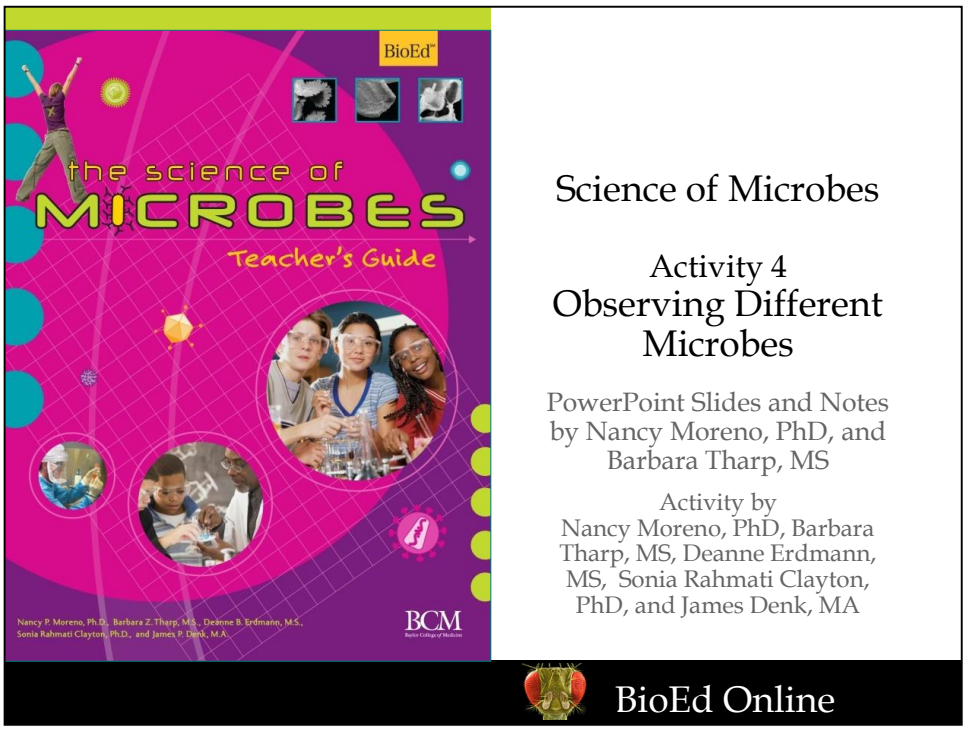

Observing Different Microbes

Observing Different Microbes is the fourth lesson in the unit, *The Science of Microbes*. This lesson addresses National Science Education Content Standards related to Inquiry and Life Science. See the downloadable lesson PDF (link below) for a complete list of the standards addressed.

In this activity, students will use a microscope to examine representatives from three different microbe groups: bacteria, fungi and protists. Specifically, students will observe bacteria (in yogurt), baker's yeast cells and paramecia.

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Materials for Each Group of Four Students

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Materials for Each Group of Four Students
This activity requires some preparation ahead of time. Well in advance, order pond water from a science supplier, collect fresh "pond water" from a ditch or pond, or make your own (see instructions in lesson PDF). One day before conducting the activity, mix yeast and one teaspoon of sugar in warm water and leave out overnight. Also, leave a container of yogurt unrefrigerated overnight. Make six copies of the student sheet (Slide Preparation Cards, pp. 17) on card stock and cut out cards. Have glycerin available for use in preparing slides of rapidly moving pond life (a small amount of glycerin on the slide will slow movement of the organisms being observed).

Have one or more microscopes available for each group of four students. Before class, prepare trays with the following items for student groups.

- Samples of microbes in small containers (pond water, yeast, yogurt), with a dropper for each container (toothpick for yogurt)
- Tap water in a small container, with a dropper
- 3 plastic slides and cover slips
- Colored pencils or markers
- Drawing paper (or students' lab notebooks or science journals)
- Copy of Slide Preparation Cards
- Group concept map (ongoing)

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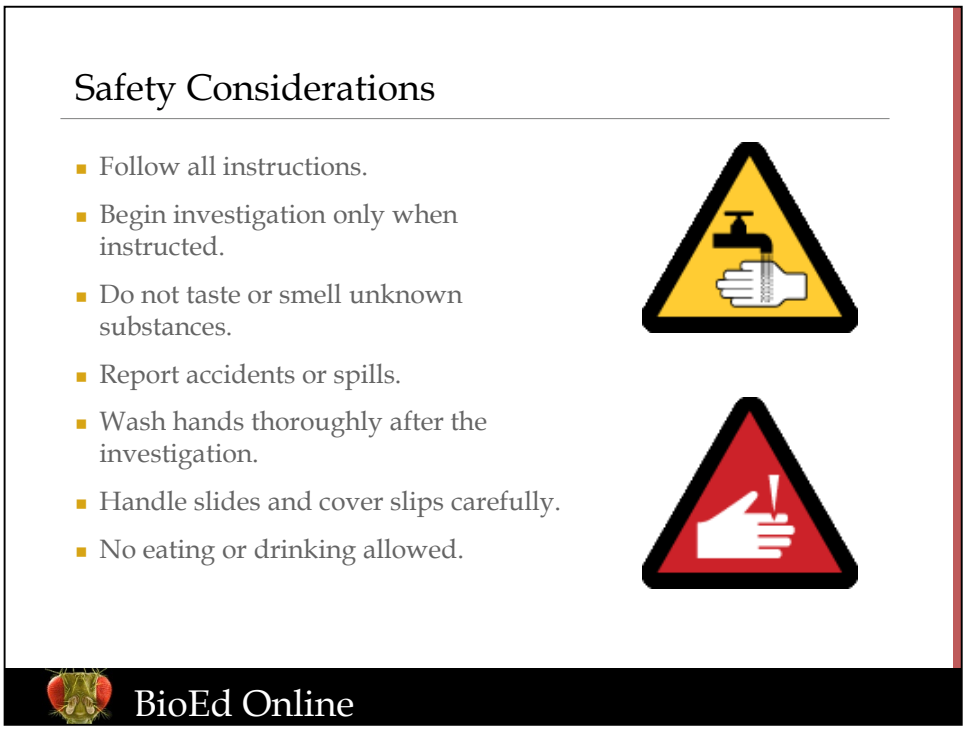

Safety Considerations

It is important that students always think about safety when conducting a science investigation, and this slide may be used to review safety with your class before starting the activity. Also, keep the following points in mind.

- Always follow your district and school safety guidelines.
- Have a clear understanding of the investigation in advance (practice any investigation with which you are not familiar).
- Make sure appropriate safety equipment, such as safety goggles, is available.
- Continually monitor the area where the investigation is being conducted.
- Glass slides should be discarded in separate containers designed for glass and sharps disposal.
- Any student who is immuno-compromised should wear disposable gloves when handling pond water.
- Students must wash hands thoroughly after handling slides with pond water.

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Engage Students by Asking…
Begin by encouraging students to share their ideas about microbes. Ask questions, such as the ones listed on this slide, to prompt students' thinking. Make note of any other questions that students raise.

Over the course of this activity, students will learn that microbes are any organisms that are too tiny to observe with the unaided eye. Students will observe members of three different groups with microscopic members: bacteria (in yogurt), fungi (baker's yeast) and protists (paramecia or other inhabitants of pond water). Of these groups, only bacteria consist exclusively of single-celled, microscopic members.

"Microbe" is a general term used to refer to a living thing too small to see without magnification. Many biologists do not consider viruses, which are unable to live and reproduce on their own, to be living. However, viruses usually are included in the study of microorganisms, because they play important roles as disease-causing agents and are able to transfer genes among bacteria and other cells.

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Image Reference:
National Institute of Allergy and Infectious Diseases. *Mycobacterium tuberculosis*.

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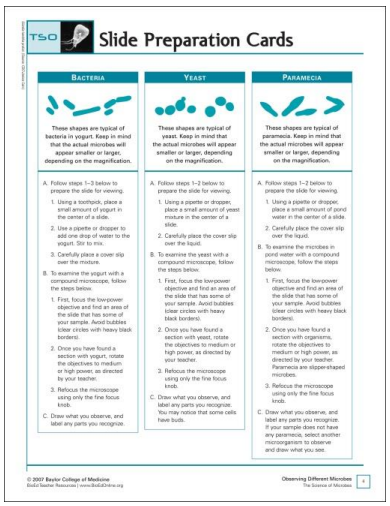
Prepare Slides of Microbes to Observe

- Follow the instructions on the Slide Preparation Cards to observe and compare different kinds of microbes.
  - Bacteria
  - Yeast
  - Paramecia
- Draw what you observe.
- Look for similarities and differences.



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Prepare Slides of Microbes to Observe

Students will investigate representatives from three different groups with microscopic members: bacteria, fungi and protists. Students will create simple wet mounts on slides and observe specimens through a microscope. Obtain specimen samples in advance (see lesson PDF).

Students will not be able to observe many internal structures of bacteria or yeast. However, they may be able to see the nuclei, some organelles and cilia (tiny hairs outside the cell membrane) of paramecia. If you use pond water collected from natural sources or make your own, students will see a variety of microorganisms in the water, including algae, protozoans (informal designation used to describe motile, animal-like unicellular organisms) and small animals (such as water fleas—*Daphnia*—or insect larvae).

Throughout this activity, be sure to have students write down the magnifications at which they make their observations and drawings.

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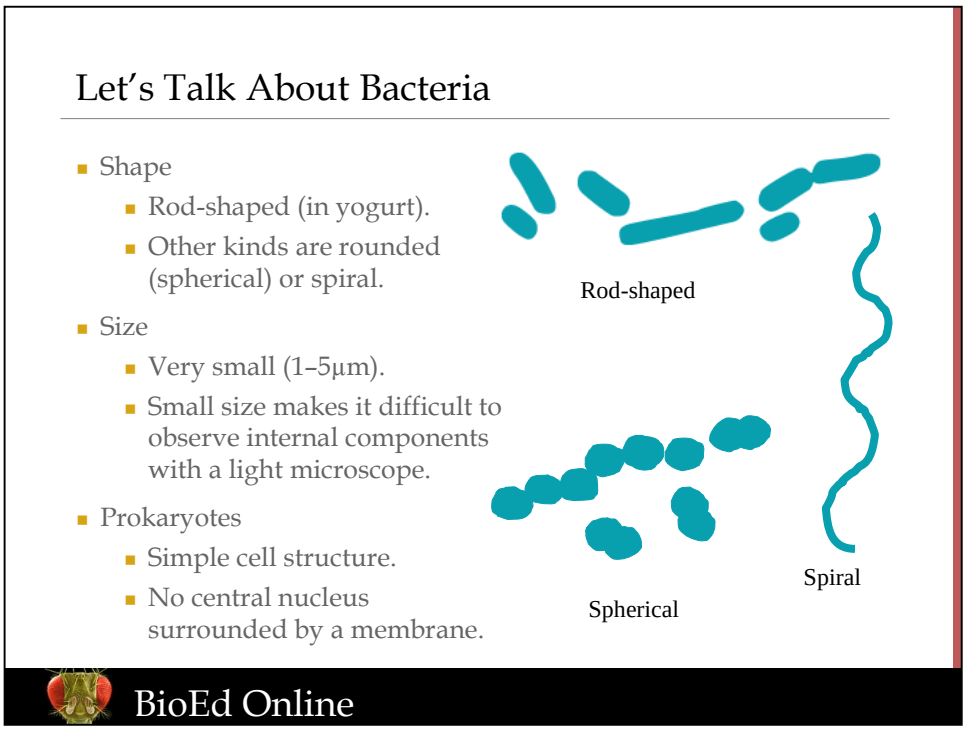

Let's Talk About Bacteria

In this activity, students will observe the bacteria in yogurt *(Lactobacillus** and others), which are rod-shaped. Other types of bacteria can be spherical or spiral-shaped. Bacteria are examples of prokaryotes, which are almost always microscopic and single-celled (unicellular).

Typically, prokaryotes are surrounded by a cell wall and lack internal compartmentalization. In the Five Kingdom system of classification, all prokaryotes are assigned to the Kingdom Monera. More recent classifications, however, separate the prokaryotes into two different Domains: Domain Bacteria and Domain Archaea. A third Domain, Eukarya, consists of all Eukaryotic organisms, such as plants, animals, fungi and protists. Learn more about recent classification of prokaryotes at http://www.tigr.org/tol/.

Most bacterial cells are 1–5µm in diameter, but there are exceptions. (*Thiomargarita namibiensis, for example,* is 750µm in diameter and is visible to the naked eye.) Because most bacteria are so small, their internal structures are not visible through most classroom microscopes. Instead, students will see rod shapes, such as those above, distributed throughout the yogurt on the slides they prepare.

**Lactobacilli* are found in the intestines of humans and generally are beneficial. They convert lactose and other sugars to lactic acid. Some species produce vitamin K and anti-microbial substances.

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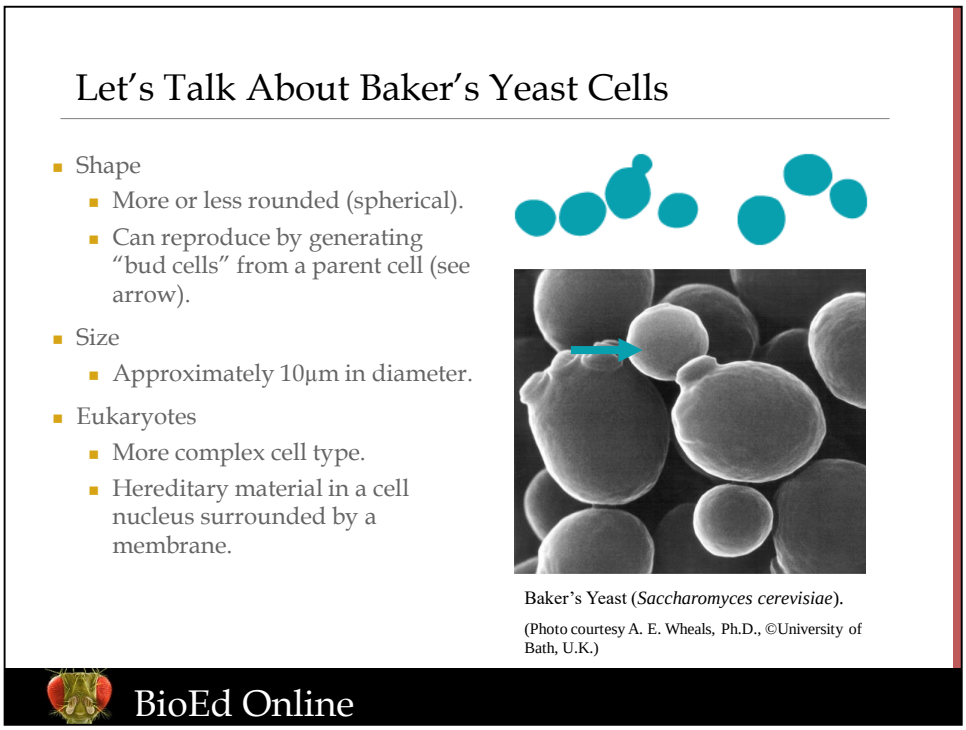

Let's Talk About Baker's Yeast Cells

The term "yeast" is used to described any single-celled fungus species, including Baker's yeast (*Saccharomyces cerevisiae*). Most fungi, such as mushrooms, molds and rusts, are multicellular and are not microbes. Members of the Fungus group are eukaryotes (their cells contain membrane-enclosed nuclei and organelles) that feed by absorption. The cell walls of fungi are composed of chitin, the material that gives hardness to the exoskeletons of insects.

Baker's yeast cells are larger than bacteria cells, usually about 10µm in diameter. Students will not be able to observe many internal details of yeast cells using a typical classroom microscope set-up. However, they may notice some dividing or budding yeast cells. Yeasts are able to reproduce asexually by simple cell division or by pinching off bud cells from a parent cell. Baker's yeast has many uses, including in the production of beer and bread, and as a model organism for the study of processes inside cells.

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Image Reference:
Courtesy A. E. Wheals, Ph.D., ©University of Bath, U.K. (scanning electron micrograph of *Saccharomyces cerevisiae).*

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Let's Talk About Paramecia

- Shape
  - "Slipper-shaped."
  - Long "oral groove" directs food to a place where it can be incorporated into the cell (see arrow).
  - External cilia for locomotion and movement of food.
- Size is approximately 250 µm.
- Eukaryotes
  - Cell structure with many internal components.
  - Cell nucleus surrounded by a membrane.

Paramecium

(Photo courtesy Ron Neumeyer, © Microimaging Services)

BioEd Online

Let's Talk About Paramecia

Paramecia (sing. Paramecium) are single-celled eukaryotes (their cells contain membrane-enclosed nuclei and organelles) that use cilia (hair-like appendages; sing. cilium) for movement and feeding. Paramecia are much larger than bacteria or yeast, and measure from about 50 to 350µ in length, depending on the species. They feed on bacteria and other small cells. When observing with a microscope, students will notice the paramecium's characteristic "slipper shape." At a magnification of 400x, the nucleus usually is visible and the movement of the cilia on the surface of the organism can be observed.

Within the Five Kingdom system of classification, paramecia are included in the very diverse Kingdom Protista. Other, more recent classifications divide the Protista into a number of more clearly defined Kingdoms and subgroups—all within the Domain Eukarya. Members of the Domain Eukarya all have specialized internal structures, such as an envelope around the cell nucleus (which contains genetic material), an endoplasmic reticulum and mitochondria.

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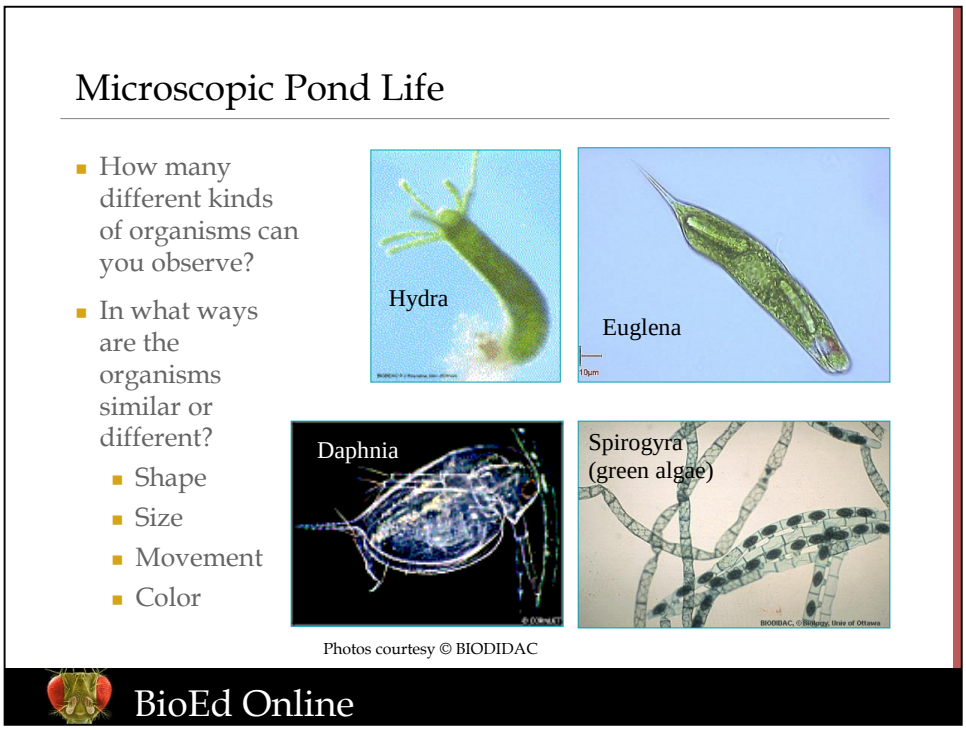

EXTENSION: Microscopic Pond Life

Pond water derives its greenish color from the numerous photosynthetic organisms it contains. When students observe pond water under the microscope, they may see examples of several different groups of organisms: protozoans (animal-like, single-celled organisms once included within the Kingdom Protista); algae (single-celled or multicellular plant-like organisms); and small invertebrate animals. The following examples are shown in this slide.

Euglena: single-celled member of the protozoan group; photosynthetic, but also can engulf prey; single-celled; single, long flagellum [hair] for movement.

Hydra: invertebrate animal related to jelly fish; its green color comes from single-celled algae that live in the lining of its digestive cavity.

Spirogyra: filamentous, multi-cellular green alga (relative of green land plants).

Daphnia (water flea): invertebrate animal related to crayfish and lobsters (crustaceans); important component of the aquatic food chain.

Encourage students to use web resources, such as the Pond Life Identification Kit (www.microscopy-uk.org.uk/pond/index.html), to identify organisms in pond water.

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Euglena (BRIE013P.jpg), Hydra (HYDR036P.gif), Daphnia (CORN007P.gif). Spirogyra (CHRO002P.gif)

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