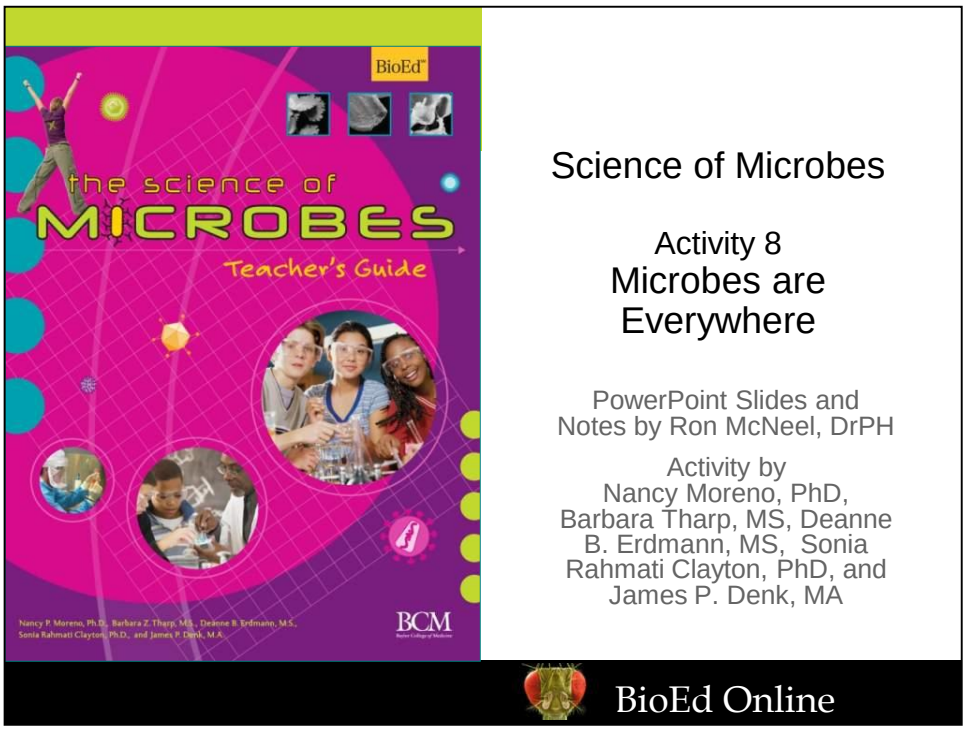


Science of Microbes

Microbes are Everywhere is the eighth lesson in the unit, *The Science of Microbes*. It addresses National Science Education Content Standards related to Inquiry and Life Science. See the downloadable lesson PDF (web address below) for a complete list of the standards addressed.

In this activity, students will learn that microbes can be found everywhere. The activity will demonstrate that with the proper resources, microbes (in this experiment, mostly bacteria) grow rapidly in number to form colonies with distinct appearances. Some fungi, in the form of molds, also may be seen.

Viewing this presentation fulfills part of the requirements for completing the short course on *The Science of Microbes*, offered on BioEd Online for professional development contact hours. *The Science of Microbes* Teacher's Guide may be obtained in its entirety from the Center for Educational Outreach at Baylor College of Medicine (1-800-798-8244). You can download a PDF of this lesson and other lessons from the Science of Microbes unit (including a unit pre/post assessment) from www.bioedonline.org or www.K8Science.org.

Reference:

Moreno, N., Tharp, B., Erdmann, D., Rahmati Clayton, S., Denk, J. (2008). *The Science of Microbes Teacher's Guide.* Houston, TX: BioEd.

The Science of Microbes and accompanying online professional development

activities were supported, in part, by Science Education Partnership Award number 5R25RR018605 from the National Center for Research Resources, National Institutes of Health (NIH) to Baylor College of Medicine. The unit was developed in partnership with the Baylor-UT Houston Center for AIDS Research, an NIH-funded program (AI036211). The opinions, findings, and conclusions expressed in this presentation are solely those of the authors and do not necessarily reflect the views of Baylor College of Medicine or the sponsoring agencies.

Materials for Each Group of Students

When setting up for this activity, prepare enough 100-mm Petri dishes with nutrient agar to provide 5 dishes to each student group. Also, have a supply of 10% chlorine bleach solution (10 mL chlorine bleach mixed with 90 mL water) on hand to disinfect any spills, any disposables that come in contact with the microbes, and microbe growth on the nutrient agar dishes.

Each group of four students should receive the following supplies.

- 4 sterile cotton swabs in a resealable plastic bag
- 5 prepared Petri dishes (one dish will serve as the control)
- Clean, empty Petri lid or dish (for use as a drawing template)
- Container of distilled or boiled water
- Magnifiers or low power microscopes
- Masking tape
- Permanent marker or wax pencil
- Colored pencils or markers
- 12 sheets of white paper for observations (3 sheets per student)
- Graph paper
- Paper towels
- Hot pads or pot holders

• Group concept map (ongoing)

Viewing this presentation fulfills part of the requirements for completing the short course on *The Science of Microbes*, offered on BioEd Online for professional development contact hours. *The Science of Microbes* Teacher's Guide may be obtained in its entirety from the Center for Educational Outreach at Baylor College of Medicine (1-800-798-8244). You can download a PDF of this lesson and other lessons from the Science of Microbes unit (including a unit pre/post assessment) from www.bioedonline.org or www.K8Science.org.

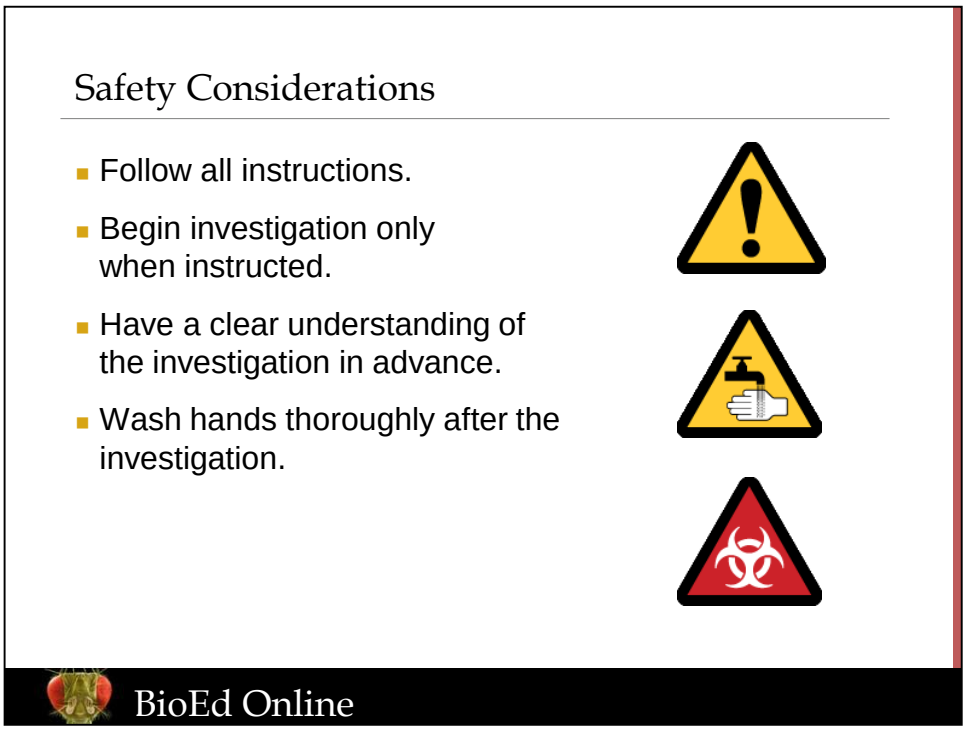
Reference:

Moreno, N., Tharp, B., Erdmann, D., Rahmati Clayton, S., Denk, J. (2008). *The Science of Microbes Teacher's Guide.* Houston, TX: BioEd.

Image Reference:

Denk, J. (2009). Materials for activity 8. Baylor College of Medicine. Houston, TX.

The Science of Microbes and accompanying online professional development content were supported, in part, by Science Education Partnership Award number 5R25RR018605 from the National Center for Research Resources, National Institutes of Health (NIH) to Baylor College of Medicine. The unit was developed in partnership with the Baylor-UT Houston Center for AIDS Research, an NIH-funded program (AI036211). The opinions, findings, and conclusions expressed in this presentation are solely those of the authors and do not necessarily reflect the views of Baylor College of Medicine or the sponsoring agencies.



Safety Considerations

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

- Always follow district and school safety guidelines.
- Have a clear understanding of the investigation in advance (practice any investigation with which you are not familiar).
- Continually monitor the area where the investigation is being conducted.

Do not allow students to test any body fluids for microbes, as these fluids might grow a disease-causing microbe. All supplies that come in contact with cultured microbes should be disinfected with a 10% chlorine bleach solution (10 mL chlorine bleach mixed with 90 mL water) and disposed of in accordance with district and school safety procedures. After the nutrient agar has been inoculated with the cotton swabs, seal the Petri dishes with masking tape to prevent exposure to the growing microbes. Before and after the activity, disinfect all work areas with a 10% chlorine bleach solution.

Viewing this presentation fulfills part of the requirements for completing the short course on *The Science of Microbes*, offered on BioEd Online for professional development contact hours. *The Science of Microbes* Teacher's Guide may be obtained in its entirety from the Center for Educational Outreach at Baylor College of Medicine (1-800-798-8244). You can download a PDF of this lesson and other lessons from the Science of Microbes unit (including a unit pre/post assessment) from www.bioedonline.org or www.K8Science.org.

Reference:
Moreno, N., Tharp, B., Erdmann, D., Rahmati Clayton, S., Denk, J. (2008). *The Science of Microbes Teacher's Guide.* Houston, TX: BioEd.

The Science of Microbes and accompanying online professional development content were supported, in part, by Science Education Partnership Award number 5R25RR018605 from the National Center for Research Resources, National Institutes of Health (NIH) to Baylor College of Medicine. The unit was developed in partnership with the Baylor-UT Houston Center for AIDS Research, an NIH-funded program (AI036211). The opinions, findings, and conclusions expressed in this presentation are solely those of the authors and do not necessarily reflect the views of Baylor College of Medicine or the sponsoring agencies.

Session 1: Where Do Microbes Live and Grow?

Have your students suggest places they think microbes might live and grow. Ask, *Do you think there are any microbes in this room?* List and discuss their ideas. Encourage students to share their ideas about how to determine if microbes are present in a particular place or on a particular object. Ask students if they ever have seen bacteria grown on agar plates.

Viewing this presentation fulfills part of the requirements for completing the short course on *The Science of Microbes*, offered on BioEd Online for professional development contact hours. *The Science of Microbes* Teacher's Guide may be obtained in its entirety from the Center for Educational Outreach at Baylor College of Medicine (1-800-798-8244). You can download a PDF of this lesson and other lessons from the Science of Microbes unit (including a unit pre/post assessment) from www.bioedonline.org or www.K8Science.org.

Reference:

Moreno, N., Tharp, B., Erdmann, D., Rahmati Clayton, S., Denk, J. (2008). *The Science of Microbes Teacher's Guide.* Houston, TX: BioEd.

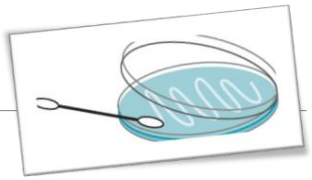
Image Reference:

Hand Print. 123rf

The Science of Microbes and accompanying online professional development content were supported, in part, by Science Education Partnership Award number 5R25RR018605 from the National Center for Research Resources, National Institutes of Health (NIH) to Baylor College of Medicine. The unit was developed in partnership

with the Baylor-UT Houston Center for AIDS Research, an NIH-funded program (AI036211). The opinions, findings, and conclusions expressed in this presentation are solely those of the authors and do not necessarily reflect the views of Baylor College of Medicine or the sponsoring agencies.

Testing for Microbes



- Select four locations to test.
- Make a prediction about whether microbes will be detected at each location.
- Prepare data table and label all Petri dishes.
- Rub a moistened cotton swab over the first location to be tested for microbes.
- Inoculate the appropriately labeled Petri dish by using a streaking technique (see illustration).
- Repeat steps 2-3 for each of the remaining locations.
- Inoculate one Petri dish with a clean, moistened swab. Why is this step important?

BioEd Online

Testing for Microbes

Have each group select four locations to test for the presence of microbes. Remember, no body fluids are to be tested. Possible test sites could include the floor, doorknob, writing utensils, etc. Allow students to be creative in their selections, without prompting. Encourage them to choose as many varied locations as possible.

Have each group create a table with two columns, labeled “Location Sampled” and “Predicted Results.” Students should use a piece of masking tape and marker to label the bottom (nutrient agar side) of each Petri dish with the location to be sampled. Each group also should include a unique group name or identifier on the labels, to distinguish their plates from other groups’.

Have groups list selected locations in the “Location Sampled” column. In the “Predicted Results” column, each group should predict if each chosen location will grow microbes. Students also should predict which sample locations will grow the most and fewest microbes.

Have students rub a cotton swab, moistened in boiled water, several times over one of the locations to be tested. Students should open the Petri dish with that location’s name on the label and rub the swab gently in a zigzag pattern across the total surface of the nutrient agar. (This inoculation technique is known as streaking.) Then, students should rotate the Petri dish one quarter turn and streak again. Caution students not to break the surface of the agar. Groups should repeat the inoculation process for the remaining three locations, using the appropriately labeled Petri dish and clean swab for each. Collect all used swabs and dispose of them in a 10% chlorine bleach solution.

The fifth Petri dish should be inoculated with a clean moist swab and used as a control. Ask, *Why are we inoculating with a clean swab?* Students should realize that the control plate will help confirm that the nutrient agar, cotton swab, and water used for moistening are not contaminated, and do not cause any microbe growth that could confound the outcomes of the experiment.

All inoculated Petri dishes should be sealed with masking tape and should not be opened again. Collect all inoculated Petri dishes and store them upside down (agar-

side up) in a warm place (37° C).

Viewing this presentation fulfills part of the requirements for completing the short course on *The Science of Microbes*, offered on BioEd Online for professional development contact hours. *The Science of Microbes* Teacher's Guide may be obtained in its entirety from the Center for Educational Outreach at Baylor College of Medicine (1-800-798-8244). You can download a PDF of this lesson and other lessons from the Science of Microbes unit (including a unit pre/post assessment) from www.bioedonline.org or www.K8Science.org.

Reference:

Moreno, N., Tharp, B., Erdmann, D., Rahmati Clayton, S., Denk, J. (2008). *The Science of Microbes Teacher's Guide.* Houston, TX: BioEd.

The Science of Microbes and accompanying online professional development content were supported, in part, by Science Education Partnership Award number 5R25RR018605 from the National Center for Research Resources, National Institutes of Health (NIH) to Baylor College of Medicine. The unit was developed in partnership with the Baylor-UT Houston Center for AIDS Research, an NIH-funded program (AI036211). The opinions, findings, and conclusions expressed in this presentation are solely those of the authors and do not necessarily reflect the views of Baylor College of Medicine or the sponsoring agencies.

Follow-up Observations

- Describe the changes that occur inside the Petri dishes over time.
- What words would you use to describe the microbes?
- How many different kinds of colonies of organisms can you distinguish on your Petri dishes?
- After 3 days, count the number of colonies and note changes in the diameters of existing colonies.
- Which sample locations had the most kinds of microbes?

Agar plate growth after approximately 24–36 hours. This plate was streaked with microorganisms isolated from a deep–water sponge.

BioEd Online

Sessions 2-4: Follow-up Observations

Using a Petri dish as a template, each student should draw 3 circles on a sheet of plain paper. (Each group will use four sheets of paper, one sheet for each sample location.) The circles should be labeled "Day 1," "Day 2" and "Day 3." One student should prepare an extra sheet and label it "control."

Instruct group members to draw what they observe on one of the inoculated Petri dishes, with each member observing a different sample location dish. Students can take turns drawing what they see on the control dish. If possible, have them observe microbe colonies through the Petri Dish lids, using a microscope on low power. Remember, students are not to open the Petri dishes.

Student observations and drawings should be carried out for 1 to 3 consecutive days. Have students describe changes inside the Petri dishes over time, including the color, size, shape and apparent texture of the colonies. Help students to recognize the fuzzy, felt-like appearance of molds (fungi) on their plates.

Ask the students, *How many different kinds of organisms can you distinguish on your Petri dishes? What criteria are you using to arrive at your number?* It may be useful for students to examine their samples with a hand lens, as this will provide better detail. It is not necessary for students to identify which of the four major groups of microbes are present. However, ask them which groups are most likely be visible on the agar. Answers should include bacteria and fungi. It would be rare for protists to appear on the agar. Virus particles could be on the dish, but they would not be visible.

After three days, have students count and measure the diameter of the colonies on their plates. Let them decide which sample location produced the most microbes. You may even want them to add a third column to their table, labeled "Actual Results." In this column, students can record the results for each sample location and explain if they predicted correctly. Each group should share its results with the class.

Viewing this presentation fulfills part of the requirements for completing the short course on *The Science of Microbes*, offered on BioEd Online for professional development contact hours. *The Science of Microbes* Teacher's Guide may be obtained in its entirety from the Center for Educational Outreach at Baylor College of

Medicine (1-800-798-8244). You can download a PDF of this lesson and other lessons from the Science of Microbes unit (including a unit pre/post assessment) from www.bioedonline.org or www.K8Science.org.

Reference:
Moreno, N., Tharp, B., Erdmann, D., Rahmati Clayton, S., Denk, J. (2008). *The Science of Microbes Teacher's Guide.* Houston, TX: BioEd.

Image Reference:
Agar plate. National Oceanic and Atmospheric Administration. Retrieved 12-15-2009 from http://en.wikipedia.org/wiki/File:Agar_plate_with_colonies.jpg

---

The Science of Microbes and accompanying online professional development content were supported, in part, by Science Education Partnership Award number 5R25RR018605 from the National Center for Research Resources, National Institutes of Health (NIH) to Baylor College of Medicine. The unit was developed in partnership with the Baylor-UT Houston Center for AIDS Research, an NIH-funded program (AI036211). The opinions, findings, and conclusions expressed in this presentation are solely those of the authors and do not necessarily reflect the views of Baylor College of Medicine or the sponsoring agencies.

Sessions 2-4: Let's Talk About It
Present students with the following statement: 'microbes are everywhere.' Have them defend or dispute this statement based on the class results.

Ask, *What do you think is happening when you see microbes growing on something?* The microbes are using the substance as a food source. Remind students that microbes may be present, even if we can't see them. Did the results from any of their sample locations support this statement? (Test locations such as door knobs should have demonstrated the presence of microbes that are too small to see individually.)

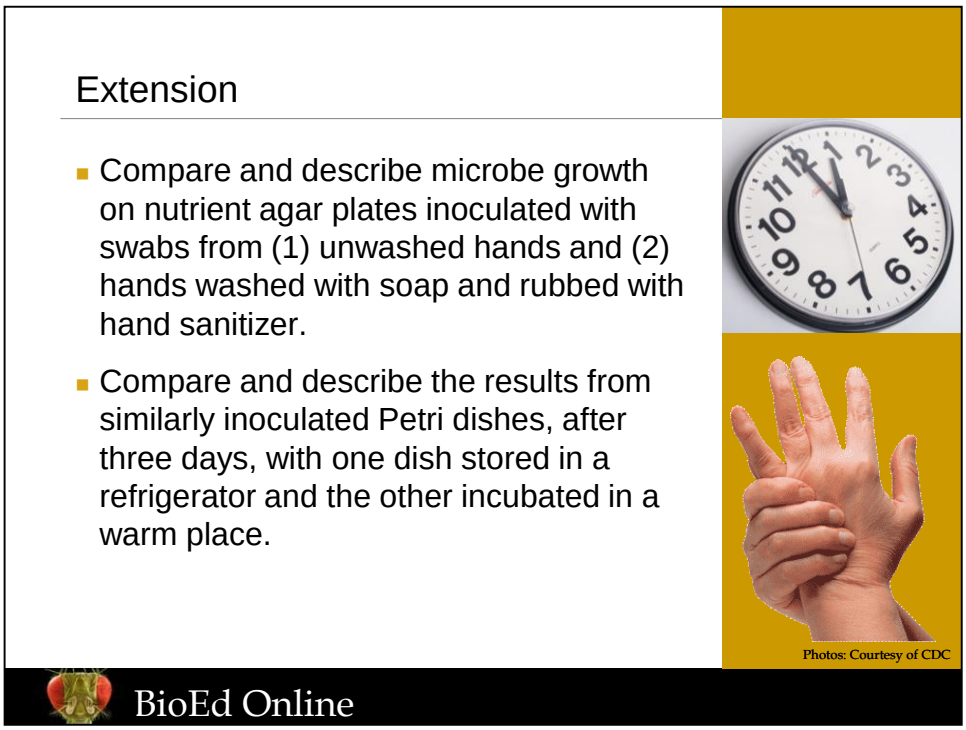
Pose the following question, which will lead into the next activity: *If microbes are located everywhere, why aren't we all sick?* Allow students to discuss as a class. They should come to realize that many microbes are not harmful, but are, in fact, beneficial. In addition, students also should understand that many microbes can survive without growing or reproducing on surfaces or in the air for periods of time that vary from several hours to days or weeks.

Viewing this presentation fulfills part of the requirements for completing the short course on *The Science of Microbes*, offered on BioEd Online for professional development contact hours. *The Science of Microbes* Teacher's Guide may be obtained in its entirety from the Center for Educational Outreach at Baylor College of Medicine (1-800-798-8244). You can download a PDF of this lesson and other lessons from the Science of Microbes unit (including a unit pre/post assessment) from www.bioedonline.org or www.K8Science.org.

Reference:
Moreno, N., Tharp, B., Erdmann, D., Rahmati Clayton, S., Denk, J. (2008). *The Science of Microbes Teacher's Guide*. Houston, TX: BioEd.

The Science of Microbes and accompanying online professional development content

were supported, in part, by Science Education Partnership Award number 5R25RR018605 from the National Center for Research Resources, National Institutes of Health (NIH) to Baylor College of Medicine. The unit was developed in partnership with the Baylor-UT Houston Center for AIDS Research, an NIH-funded program (AI036211). The opinions, findings, and conclusions expressed in this presentation are solely those of the authors and do not necessarily reflect the views of Baylor College of Medicine or the sponsoring agencies.



Extension

Have the students compare and describe microbe growth on nutrient agar plates inoculated with swabs from (1) unwashed hands and (2) hands washed with soap and rubbed with hand sanitizer.

Lead a class discussion about the importance of hand washing. Emphasize that this simple step is the most effective way for us to help control the spread of microbes and disease. View this short video from the CDC, demonstrating proper hand washing technique and the importance of washing hands: http://www.youtube.com/watch?v=XHISh559oho.

Have students compare and describe the results from similarly inoculated Petri dishes, after three days, with one dish stored in a refrigerator and the other incubated in a warm place. Help the students to understand the importance of refrigerating leftover food as a means to help control microbe growth.

Viewing this presentation fulfills part of the requirements for completing the short course on *The Science of Microbes*, offered on BioEd Online for professional development contact hours. *The Science of Microbes* Teacher's Guide may be obtained in its entirety from the Center for Educational Outreach at Baylor College of Medicine (1-800-798-8244). You can download a PDF of this lesson and other lessons from the Science of Microbes unit (including a unit pre/post assessment) from www.bioedonline.org or www.K8Science.org.

Reference:

Moreno, N., Tharp, B., Erdmann, D., Rahmati Clayton, S., Denk, J. (2008). *The Science of Microbes Teacher's Guide.* Houston, TX: BioEd.

Image References:

Centers for Disease Control and Prevention. (2002). *Materials to promote hand hygiene in your healthcare facility, supplementary slides* (downloadable PowerPoint file). Retrieved 3-5-2008, from http://www.cdc.gov/handhygiene/materials.htm.

Clock. 123rf

–

The Science of Microbes and accompanying online professional development content were supported, in part, by Science Education Partnership Award number 5R25RR018605 from the National Center for Research Resources, National Institutes of Health (NIH) to Baylor College of Medicine. The unit was developed in partnership with the Baylor-UT Houston Center for AIDS Research, an NIH-funded program (AI036211). The opinions, findings, and conclusions expressed in this presentation are solely those of the authors and do not necessarily reflect the views of Baylor College of Medicine or the sponsoring agencies.