Super STEM Sleuths: 2

Teacher's Guide and After School Activities

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Contents

Always follow district and school laboratory safety procedures. It is a good idea for students to wash their hands with soap and water before and after any science activity.

Unless noted, each activity in this guide is designed for students working in groups of four (see "Using Cooperative Groups in the Classroom").

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 cooperative model for learning is established in the classroom, students are able to conduct science activities in an organized and effective manner. The job titles and responsibilities are as follow.

Principal Investigator
- Reads the directions
- Asks questions of the instructor/teacher
- Checks the work

Maintenance Director
- Ensures that safety rules are followed
- Directs the cleanup
- Asks others to help

Reporter
- Records observations and results
- Shares results with group or class
- Tells the teacher when the investigation is complete

Materials Manager
- Picks up the materials
- Directs use of equipment
- Returns the materials

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

Materials Sheet

for class of 24 students in groups of 4

Activity 1 – Microscope Parts and Powers
<u>Per Class</u>
- Hand lens

<u>Per Group</u>
- 4 pairs of scissors
- Set of objects such as feathers, butterfly wings, fish scales, etc.
- index card
- small plastic bag
- Clear tape
- 4 rulers (metric)
- microscope with eyepieces
- Set of colored pencils or markers
- <u>Per Student</u>
- Copies of *Magnification Observations* and the *Magiscope Microscope* student sheets

Activity 2 – Exploring with the Magiscope
<u>Per Class</u>
- Note cards
- Scissors
- Tape
- Selected materials
- Microscopes
- Copies of *Mystery Slide Investigations* sheet

Activity 3 – Magnifying and Observing Cells
<u>Per Class</u>
- Sharp knife
- 1 white onion
- Several stalks of Elodea plant
- Computer with internet access
- Projector

<u>Per Group</u>
- Microscope
- 4 pairs of safety goggles
- 4 microscope slides
- 2 pairs of forceps
- 1/6 of an onion, vertical slice
- Small stalk of Elodea leaves
- Iodine solution in small portion cup
- Water in small portion cup
- 2 pipettes (droppers)
- Science notebooks or drawing paper
- 4 copies *Preparing and Viewing* student sheet

Activity 4 – Observing Fungi
<u>Per Class</u>
- Head of purple cabbage
- Sharp knife
- 6 clear, heavy duty, re-sealable sandwich size plastic bags

<u>Per Group</u>
- Microscope
- Hand lens
- 5 ml dry yeast in small portion cup (Mystery solid #1)
- 5 ml sand in small portion cup (Mystery solid #2)
- 1 index card
- Scissors
- 8 cm of clear tape
- Clear, heavy duty, re-sealable sandwich size plastic bag, filled with raw, finely sliced purple cabbage
- 500 ml very warm water
- 250 ml beaker
- 3- clear plastic cups
- 50 ml vinegar in clear plastic cup
- 20 ml baking soda in small portion cup
- 10 ml sugar in small portion cup
- 8 cm masking tape
- 3 pipettes or droppers
- 5 ml measuring spoon (teaspoon)
- 6 coffee stirrers
- 8 slides

Activity 5 – Observing Different Microbes
<u>Per Class</u>
- Blue bulletin paper circle 150 cm in diameter

<u>Per Group</u>
- 4 magnifiers
- Microscope
- 4 sets of gloves
- 4 goggles
- 4 pipettes or droppers
- 4 microscope slides
- 50 ml of pond water in clear plastic cup
- 4 index cards
- colored pencils
- Small portion cup with glycerin

<u>Per Student</u>
- 4 sheet of blank paper for graphic organizer

Activity 6 – Can You Clean the Water?

Per Group

- 400 ml of pond water
- Microscope
- 4 slides
- Glycerin
- Eye dropper or micropipette
- 6 Styrofoam coffee cups
- 6X6 inch fabric squares one each of
    - Cheese cloth
    - Chiffon
    - Muslin
- Scissors
- Gloves
- Eye protection

Activity 7 – Modeling Mystery Microbes

Per Teams of 6 Students

- 1 self-closing plastic sandwich bag
- clear tape
- ½ sheet clear transparency
- 1 piece of clear plastic wrap (same size as the transparency sheet)
- 1 small red bead
- 16 small green beads with hole
- 2 clear or semi-transparent balloons
- 1 (30 cm or 12 inch) piece of clear cellophane gift wrap
- 36 (11 cm or 4 inch) strands of sewing thread
- 5 small clear containers like pill capsules
- 1 translucent surgical glove
- 1/3 cup uncooked rice
- 2 small "star" stickers
- 1 Head capsid (see instruction sheet)
- 2 green pipe cleaners
- 4 pipe cleaners (3 in one color, 1 in another)
- 1 pipe cleaner cut into 1.25cm (1/2 inch) pieces
- 1 metal washer
- 2 clear, small plastic drinking cups
- 46 cm (or about 18") of clear plastic wrap
- 96 cm (or about 24 inches) of black yarn

Activity 8 – Extracting DNA

Per Class

- 4 hand lens
- 4 pipettes or droppers
- 4 microscope slides
- Microscope
- 50 ml cold water
- 4 ripe strawberries, stems removed
- 2 clear plastic cups
- coffee filter or cheesecloth
- rubber band
- 5 ml table salt
- 50 ml Graduated cylinder
- 250 ml beakers
- 4 craft stick
- 30 ml liquid detergent
- Ice cold alcohol (95% Ethanol or 92% Isopropanol)

Per Student

- Copy of *How to Extract DNA* student page

Activity 9 – Microbes and Disease

Per Group

- Paper and supplies for art projects
- Sheet of paper on which to create an activity concept map
- 6 copies of the 3-2-1 student sheet
- 4 copies of one Disease Information sheet (all members of a group receive the same disease sheet)
- Group concept map (ongoing)

Activity 10 – Diagnosing Microbial Diseases

Per Class

- 270 letter-size plain envelopes
- 18 sheets of white, self-stick folder labels, 3-7/16 in. x 2/3 in., 30 labels per sheet (Avery™ #5366, 5378 or 8366)

Per Group

- Set of prepared Allison envelopes (15 envelopes per set)
- Set of prepared Carlos envelopes (15 per set)
- Set of prepared Stephanie envelopes (15 per set)
- Copies of *Looking at Case Studies*, *Disorders and Symptoms*, *What is Wrong with Allison? What is Wrong with Carlos?* and *What is Wrong with Stephanie* group sheets

Alternatively, Students can do part of the activity online at https://dl.dropbox.com/u/2017824/DD-OM/DiseaseDiagnosis.html (Works best in Chrome, Firefox, or Safari

1) Microscope Parts and Powers

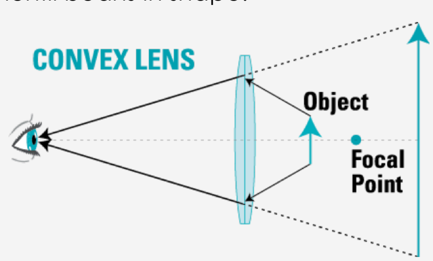
Seeing the Small Stuff

Time Needed
1 Session

You Need This Stuff
Per Class
- Hand lens

Per Group
- 4 pairs of scissors
- Set of objects such as feathers, butterfly wings, fish scales, etc.
- index card
- small plastic bag
- Clear tape
- 4 rulers (metric)
- microscope with eyepieces
- Set of colored pencils or markers
- Per Student
- Copy of "Magnification Observations" and "Magiscope® Microscope" student sheets

With an object closer to a lens than the focal point, the light rays diverge, giving the viewer the illusion that he or she is seeing a larger object, farther away, in the same orientation. The word "lens" comes from the Latin word for lentil, because early magnifiers resembled lentil beans in shape.



What is it About?

Scientific progress often is tied to the development of new tools and technologies. For example, until magnifying lenses were developed, people were able to see only as much of the world as their naked eyes would allow. The development of high quality magnifiers and microscopes opened up the world of cells and microorganisms for exploration by generations of scientists.

Lenses are made of transparent materials and have one or two curved surfaces. They work by refraction, which means that the pathway of light is altered as it passes from one clear material, such as air, into another of a different density, such as glass. Magnifying glasses are single lenses that are convex on both sides. The compound light, or optical, microscope uses two magnifying lenses in series to make things appear much larger to the eye than would be possible with a single lens. The simplest compound microscopes consist of tubes with lenses at each end. Objects can be magnified up to 2,000 times using a high quality compound microscope.

The invention of the transmission electron microscope (TEM) in the mid-20th Century made it possible to view objects even tinier than cells, such as viruses. This type of microscope magnifies objects up to two million times by passing a beam of electrons through a very thin specimen and recording changes in the electron beam.

Zacharias Janssen is credited with developing the first compound microscope around 1595. But in 1665, scientist Robert Hooke was the first to use such an instrument to observe the division of plant tissues into tiny compartments, which he termed "cellulae," or cells. Inspired by the work of Hooke, Anton van Leeuwenhoek, a Dutch inventor, used simple (one lens) microscopes to describe bacteria and protists. Van Leeuwenhoek's well-made microscopes magnified objects more than 200 times and allowed him to make very detailed observations.

What's The Question?

What are the parts and powers of a microscope?

Before You Start

Prepare small plastic bags for each group with a variety of small items to view.

Make sure that all Magiscopes have a 5X eyepiece and a 4X objective lens in place. Make copies of the student sheets. Place materials for groups on trays in a central location. Before allowing students to carry microscopes to their work areas, demonstrate how to hold a microscope by placing one hand on the microscope stand (arm) and the other under the base (foot).

Have students work in groups of four.

Scientists use a variety of high-powered microscopes to study the surface and internal structure of a sample, and to measure the size of things too tiny to see with light microscopes.

A transmission electron microscope (TEM) uses an electron beam that passes through a specimen, enabling the interior of an object to be observed (image).

A scanning electron microscope (SEM) uses electrons to image the surface of an object (image).

What To Do

1. Hold up a magnifier or hand lens. Ask students, *How does a magnifier work?* Have students explain based on the activity in Unit 1 where they made magnifiers from water drops and flat marbles. Make sure they understand that lenses are made of transparent materials and have one or two curved surfaces. They work by refraction, which means that the pathway of light is altered as it passes from one clear material, such as air, into another, such as glass.
2. Ask, *What could we use to magnify the materials more than the hand lens?* Distribute the Magiscope® microscopes and allow groups to examine them for a few minutes. If they are picking them up, make sure you first instruct students on how to hold it carefully by the arm.
3. If students are not familiar with microscopes, help them locate the basic parts. For example, tell students, *One part of the microscope is called the stage. It is similar to a stage for a performance. Can you find it? What about the arm?* Have students use The "Magiscope® Microscope" sheet to find the eyepiece, objective lens, body tube, stop rivet, support clamp, arm, stage and light source of the microscope.
4. Tell students that they will be removing the lens after your demonstration. Show students how to properly remove the eyepiece by holding the body tube with one hand and pulling the eyepiece straight up with the other hand. Tell students that once the lens has been removed they will need to gently place the removed eyepiece on the table with the lens on top, so that it is not scratched. Then demonstrate how to remove the objective by screwing it out and again laying the lens down carefully with the lens side up. Make sure students are careful not to jam or cross threads as they screw the objective lens in or out.
5. First, instruct students to carefully remove the eyepiece and examine it. They should pass it around so that the entire group can examine it. Ask, *What do you notice about the lens?* Students should note the curvature of the lens and the "X" markings on the sides of the eyepiece.
6. Next, have students carefully remove the bottom lens, the objective, and examine. Ask, *What does "X" usually mean in mathematics?* (multiplication or "times") Explain that each lens has a number with the X. The eyepiece number is multiplied by the objective number to indicate the total number of times a specimen is magnified when observed. For example, an eyepiece of 10X with an objective of 4X will magnify an image 40 times (10 x 4 = 40).
7. Give each group a small bag of specimens to observe. Some items that could be used include feathers, butterfly wings, fish scales or other natural objects. Made-made materials can also be used like fabrics or sandpaper.
8. Explain that to get a better view of the objects, students can create a paper slide from ¼ of an index card. Demonstrate how to make a paper slide by first cutting the card into fourths. Then gently folding (no crease) side to side to locate the approximate center of the card. Next, cut a 1-cm x 1-cm square from the center of the card, and place a piece of clear tape over the square. Explain that a specimen can be mounted on the tape for better viewing.
9. Instruct each student to create a slide by placing a small piece (if it can be cut) of a selected specimen onto the sticky side of the tape.
10. Once slides are finished, demonstrate how to place the slide on the stage, directly over the hole above the eyepiece. Explain to students that the Lumarod (light rod) picks up the light in the room, so for the best lighting they need to position the Magiscope's light rod toward the window or other light source.

11. Direct students to note that the eyepiece lens is 5X and the objective lens is 4X. Students should look through the eyepiece and slide the body tube up or down to move the objective gradually until the specimen on the slide comes into view.

    Remind students that the object sample will come into focus when the objective is very close to the stage but use caution not push the objective into the stage. Each student should have an opportunity to adjust and focus the microscope as they observe their slides. After each student has observed their own slides, allow them to share their slides among their group.

12. Have students draw their observations of all four objects on the "Magnification Observations" sheet in the 20X row.

Further information about magnification, refraction, microscopes and microscopy, including free, downloadable PowerPoint™ slides for classroom use, is available at www.bioedonline.org/. Look under the Slides > Content Slides > Tools and Techniques or Videos > Content Presentations > Tools and Techniques.

13. Once all students have observed all four objects under 20X magnification, tell students that they will be able to study the objects at a higher magnification. Next, distribute the 10X eyepiece and have students carefully place it into the opening of the body tube with the magnification number facing up. Remind students that the total magnification or power of the microscope is now 40X (10 x 4= 40X). Have students draw their observations of all four objects on the student sheet in the 40x row.
14. To increase the microscopes magnification power to 50X, ask, *What eyepiece and objective combination do you need to make observations at 50X?* They should replace the 10X eyepiece with the 5X eye piece and use the 10X objective lens. Have students observe all items under this magnification and draw the student sheet in the 50X row.
15. Ask student, *What is the highest magnification we can achieve with the eyepiece and objective available?* 100X using the 10 objective and 10 eyepiece. Instruct students to make the changes to the microscope and observe all items under this magnification and draw their observations on the student sheet in the 100X row.

Wrapping Up

Discuss students' observations. Ask students what other items they might want to observe with the Magiscopes.

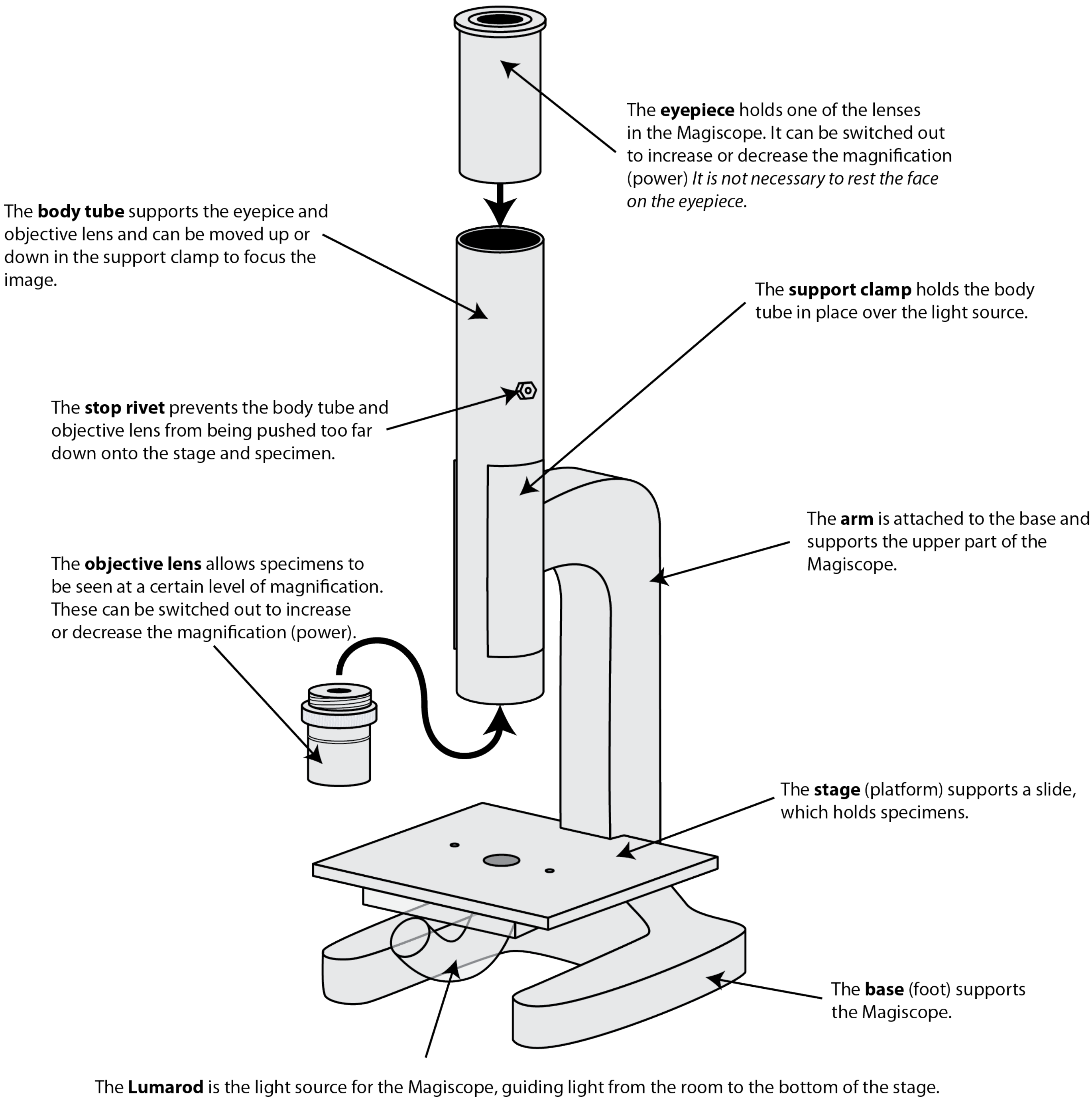
Extras

Encourage students to bring in other materials to observe for the next session. Explain that they will each make a slide for the rest of the class to try to identify.

Magnification Observations

Object	20X	40X	50X	100X
1 ______				
2 ______				
3 ______				
4 ______				

Magiscope® Microscope

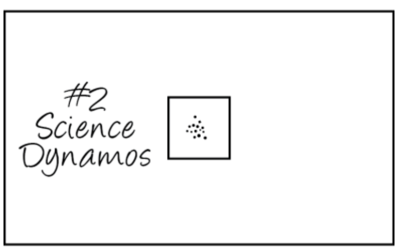


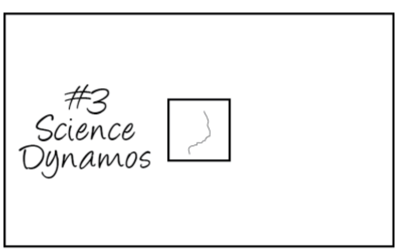
2) Exploring with the Microscope

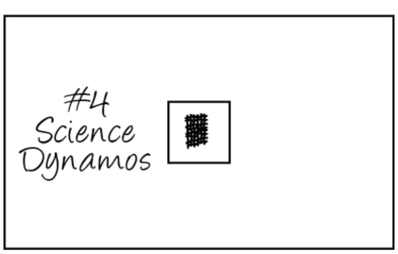
Making “Mystery” Slides

Time Needed
1 session

You Need This Stuff
Per Class
- Note cards
- Scissors
- Tape
- Selected materials
- Microscopes
- Copies of *Mystery Slide Investigations* sheet







What is it About?

Before the discovery of magnification the microscopic world was invisible. From the time of Aristotle there was a belief or supposition that “stuff” could be divided to near infinity – with there being an ultimately “small” particle, one that could not be seen.

Although Zacharias Janssen is credited with inventing the compound microscope, which has two lenses, Anton van Leeuwenhoek and Robert Hooke created the first microscopes that enabled viewing of the microscopic world. Though simple by today’s standards, these early microscopes allowed scientists to see tiny insects, plant cells, bacteria and protozoans for the first time. Hooke was the first person to use the word “cell” in biology. Van Leeuwenhook perfected the process for making glass lenses. He also made detailed observations of tiny organisms never seen before, and was the first person actually to see bacterial cells. Over the course of his lifetime, he made more than 400 microscopes by hand.

What’s The Question?

What do you notice about a specimen observed as the power of magnification increases?

Before You Start

Collect materials for students that may not have remembered to bring in a specimen and/or go outside with students to collect specimen for their slides.

What To Do

1. Remind students of how they made the note card slide and explain that they each have the opportunity to create another of their choice. They will challenge another team to identify the material on their slides.
2. Student teams will create a set of 4 slides, labeled 1-4 and include their group number or group name.
3. Each team member will choose something to place on their slide, for example a piece of grass, a leaf, dirt or sand, egg shell, or pencil lead.
4. Groups will examine their slides and answer the questions on the “Mystery Slides Investigation” student page, beginning with the one each individual created and then reviewing others.
5. Next, after each group’s four slides have been examined, they will trade with another group and repeat. If time permits, encourage students to view all the slides available and

record the possible identity of each specimen.

6. Ask, *Were you able to identify all the specimens?* Have each group share with the class the identity of their four specimens. Ask, *Were there any surprises?*

Wrapping Up

Show students photos from the Amazing Scanning Electron Microscope

http://www.youtube.com/watch?v=f37FQ1u2p8QTEXT

In order to download a YouTube video for use in your classroom:

1. Copy the YouTube video URL
2. Go to http://www.keepvid.com
3. Paste the copied YouTube Video URL into the box at the top.
4. Click download (ignore the other downloads and pop ups)
5. After a few seconds it will ask you what format and where to save the file.

Mystery Slides Investigation (1 of 2)

Group # or name ______________________

What do you see?

What does it look like? ____________________

____

What can it be? ________________________

____

What do you see?

What does it look like? ____________________

____

What can it be? ________________________

____

What do you see?

What does it look like? ____________________

____

What can it be? ________________________

____

What do you see?

What does it look like? ____________________

____

What can it be? ________________________

____

Mystery Slides Investigation (2 of 2)

What do you see?

What does it look like? ____________________

____

What can it be? ____________________

____

What do you see?

What does it look like? ____________________

____

What can it be? ____________________

____

What do you see?

What does it look like? ____________________

____

What can it be? ____________________

____

What do you see?

What does it look like? ____________________

____

What can it be? ____________________

____

3) Magnifying and Observing Cells

Looking at Onion and *Elodea* Cells

Time Needed
1 Session

You Need This Stuff
Per Class
- Sharp knife
- 1 white onion
- Several stalks of Elodea plant
- Computer with internet access
- Projector

Per Group
- Microscope
- 4 pairs of safety goggles
- 4 microscope slides
- 2 pairs of forceps
- 1/6 of an onion, vertical slice
- Small stalk of Elodea leaves
- Iodine solution in small portion cup
- Water in small portion cup
- 2 pipettes (droppers)
- Science notebooks or drawing paper
- 4 copies *Preparing and Viewing* student sheet

What is it About?

Every living thing is composed of cells, the microscopic building blocks of life. In fact, most life forms exist as single cells that carry out all functions needed for their own independent existence. Examples of common single-celled organisms are bacteria (tiny organisms found in almost every habitat on Earth), diatoms (algae that are common components of phytoplankton), and yeast (a kind of fungus). Multicellular organisms consist of several to many cells. Single-celled and small multicellular organisms that must be magnified to be observed are called microbes or microorganisms.

Plants and animals are examples of multicellular organisms visible to the naked eye. These macroscopic multicellular organisms can have up to trillions of cells that carry out specialized functions.

In this activity, students will observe onion cells (in the thin membrane around each onion layer) and a leaf from *Elodea, a water plant*. With these examples, students will be able to see basic plant cell parts, including the nucleus (structure in the center of the cell that holds genetic information), cytoplasm (gel that fills the cell), cell wall (rigid outer boundary of plant and other kinds of cells), and chloroplasts (large green structures in which photosynthesis occurs).

What's The Question?

What are cells? What are some characteristics of plant cells?

Before You Start

Load the PowerPoint® from the flash drive provided (or download from www.bioedonline.org). If you prefer to select your own images of a plant cell and animal cell, refer to the website listed in the "Extras" section of this activity. Do not have the images labeled or identified except on the last slide.

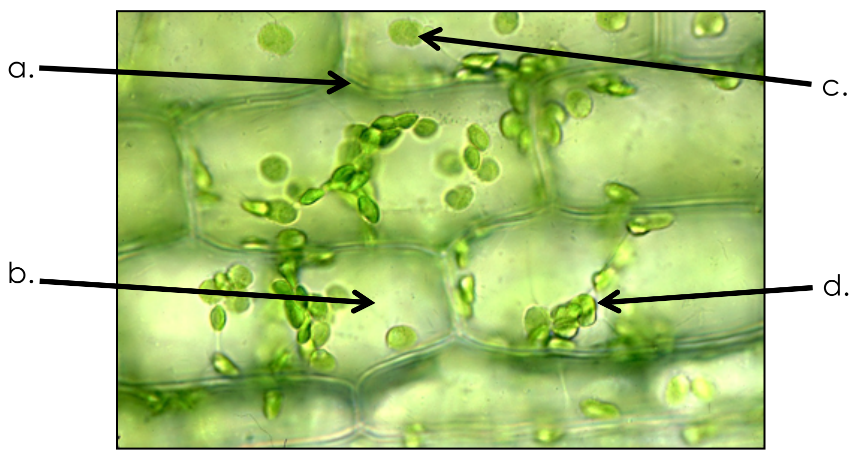
Make copies of the Preparing & Viewing Slides student page. Have students work in groups of two or four, depending on resources. Prepare a tray with all group materials and place in a central location. Optional: If Elodea is not available, new growth celery leaves may be substituted.

Portion out iodine into small cups for use by students.

Have students wear goggles when working with iodine, which is poisonous if ingested and can stain clothing permanently. Some students may be allergic to iodine. Methylene blue may be used instead of iodine, but it also can cause skin or eye irritation and should not be ingested. If skin is exposed to either stain, wash with soap and water. If stain gets into the eyes, rinse eyes with water for at least 15 minutes. Have students wash their hands before and after any lab activity.

What To Do

1. Show the activity PowerPoint® presentation to students. Do not tell them what they are looking at.
2. Ask, *What can you tell me about the pictures?* (cells) *Are there any similarities? Can you identify any parts?*
3. Explain that the images show different types of cells. Ask students, *What do you know about cells?* Have them work in groups to write down what they know and share. Mention that cells are the basic component of living organisms and that some life forms are only made of one cell (single-celled) and others are made of many (multicellular).
4. Show the final slide, an image of a plant cell with the following labeled parts on the PowerPoint. (see photo below)
    a. Cell wall – strong wall outside of a plant cell that provides support
    b. Cytoplasm – the gel-like content in a cell
    c. Nucleus – a structure in the cell containing genetic material
    d. Chloroplast – a small structure that contains a green substance called chlorophyll which is involved in photosynthesis



5. Explain that these and other structures cannot be seen without magnification. Tell students that they will be making their own slides to observe plant cells.
6. Point out that they will look for similar structures in their specimens.
7. If necessary, review microscope use with all students before preparing slides.
8. Have students work in groups to make their slides by following the instructions on the Preparing & Viewing student sheet or demonstrate the procedure.
9. Have students take turns observing and drawing the specimens (noting the magnification being used). Have students first examine the cells using low power (20X) and then switch objectives or eyepieces to achieve higher power. Remind them of the cell parts discussed in step #4. Instruct students to make detailed drawings and to label any cell parts that are recognizable. Tell students that some parts of a cell may not be visible when viewed under a microscope.

    Note: Have students determine the total magnification by multiplying the power stamped on the eyepiece (for example, 10x) by the power of the objective.

10. Students usually will be able to observe the cell nuclei in the stained onion skin cells. They also should be able to observe cell walls and cytoplasm in both kinds of cells, and to identify chloroplasts in the *Elodea* cells.
11. Encourage groups to discuss what they observed. Ask, *Are all the cells about the same size? Could you see the nucleus inside all the cells? If not, why do you think this is the case?*

Wrapping Up

Discuss why the onion cells were not green like the Elodea cells. Remind students that photosynthesis, the process that converts water and carbon dioxide into sugar using sunlight, occurs in plant leaves. The onion bulb has a different function than the leaves. This plant part is found underground and stores energy for new growth. Ask students to think about what differences animal cells may have compared to plant cells. Revisit the PowerPoint and have students look at the structures of plant and animal cells and compare. They may notice that animal cells do not have green chloroplasts or cell walls.

Extras

Color images of cells used in this lesson may be viewed from the Kuhn Photo website at http://dkphoto.photoshelter.com/gallery/Microscopic-Plant-Cells/G00005l.MbuYRzEQ/C0000oyPxKwu0APU.

Preparing and Viewing Slides

ONION SKIN

A. Follow steps 1–3 below to prepare the slide for viewing.
    1. Using a pipette or dropper, place one drop each of water and iodine in the center of a slide.
    2. Carefully remove a small, thin, transparent section of skin from the onion's inside layer. Use forceps to place the skin on top of the drops.
    3. Slowly place another slide over the skin and drops, trying not to squeeze any liquid out of the slides.

B. To examine the onionskin with a microscope, follow the steps below.
    1. Place the slide on the microscope stage.
    2. Focus the low-power magnification (20X) to find an area of the slide that has some of your sample. Avoid bubbles (clear circles with heavy black borders).
    3. Once you have found a section with onionskin, examine the cells. Center the object in the field of view. Change to a medium-power (50X) or high-power magnification (100X).

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

D. Record the magnification at which you made your observations.

ELODEA LEAF

A. Follow steps 1–3 below to prepare the slide for viewing.
    1. Using a pipette or dropper, place one drop of water in the center of a slide.
    2. Carefully remove a small, thin leaf from the plant. Use forceps to place the leaf on top of the drop.
    3. Slowly place another slide over the leaf and drop, trying not to squeeze any liquid out of the slides.

B. To examine the leaf using the microscope, follow the steps below.
    1. Place the slide on the microscope stage.
    2. Focus the low-power magnification (20X) to find an area of the slide that has some of your sample. Avoid bubbles (clear circles with heavy black borders).
    3. Once you have found a section with leaf sample, examine the cells. Center the object in the field of view. Change to a medium-power (50X) or high-power magnification (100X).

C. Draw what you observe and label any parts you recognize. (Note: The Elodea leaf has two layers that can be observed separately by slowly changing the focus.)

D. Record the magnification at which you made your observations.

4) Observing Fungi

The Fungus Among Us

Time Needed
1 Sessions

You Need This Stuff
<u>Per Class</u>
- Head of purple cabbage
- Sharp knife
- 6 clear, heavy duty, re-sealable sandwich size plastic bags

<u>Per Group</u>
- Microscope
- Hand lens
- 5 ml dry yeast in small portion cup (Mystery solid #1)
- 5 ml sand in small portion cup (Mystery solid #2)
- 1 index card
- Scissors
- 8 cm of clear tape
- Clear, heavy duty, re-sealable sandwich size plastic bag, filled with raw, finely sliced purple cabbage
- 500 ml very warm water
- 250 ml beaker
- 3- clear plastic cups
- 50 ml vinegar in clear plastic cup
- 20 ml baking soda in small portion cup
- 10 ml sugar in small portion cup
- 8 cm masking tape
- 3 pipettes or droppers
- 5 ml measuring spoon (teaspoon)
- 6 coffee stirrers
- 8 slides

What is it About?

The world of microbes is extremely diverse. Although often confused as plants, fungi are distinctly unique and are classified in a separate kingdom. The most familiar fungi are mushrooms and molds. Many fungi are important decomposers within ecosystems. Unlike plants, fungi are unable to derive their own energy from the sun through photosynthesis; they must obtain energy from other organisms. When organisms utilize energy stored in food, oxygen from the environment is consumed and some carbon dioxide is released.

The fungi kingdom contains many multicellular and single-celled species. Yeasts are microscopic fungi that have numerous applications in food production, such as leavening in bread and fermentation in alcoholic beverages. Some kinds of yeast also cause diseases, such as diaper rash or thrush (a painful infection of the mouth and throat).

Students will observe that yeast cells give off carbon dioxide gas when sugar is used as food. Red cabbage "juice" is used as an indicator for the presence of carbon dioxide. Cabbage "juice," naturally purple, turns bright pink in the presence of acids, such as the carbonic acid produced by dissolved carbon dioxide in water. It also turns blue when a base substance is introduced.

What's The Question?

Are yeast cells alive? What do yeast cells look like under the microscope?

Before You Start

Make sure that the microscope magnification is preset at 100X using the 10X eyepiece and 10X objective lens. Finely chop purple cabbage and place a handful in a re-sealable bag for each group. Prepare portion containers with baking soda and sugar and a larger cup with 50 ml vinegar. To create mystery items, place 5 ml of sand and 5 ml of dry yeast into separate small portion cups labeled #1 (yeast) and #2 (sand) for each group of students. Place all material on a tray in a central location

What To Do

1. Have a designated student collect the materials for their group.

2. Instruct students to make observations of mystery solid #1 and mystery solid #2 with a hand lens.

3. Next have students make observations of the mystery solids by preparing slide of each solid using an index card cut into fourths (see activities 1 and 2) to examine under the microscope at 100X. Ask students to compare and contrast the two mystery solids. Ask, *How are they alike and different*. Encourage students to share their ideas.

4. Explain that one of the mystery solids is a living microbe and it is their task to discover whether it is solid #1 or #2. Remind students that all living organisms have basic needs. Discuss that this mystery microbe is presently dormant but with a food source will begin reproducing. In this investigation they will use sugar as the food source for both mystery solids to discover which one is actually a living microscopic organism.

Scanning electron micrograph of *Penicillium* producing chains of spores. *Penicillium* is the fungus from which the antibiotic penicillin is derived.

(source: Wellcome Images, David Gregory & Debbie Marshall)

5. Direct the students to label two clear plastic cups as #1 and #2 using small pieces of masking tape. Have students add approximately 125 ml warm water to each cup. Then add 5 ml of mystery item 1 to cup #1 and the same amount of mystery item 2 to cup #2. Ask, *What do you think will happen if we add sugar to both of the cups?* Have students discuss their predictions.

6. Have one person in each group add 5 ml of sugar to one of the cups. He or she should swirl or stir the cup gently. Then have another student add 5 ml of sugar to the second cup and stir or swirl gently.

7. Direct the groups to set the cups side-by-side and to observe both cups at 5 minute intervals. The yeast in the cup with sugar will begin to produce CO_2 (making the liquid foamy) after a short period of time. Students should stir the cups (with separate stirrers) each time they make their observations. They may draw and label the cups at the timed intervals. Discuss any changes observed. Ask, *What do you think is happening?*

8. During the wait for the organisms to respond, remind students that when many organisms, including humans, take in nutrients, they release carbon dioxide gas. When carbon dioxide is added to water, the chemistry changes, making the water more acidic. We can test for acids by using an indicator. Tell students purple cabbage water will be used in this activity as the indicator to detect whether a solution is an acid or base. Ask students what they know about acids and bases. You can explain that vinegar is a weak acid. Ask, *Where is vinegar used?* Pickles, salad dressing, etc. Explain that baking soda is a base. It neutralizes acids. People used to take baking soda when they had stomach aches caused by the acid produced in the stomach.

9. Explain that to make the indicator the students will place 250 ml of very warm water in the bag with the cabbage and seal the bag tightly. Direct students to take turns, gently kneading the cabbage inside the bags until the water becomes dark purple (usually about 10–15 minutes). This is the indicator solution.

10. Ask students to pour about 50 ml of indicator solution into a clear cup. Ask, *What color is the liquid? What do you think will happen if you put something acidic into the solution?* Instruct them to add about 5 ml of vinegar to the solution. Have students continue to add vinegar in 5 ml increments until the solution changes color. Ask, *What is happening?* In a base solution the water turns green to blue while in an acid solution the cabbage water turn shades of pink.

11. To change the indicator solution from acid to base, have students add about 5 ml of baking soda. Have students continue to add baking soda in 5 ml increments until the solution turns pale blue or green. This demonstrates how the indicator solution reacts to bases. Explain to students that they will

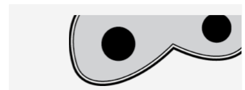
be using the indicator solution to test for the presence of carbon dioxide (CO_2), a gas that is given off when living things use food for energy, with their two mystery solutions.

12. When change is relatively evident by the foam on top of the container with the yeast. Instruct students to first predict what will happen. Ask, *Will there be a color change? If so, what color will we observe?* (Pink)

13. Instruct students to pour 20 ml of the cabbage juice into each mystery solution and stir. They should observe a color changes. Have students record their observations. (Cup #1, with yeast, will be pink while cup #2 will remain purple)

14. Ask, *Which mystery solid was a living organism?* Explain that when given the right conditions, the yeast, a living, microscopic single-celled organism begins to grow and multiply. Help students understand that the yeast cells were using the sugar as a source of energy. Make sure students understand the gas given off by the yeast, which caused the bubbles, is carbon dioxide. You may want to mention how it is used to make bread rise.

15. Now that students know which container holds yeast, ask students, *What do you think growing yeast cells look like?* Will they look different than the first observation? How can we determine for sure? Guide students to realize that they can observe yeast under the microscope. The yeast will often have buds.


Yeast with bud

16. Show students a slide and explain that it will be used to help them focus on one drop of yeast culture (mixture). Mention that each student in the group should prepare a slide for the whole group to observe. Demonstrate how to make a slide by using a pipette or dropper, and placing a small amount of yeast culture on the center of the slide, then placing a second slide over it. Ask the groups to create their own.

17. Tell students that they will now look at the yeast slides under 100X magnification. Ask, do they look any different than before they were growing?

18. Ask students, *What did the yeast cells look like?* Mention that the round shapes they observed are typical of yeast. Also point out that yeast reproduce by a process of division called budding. They may observe yeast cells that are budding.

Wrapping Up

Have students create bread dough using rapid rise yeast to shorten the amount of time need for the dough to rise or "proof". Proofing allows the yeast to undergo a process called fermentation, where sugars and other carbohydrates are broken down and carbon dioxide gas is released. This causes the dough to rise and when baked, gives the bread the characteristic spaces inside. The dough can be baked later and brought back for student to sample if desired. One recipe can be found at the following link: http://www.breadworld.com/Recipe.aspx?id=235

For additional information about baking yeast, visit www.breadworld.com. One section is devoted to the science of yeast.

Extras

The fungi kingdom includes many organisms, some not microscopic, like mushrooms and molds. Students may be familiar with these decomposers. This could include the mold on bread or a piece of fruit or the "fairy ring" of mushrooms that often grows on lawns, especially during damp seasons. Students may want to observe the stems of mushrooms, as another look at a different type of fungi. They could also prepare slides to view under the microscope. Make sure you use mushrooms from the grocery store and do not collect mushrooms from natural sites, as many are poisonous.

5) Observing Different Microbes

What's in a Drop of Pond Water?

Time Needed

1 Session for observations
1 Session to research and complete pond water drop mural

You Need This Stuff

Per Class

- Blue bulletin paper circle, 150 cm in diameter

Per Group

- 4 magnifiers
- Microscope
- 4 sets of gloves
- 4 goggles
- 4 pipettes or droppers
- 4 microscope slides
- 50 mL of pond water in clear plastic cup
- 4 index cards
- colored pencils
- Small portion cup with glycerin

Per Student

- 4 sheet of blank paper for graphic organizer

What is it About?

Microbes are organisms too small to be seen with the naked eye. There are enormous variations in the kinds and sizes of microbes. A drop of pond water can potentially contain thousands of organisms. Some are single-celled while many are multicellular. One group of microbes that can be found in pond water includes large eukaryotic (containing DNA within nucleus) microorganisms called protists. Some protists are "plant-like", undergoing photosynthesis to make their own food (autotrophic). Others are "animal-like", consuming other microbes for energy (heterotrophic).

Protist are an extremely diverse, informal group of microorganisms that vary in size and structure. Some are microscopic, some are single-celled, and some are multicellular. Each cell has a cell membrane, a well-defined nucleus, and organelles. Some have cell walls. Recent classifications assign different protist groups to several separate kingdoms within the domain Eukarya. The following three groups of protists often are recognized informally.

- **Algae -** Plant-like; single-celled or multicellular; contain chloroplasts; autotrophic (able to carry out photosynthesis).
- **Protozoa -** Animal-like; always single-celled; no cell walls; often motile; absorb nourishment from the environment by feeding on prey or surviving as parasites (heterotrophic).
- **Water and Slime Molds -** Fungus-like; single-celled or multicellular; absorb nourishment from the environment (heterotrophic).

Most protists are harmless but a very small percentage cause diseases to humans. Malaria is caused by a parasitic protozoan, which is carried from person to person by certain kinds of mosquitoes. African sleeping sickness, or trypanosomiasis is caused by another type of protozoan called Trypanosoma. Cryptosporidium and giardia infect humans usually from contaminated water and causes stomach disorders.

What's The Question?

What are some different types of microbes found in pond water and what can you observe about them using a microscope?

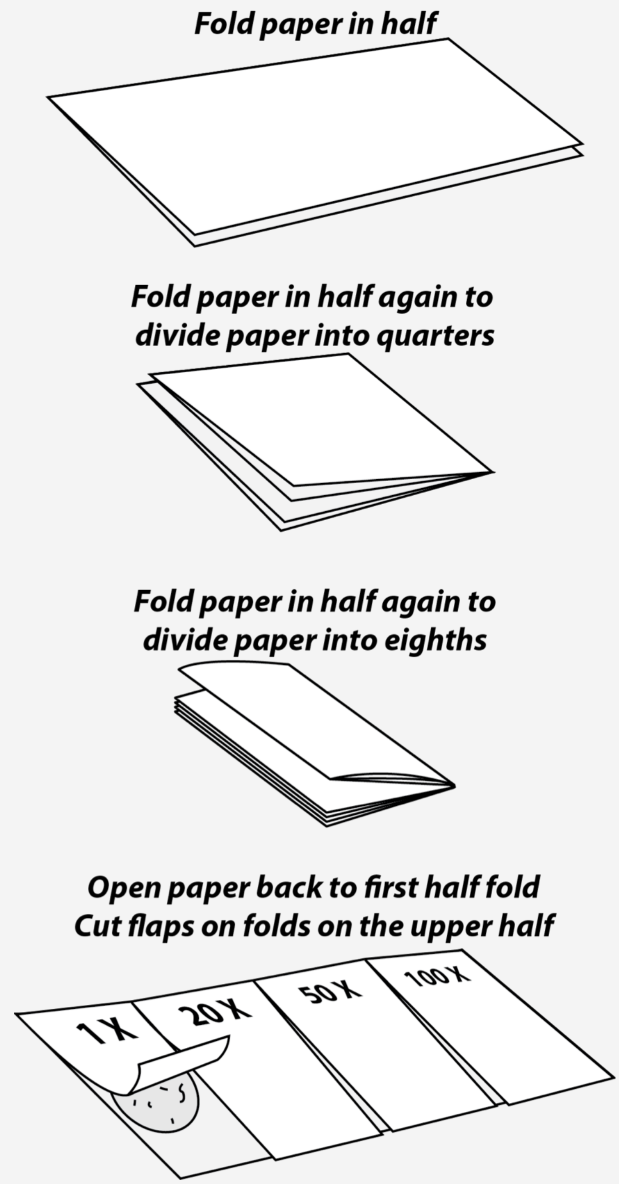
Before You Start

Place 50 ml of pond water collected from a pond or drainage area into a container for each group of four. Place materials for each group in a central location.

What To Do

1. First, have students create a graphic organizer using a sheet of 8.5-in. X 11-in. paper to record their observations. Tell students to hold a sheet of paper so that the longer side is facing up. Next, have the students fold the sheet in half, creasing the fold. Then fold the paper into fourths horizontally. Open the paper back up to the previous step and you should see three creased lines. Take scissors and cut through the lines only on the top layer. Four flaps will be created. Mark on the first flap, "None." On the next flap, write "20X", then "50X" and on the last flap, write "100X". Students will draw their observations on the area directly under the flap that corresponds to the magnification used.
2. Give each group of students a clear cup containing 50 mL of pond water and four magnifiers. Prompt students to examine it closely. Ask, *What do you see?* Hopefully there will be tiny moving organisms. Ask, *Where do you think this water came from and what might be in the water?*
3. Next explain to students that they will be examining the water more closely using a microscope. To prevent contact with any potential disease-causing microbes, provide students with gloves and goggles and have them wash their hands before and after the activity.
4. Show students a slide. If using glass, discuss carefully handling. Explain that it will be used to help them focus on one drop of pond water. Mention that each student in the group should prepare a slide for the whole group to observe. Demonstrate how to make a slide by using a pipette or dropper, and placing a small amount of pond water on the center of the slide. If available, use a document camera. Ask the groups to create their own. Have designated student pick up tray of materials. Then have each student follow your directions.
5. Next instruct students to carefully add one <u>tiny</u> drop of glycerin to the pond water drop on the slide. This will slow the movement of microorganisms so that they are easier to observe.
6. Tell students to observe the slides with their eyes only. Ask, *What do you see in the drop of pond water?* Have the students draw on the graphic organizer under the "None" flap what they see in the entire drop. Drawing will vary, but some may be able to see small organisms like mosquito larva and other organisms.
7. Have the students place the slide under the microscope using the 4X objective lens and 5X eyepiece. Remind students that the power is the product of the objective lens times the eyepiece. In this case, the eyepiece is 4X and the objective is 5X, so the total power or magnification is 4 X 5 = 20X magnification. Have students observe using the microscope and draw their observations on the 20X magnification flap.
8. Ask students, *If we magnify the pond water even more, what might we observe that we didn't see earlier?* Instruct students to use the 50X magnification. (Reminder: To do so, tell them to carefully unscrew the 4X lens and replace it with the 10X lens. Remind student to handle the objective lenses carefully,

<u>How to fold the graphic organizer</u>



particularly avoiding the glass lens itself.) Have students use color and draw with greater detail under the 50X magnification flap.

9. Next have students observe the pond water under 100X magnification and draw under on the 100X magnification flap.
10. As students examine all four drawings, discuss some of the similarities and differences among their drawings. The results should include that the greater the magnification the greater the detail that could be observed.
11. Have students select one organism they observed and research online using the following website:

    http://www.microscopy-uk.org.uk/index.html
12. Instruct students to try and identify the microorganism and draw it on and index card with some interesting facts recorded inside the organism. Then cut out the organism.
13. As a class, have students create a large pond water microbe mural using all of the organisms created. Students will tape their organisms on a 150 cm blue circle which models the drop of water.

Wrapping Up

Have students share the types of organisms they observed. Have students compare their drawings to the cells of plants (onion and *Elodea* plant) they observed in the previous lesson. Point out the similarities such as the shape and structures in some of the microbes they see in the pond water to the plant cells. Ask, *Did some microbes seem similar to plants? Were others more animal-like and did some microbes not fit in either category?*

Extras

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.

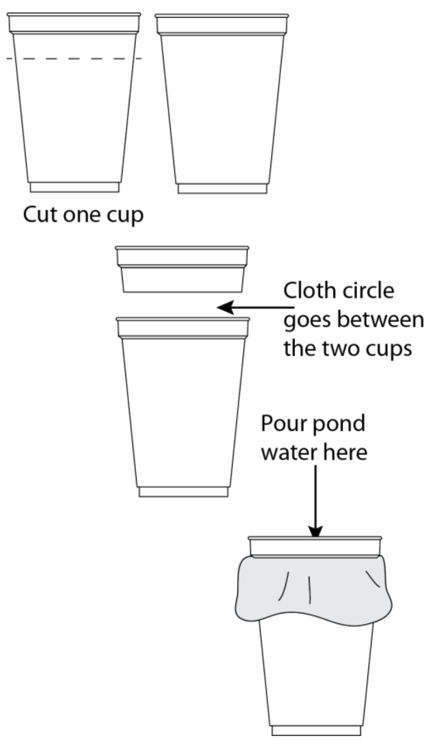
The Virtual Pond Dip presents information using graphic interface that is fun for beginners of any age.

6) Can You Clean the Water?

Filtering Out Microbes

Time Needed
1 Session

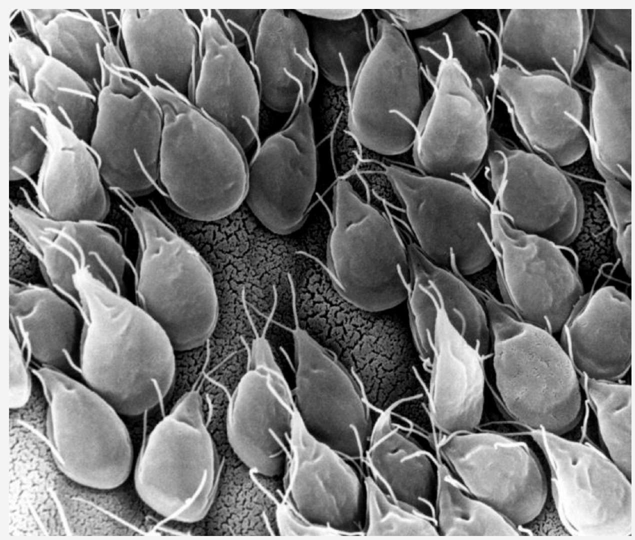
You Need This Stuff
Per Group
- 400 ml of pond water
- Microscope
- 4 slides
- Glycerin
- Eye dropper or micropipette
- 6 Styrofoam coffee cups
- 6-in. X 6-in. fabric squares, one each of
  - Cheese cloth
  - Chiffon
  - Muslin
- Scissors
- Gloves
- Eye protection



What is it About?

Students have learned that, in the previous activity, pond water is a universe of microbes. While most microbes are harmless, some are carriers of infectious diseases.

One especially nasty microbe is giardia, a parasitic protozoan that causes giardiasis. Giardia is picked up by ingesting or coming in contact with food, water, or soil that has been tainted by the feces of an infected animal. The microbe colonizes the small intestine of the victim. The symptoms of giardiasis appear 1-3 weeks after infection. They include violent diarrhea, excess gas, abdominal cramps, and nausea. Often, a few days later, constipation and excess gas occurs, producing more cramps.



Giardia is a protozoan parasite.
http://phil.cdc.gov/PHIL_Images/8698/8698_lores.jpg

Hikers and backpackers will occasionally contract giardia by drinking from streams and other back country water sources. Generally, outdoors people protect themselves by carrying their own water or bringing along a filter to screen out microorganisms from open water supplies. Filters are an effective safety measure. In areas where water purity is questionable, purification methods include filtering, boiling, and iodine treatment. In the first unit, students were challenged to create a simple water filter. Its effectiveness was judged by an examination of the clarity of the water produced. In this activity, students will judge filter effectiveness by microscopic before and after examination of pond water.

What's The Question?

Can cloth filters protect us from some infectious microbes?

Before You Start

Obtain pond water sample. Each team will need about 400 ml of pond water. Make an example of the coffee cup filter to show students how to make one.

What To Do

1. Ask students, *Would you want to drink the water you examined in the drop of water from the* Observing Different Microbes *investigation?* Of course not! Ask, *Do you think we can "clean" the water of the microbes?* Explain that they will be creating 3 filtering systems and use microscopes to examine the pond water before and after filtering.
2. Remind students of the water filters they created in the first unit. Explain that this time they will analyze their samples under a microscope to observe the changes in the water.
3. Exhibit a completed filter. Demonstrate how to make it. Show teams how to cut three cups to make the upper ring. The other three cups will serve as filter reservoirs.
4. Distribute 6 Styrofoam coffee cups, scissors, and fabric squares to each group.
5. Have teams assemble their filters. Each filter should have a different fabric sample.
6. Following the procedure of the previous pond water activity, have students prepare a pond water slide and study the microbes found in it. Have them make some sketches of what they observe in their notebooks. Teams should coordinate observations by having each team member sketch a different microbe, if possible.
7. When teams have completed their initial examinations and recorded their observations in their notebooks, have them gently pour 1/3rd of their pond water supply into the first water filter. Repeat by pouring the remaining water into the two other filters for a total of three treatments.
8. One treatment at a time, have teams examine the filtered water by preparing slides from each of the cups, then make sketches in their notebooks of what they see and compare the observations.
9. Ask, *Did the filter eliminate or change the water observations? Would you consider drinking the water after it is filtered? If so, which filter would you choose?*

Giardia and giardia infection on the small intestine of a gerbil.

Wrapping Up

If computers are available, have teams look for water filters used by outdoors people, soldiers, and people in countries that do not have good water supplies.

7) Modeling Mystery Microbes

Protist, Bacteria, Fungus, or Virus?

Time Needed
1 Session

You Need This Stuff
Per Teams of 6 Students

- 1 self-closing plastic sandwich bag
- clear tape
- ½ sheet clear transparency
- 1 piece of clear plastic wrap (same size as the transparency sheet)
- 1 small red bead
- 16 small green beads with hole
- 2 clear or semi-transparent balloons
- 1 (30 cm or 12 inch) piece of clear cellophane gift wrap
- 36 (11 cm or 4 inch) strands of sewing thread
- 5 small clear containers like pill capsules
- 1 translucent surgical glove
- 1/3 cup uncooked rice
- 2 small "star" stickers
- 2 green pipe cleaners
- 4 pipe cleaners (3 in one color, 1 in another)
- 1 pipe cleaner cut into 1.25cm (1/2 inch) pieces
- 1 metal washer, with hole at least ¼ inch in diameter
- 2 clear, small plastic drinking cups
- 46 cm (or about 18") of clear plastic wrap
- 96 cm (or about 24 inches) of black yarn
- Clay, 2 cm ball
- Copies of *Mystery Microbe Instructions* and *Microbe Identification Sheet*
- Copy of *Head Capsid* template on cardstock OR alternate template on transparency film

What is it About?

Microbes are organisms too small to be seen with the naked eye, yet they are abundant on Earth. They live everywhere—in air, soil, rock, and water. Some live happily in searing heat, while others thrive in freezing cold. Some microbes need oxygen to live, but others do not. These microscopic organisms are found in plants and animals, as well as in and on the human body. There are enormous variations in the kinds and sizes of microbes.

Most microbes have been categorized into one of four major groups: bacteria, viruses, fungi, or protists. Some microbes cause disease in humans, plants, and animals. Other microbes are essential for a healthy life. In fact, we could not exist without them. Indeed, the relationship between microbes and humans is delicate and complex.

Students will create models of each type of microbe, including common bacteria, viruses, fungi and protists. using a set of directions for each. Students will learn that microbes come in many shapes with many different characteristics.

Major Groups that Contain Microbes

BACTERIA – All members of this group are microscopic and single-celled, with a cell membrane and typically with a cell wall. Bacterial cells do not have a well-defined nucleus or organelles surrounded by membranes. Some bacteria are autotrophic and are capable of making their own food by using light energy (photosynthesis), or through other chemical reactions. Other bacteria are heterotrophic and must derive energy by breaking down organic material (food) that they obtain from their environments. Some bacteria are motile. Bacteria usually are rod-, sphere- or spiral-shaped. However, blue-green bacteria can clump together as green threads that look like algae.

FUNGI (rusts, molds, mushrooms, yeasts) – Members of this group have variable sizes. Some are microscopic, some are single-celled, and some are multi-cellular. Each cell has a cell membrane, a well-defined nucleus, and organelles (such as mitochondria) surrounded by membranes. Typically, fungal cells have cell walls. Fungi are not motile (capable of movement). They are heterotrophic and must obtain nutrients from their environments, often from dead or decaying materials. Yeasts are

> Cellular organisms are divided into two basic types, prokaryotic and eukaryotic, depending on the complexity of their internal structures. Eukaryotic organisms, such as protozoa, as well as higher plants and animals are highly structured. The cells tend to be larger than those of bacteria; have an organized nucleus surrounded by a membrane, and may even have an internal transport system to support their larger size. Prokaryotic cells, like those of bacteria, are much smaller, have a simpler design, no recognizable internal structures within the cytoplasm, and a rigid cell wall with a fluid membrane.

single-celled fungi. The bodies of larger fungi consist of threads (hyphae) that can be tangled loosely, as in bread mold, or packed tightly, as in the body of a mushroom.

PROTISTS – Members of this extremely diverse, informal group vary in size and structure. Some are microscopic, some are single-celled, and some are multicellular. Each cell has a cell membrane, a well-defined nucleus, and organelles (any of a number of organized or specialized structures within a living cell). Some have cell walls. Recent classifications assign different protist groups to several separate kingdoms within the domain Eukarya. The following three groups of protists often are recognized informally.

- **Algae** – Plant-like; single-celled or multicellular; contain chloroplasts; autotrophic (able to carry out photosynthesis).
- **Protozoa** – Animal-like; always single-celled; no cell walls; often motile; absorb nourishment from the environment by feeding on prey or surviving as parasites (heterotrophic).
- **Water and Slime Molds** – Fungus-like; single-celled or multicellular; absorb nourishment from the environment (heterotrophic).

VIRUSES – All members of this group (which is not part of a kingdom or domain) are microscopic. Individual particles consist of genetic material (DNA or RNA) encased in a protein coat (which is not equivalent to a cell membrane or cell wall). Viruses must invade living cells to make copies of themselves.

What's The Question?

What are the external and internal features of several different kinds of microbes?

Before You Start

Make copies of the student sheets. Place materials for building the organisms in bag or container and place in a central location.

What To Do

1. Explain that after viewing several pond organisms in the last activity, students will be creating models of four types of microbes, including inner and outer structures.
2. Remind students that they were able to view the overall shape of several organisms, but were not able to get much detail regarding the internal structures. Explain that they will be following a set of instructions to build an organism from the inside out.
3. Divide students into teams of 6. Give each team a set of *Mystery Microbe Instructions* student sheets and either the transparency film *Head Capsid* template or cardstock *Head Capsid* template.

   Note: While the transparency film allows the genetic material to be visible in the model, some students may find this template and material more difficult to cut and to fold than the cardstock version.
4. Tell the members of each group that they are responsible for making all six mystery organisms and completing the accompanying microbe chart. For some models they will need to work together.
5. After all the model microbes have been built, distribute the *Microbe Identification Sheet*. Instruct student groups to share the information and identify each as a fungus, protist, bacterium or virus, and explain the reasoning. If students have questions as they try to categorize the organisms, encourage them to do further research on the internet.
6. After each group has identified its model microbe, have each group display its model as one student form the group reads the microbe card to the entire class. If there is disagreement regarding a classification, have the student or teams explain their reasoning and come to a correct conclusion.
7. Ask, how were the models alike, different? Did they all have cell walls, nucleus, genetic material, appendages for motility, or movement? Were there any surprises? Remind students that these are only a few examples of the millions of microbe that exist everywhere on Earth and possibly beyond.

Wrapping Up

Show the students pictures or videos of similar microbes online.

<u>Answers</u>

Mystery Microbes
Microbe 1- Euglena
Microbe 2 – Spirogyra (Green algae)
Microbe 3 – Baker's Yeast
Microbe 4 – Amoeba
Microbe 5 – Virus
Microbe 6- Bacterium (e-coli)

Extras

- It can be difficult to imagine the relative sizes of microbes. CELLS alive! has a useful animation to help students visualize and compare the sizes of different microbes on the head of a pin. The animation may be viewed or downloaded for single use or for use in a classroom at www.cellsalive.com/howbig.htm.
- Blown glass microbes http://www.dvice.com/2013-2-3/microbes-are-surprisingly-beautiful-rendered-blown-glass
- For a discussion about how viruses work and view examples of virus images, see the presentation and slide set, produced by the National Center for Macromolecular Imaging, entitled "Viruses," at www.bioedonline.org/.

Microbe Identification Sheet

<u>Bacterium</u>
Consists of a single cell
No nucleus
No organelles surrounded by a membrane
Has cell wall
Contains DNA (genetic material)
Flagella for movement
Surrounded by a cell membrane
Usually rod-, sphere- or spiral-shaped

<u>Protist (Protista)</u>
Surrounded by a cell membrane
Has an organized nucleus surrounded by a membrane
Consists of one or multiple cells
Has organelles (specialized structures surrounded by a membrane)
Contains DNA (genetic material)
Plant- or animal-like
Plant-like protists have chlorophyll
Sometimes have structure for mobility
May have cell wall

<u>Fungi</u>
Surrounded by a cell membrane
Has an organized nucleus surrounded by a membrane
Consists of one or multiple cells
Variable size
Has organelles (specialized structures surrounded by a membrane)
Contains DNA (genetic material)
Cell wall made of chitin
Lives by absorbing nutrients from living or decaying organisms

<u>Virus</u>
Tiniest of all microbes
Does not have a cell wall, cell membrane or nucleus
Surrounded by a protein coat
Genetic material is present as DNA or RNA
Must invade a living cell in order to make copies of itself

Mystery Microbe 1

1. Make a MODEL of a microbe using the labeled drawing as a guide.
2. You must use all of the following materials:
   1 self-closing plastic sandwich bag
   8 – 12 small green beads
   1 small red bead
   clear tape
   6 (11 cm or 4 inch) strands of sewing thread – 2 stands of each of 3 colors
   15 cm (or about 6 inches) of black yarn
   1 empty clear pill capsule
3. Study the diagram and decide what each of the materials listed above will represent. For example, the small plastic bag is the cell membrane (all structures except the flagella will be inside the bag).
4. After you have assembled your microbe, complete the chart below.

Microbe structure	Model material	Function of structure
Cell membrane	1 plastic bag	Controls passage of materials in and out of cell
Genetic material		DNA which makes up the genes (instructions for all parts and functions within an organism)
Nuclear membrane		Surround and protect DNA
Flagellum		Movement
Chloroplasts		Photosynthesis (use sun's energy to produce sugar)
Red eye spot		Helps detect light for photosynthesis

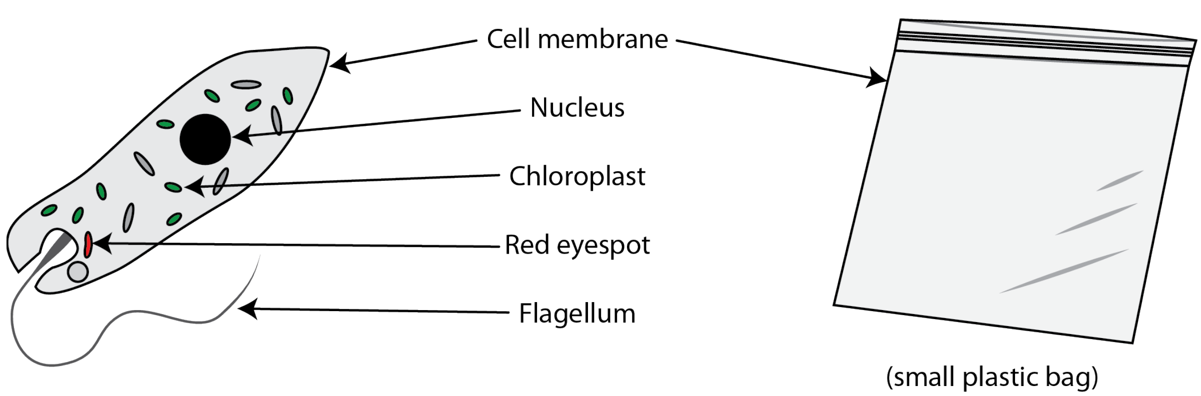
5. Obtain the 4 "Organism Cards." Read each carefully. Decide which type of organism your model organism represents.
   Type of organism______________________________

   Using key characteristics or structures, explain your decision:

   ____

   ____

   ____



Mystery Microbe 2

1. Make a MODEL of a microbe using the labeled drawing as a guide.
2. You must use all of the following materials:
   ½ sheet clear transparency
   1 piece of clear plastic wrap (same size as the transparency sheet)
   8 – 12 small green beads with hole
   2 green pipe cleaners
   clear tape
   6 (11 cm or 4 inch) strands of sewing thread – 2 stands of each of 3 colors
   1 empty clear pill capsule

3. Study the diagram and decide what each of the materials listed above will represent. For example, you will fold the transparency into a cylinder.
4. After you have assembled your microbe, complete the chart:

Microbe structure	Model material	Function of structure
Cell membrane	plastic wrap	Controls passage of materials in and out of cell
Cell wall		Protection
Genetic material		DNA which makes up the genes (instructions for all parts and functions within an organism)
Nucleus		Contain genetic material (DNA)
Chloroplasts		Photosynthesis

5. Obtain the 4 "Organism Cards." Read each carefully. Decide which type of organism your model organism represents.

Type of organism______________________________

Using key characteristics or structures, explain your decision:

____

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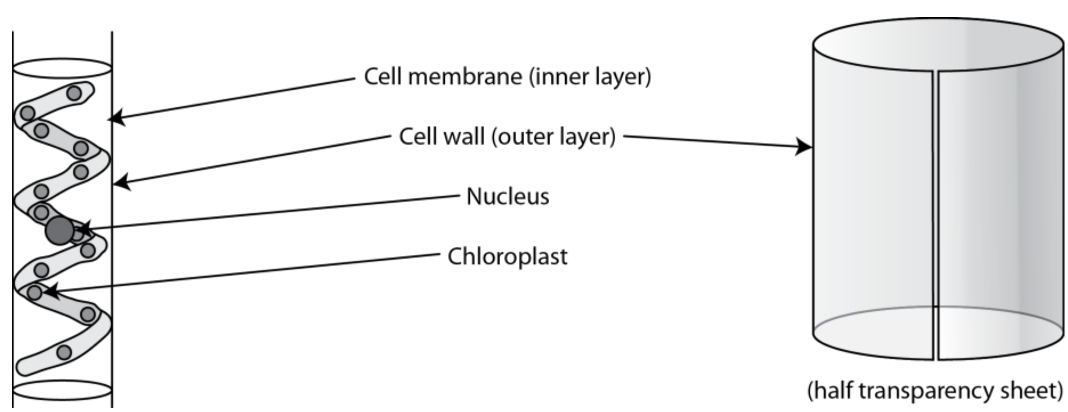


Mystery Microbe 3

1. Make a MODEL of a microbe using the labeled drawing as a guide.

2. You must use all of the following materials:
   2 clear or semi-transparent balloons
   1 (30 cm or 12 inch) piece of clear cellophane gift wrap
   clear tape
   12 (11 cm or 4 inch) strands of sewing thread – 4 stands of each of 3 colors
   2 empty clear pill capsules

3. Study the diagram and decide what each of the materials listed above will represent. For example, the main body of the organism will be made from 1 balloon. This organism produces "buds" that will be form new organisms—use the second balloon as a bud.

4. After you have assembled your microbe, complete the chart:

Microbe structure	Model material	Function of structure
Cell membrane	balloon	Controls passage of materials in and out of cell
Cell wall		Protection
Genetic material		DNA which makes up the genes (instructions for all parts and functions within an organism)
Nucleus		Contain genetic material (DNA)

5. Obtain the 4 "Organism Cards." Read each carefully. Decide which type of organism your model organism represents.

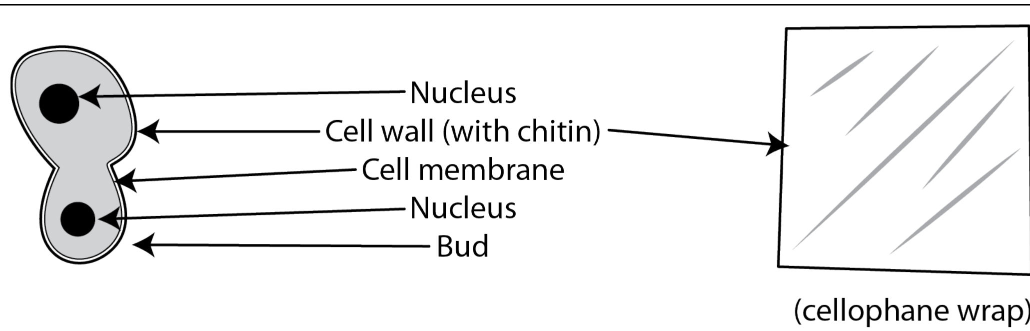
Type of organism______________________________

Using key characteristics or structures, explain your decision:

____

____

____



Mystery Microbe 4

1. Make a MODEL of a microbe using the labeled drawing as a guide.

2. You must use all of the following materials:
   1 translucent surgical glove
   1/3 cup uncooked rice
   2 small "star" stickers
   6 (11 cm or 4 inch) strands of sewing thread – 2 stands of each of 3 colors
   1 empty clear pill capsule

3. Study the diagram and decide what each of the materials listed above will represent. For example, the glove is the cell membrane (all structures will be inside the glove).

4. After you have assembled your microbe, complete the chart:

Microbe structure	**Model material**	**Function of structure**
Cell membrane	Latex glove	Controls passage of materials in and out of cell
Cytoplasm (grainy)		Everything inside the cell except the nucleus
Genetic material		DNA which makes up the genes (instructions for all parts and functions within an organism)
Nucleus		Contain genetic material (DNA)
Contractile vacuole		Collect and eliminate excess water in the cell

5. Obtain the 4 "Organism Cards." Read each carefully. Decide which type of organism your model organism represents.

Type of organism_____________________________

Using key characteristics or structures, explain your decision:

____

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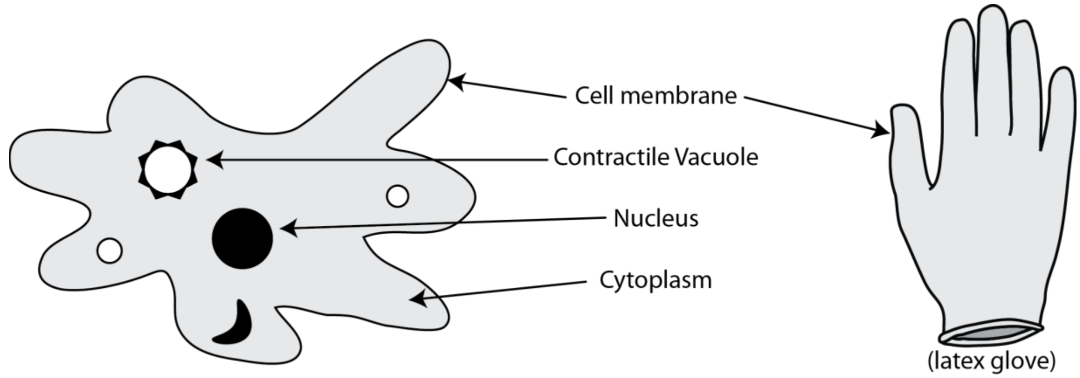
____



Mystery Microbe 5

1. Make a MODEL of a microbe using the labeled drawing as a guide.

2. You must use all of the following materials:
   1 Head capsid (see instruction sheet)
   4 pipe cleaners (3 in one color, 1 in another)
   1 Piece of yarn, at least 20 cm
   1 metal washer

3. Study the diagram and decide what each of the materials listed above will represent.

4. After you have assembled your microbe, complete the chart:

Microbe structure	Model material	Function of structure
Head capsid	Folded from template on cardstock	Holds nucleic acid until injection into a cell
Tail		Supports the head and the tail fibers, flexes to inject nucleic acid
Genetic Material		DNA or RNA which contains instructions for all parts and functions. It is stored in the head capsid until injection
Base plate		Sits at the base of the tail, acts as the point through which the genetic material enters into a cell
Long Tail Fibers		Attaches the microbe to a cell, pulls base plate of tail into cell for nucleic acid injection

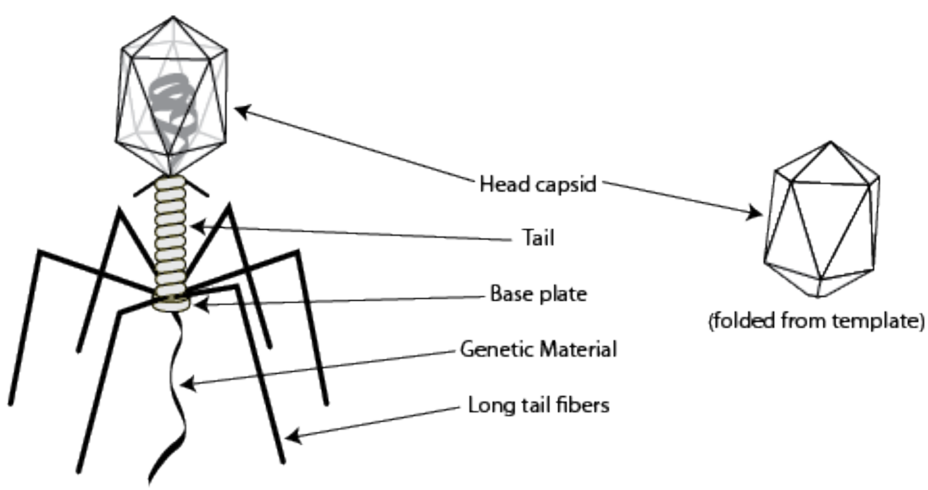
5. Obtain the 4 "Organism Cards." Read each carefully. Decide which type of organism your model organism represents.
   Type of organism______________________________

   Using key characteristics or structures, explain your decision:

   ____

   ____

   ____

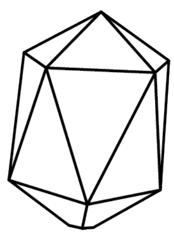


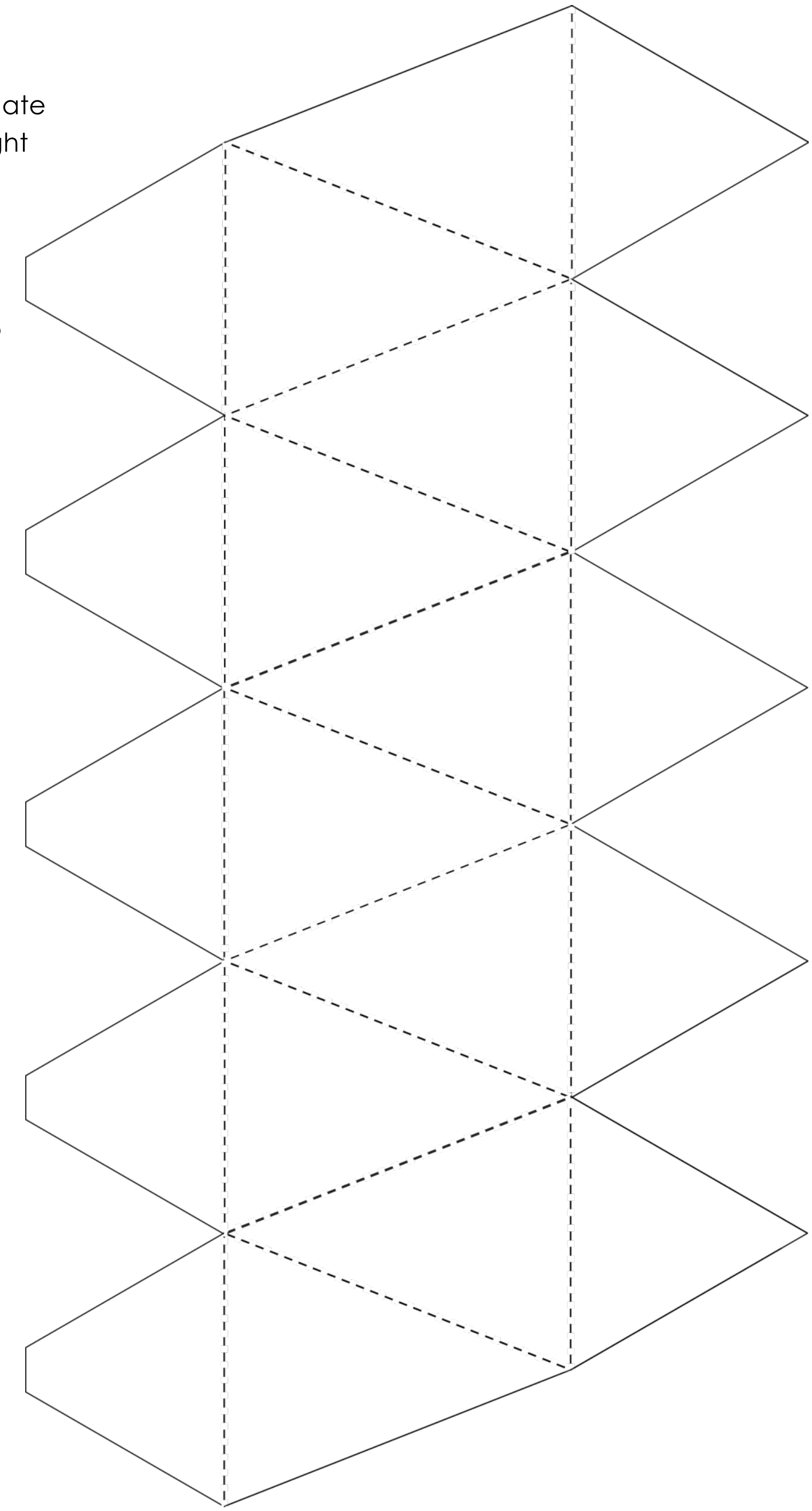
Mystery Microbe #5, Head Capsid Template
(for cardstock)

Instructions

1. Carefully cut out the template along the outer, solid straight lines
2. Color the pieces, if desired
3. Score and fold along the dotted lines
4. Use small pieces of tape to join edges together

Assembled shape



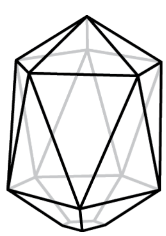


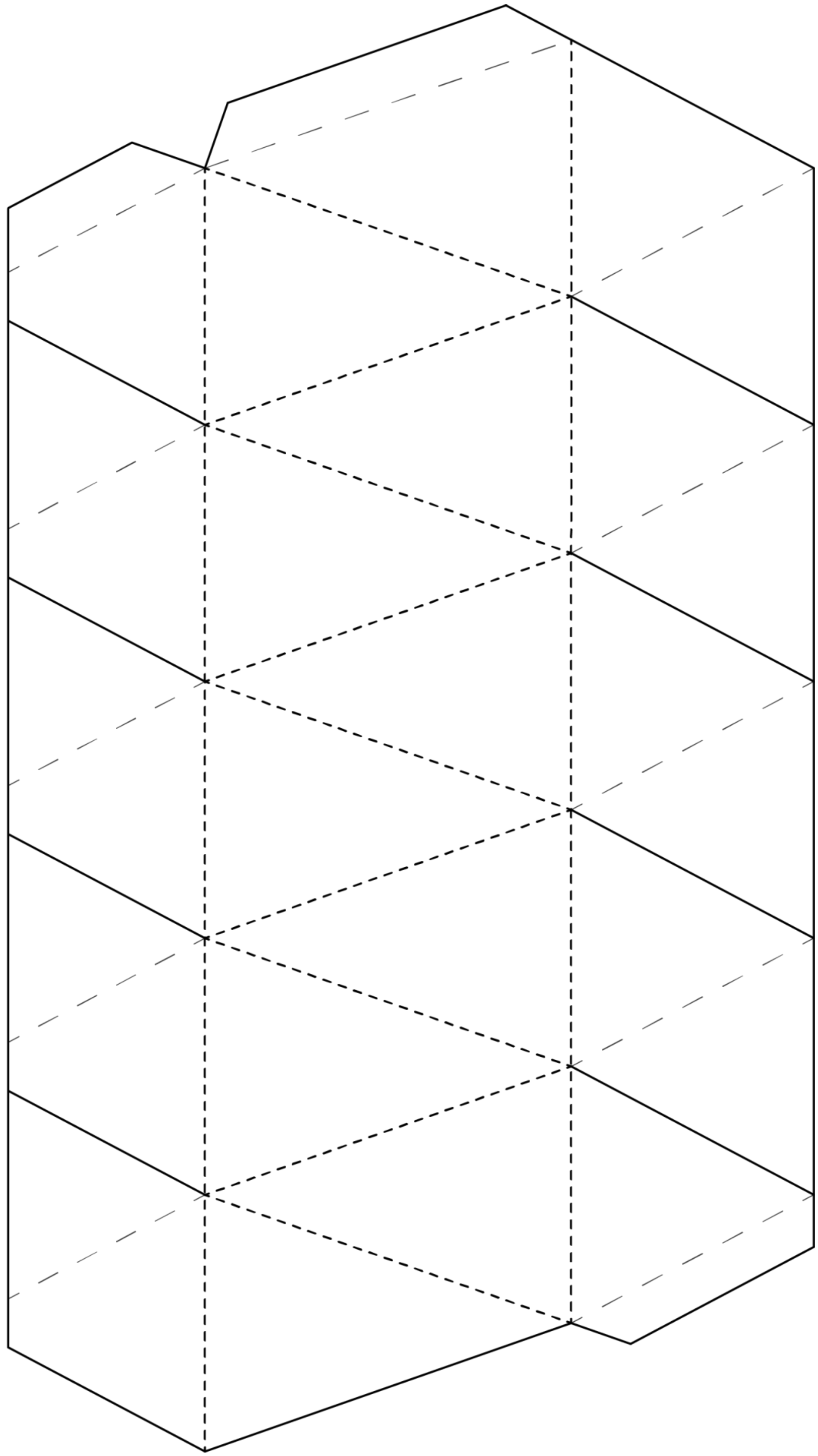
Mystery Microbe #5, Head Capsid Template
(for transparency film)

Instructions

1. Carefully cut out the template along the outer, solid straight lines
2. Color the pieces, if desired
3. Score and fold along the dotted lines
4. Tuck each triangle at the top and bottom of the capsid underneath the next triangle forming a pyramid.
5. Use small pieces of clear tape to join edges together

Assembled shape





Mystery Microbe 6

1. Make a MODEL of a microbe using the labeled drawing as a guide.

2. You must use all of the following materials:
   2 clear, small plastic drinking cups
   46 cm (or about 18”) of clear plastic wrap
   clear tape
   6 (11 cm or 4 inch) strands of sewing thread – 2 stands of each of 3 colors
   61 cm (or about 24 inches) of black yarn
   1 pipe cleaner cut into 1.25cm (1/2 inch) pieces

3. Study the diagram and decide what each of the materials list above will represent. For example, the 2 plastic cups will form the cell wall.

4. After you have assembled your microbe, complete the chart:

Microbe structure	**Model material**	**Function of structure**
Cell wall	2 clear plastic cups	Protection
Cell membrane		Controls passage of materials in and out of cell
Genetic material		DNA which makes up the genes (instructions for all parts and functions within an organism)
Flagella		Movement
Pilli		Helps organism stick to surfaces

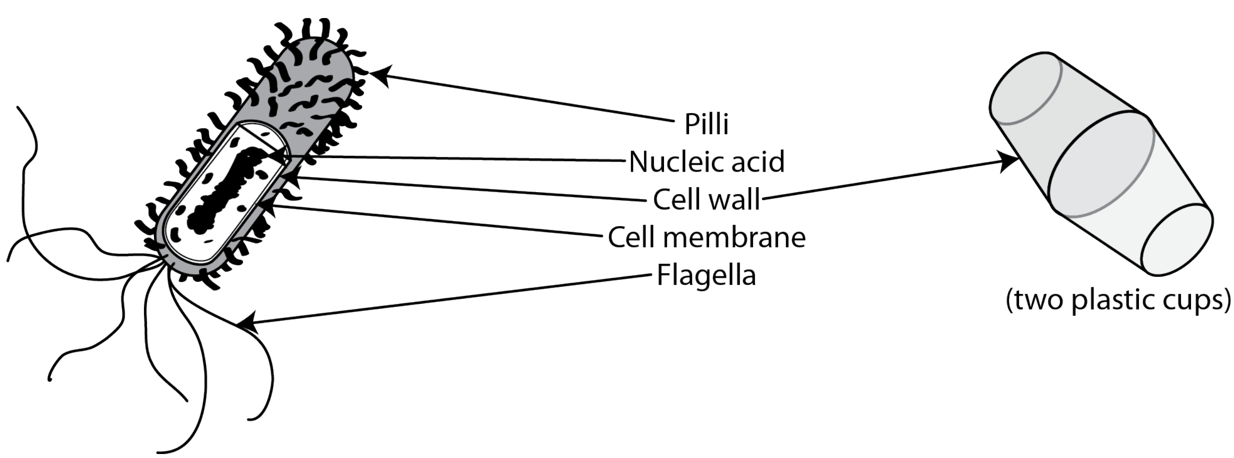
5. Obtain the 4 “Organism Cards.” Read each carefully. Decide which type of organism your model organism represents.
   Type of organism______________________________

   Using key characteristics or structures, explain your decision:

   ____

   ____

   ____



8) Extracting DNA

Strawberry Genetic Material

Time Needed
1 Session

You Need This Stuff
Per Class
- 4 hand lens
- 4 pipettes or droppers
- 4 microscope slides
- Microscope
- 50 ml cold water
- 4 ripe strawberries, stems removed
- 2 clear plastic cups
- coffee filter or cheesecloth
- rubber band
- 5 ml table salt
- 50 ml Graduated cylinder
- 250 ml beakers
- 4 craft stick
- 30 ml liquid detergent
- Ice cold alcohol (95% Ethanol or 92% Isopropanol)

Per Student
- Copy of *How to Extract DNA* student page

What is it About?

All plants and animals are composed of cells with basically the same parts. Deoxyribonucleic acid, DNA, a self-replicating material is present in nearly all living organisms. It is the carrier of genetic information. DNA is contained in the nucleus of all cells. To get to the tightly coiled strands of DNA three barriers must be crossed, cell wall, plasma membrane and nuclear membrane.

What's The Question?

Can we extract DNA from plant cells?

Before You Start

Place water and alcohol on ice or keep in refrigerator until ready to use. Make copies of the student sheets. Place materials for each group in a central location.

What To Do

1. Have students examine a strawberry using a hand lens and then the microscope. You may have them cut a thin slice or smash a small piece of the strawberry onto a slide to have a closer look. Have them draw what they observe.
2. Ask, *could you see cells?* Have students describe what they observed. (Cannot see cells with 100X)
3. Remind them they all plants are made of cells and have a nucleus. Ask, *What is inside the nucleus?* They should mention the genetic material that they placed in the model organisms in the last activity. Have them describe the genetic material, DNA. (Capsule with colored string)
4. Show students several pictures of DNA. Or take the Tour of the Basics from Utah State University. http://learn.genetics.utah.edu/content/begin/tour/
5. Ask, *Do you think we could take the DNA out of a cell and be able to see it?* Discuss.
6. Explain that they will be extracting DNA from the strawberry they have been observing. Have students follow the student instruction sheet.

Wrapping Up

Discuss students' observations. Ask, *Were there any surprises. What do you think is happening?*

Explain to students:

> DNA is a long stringy molecule located in the nucleus. Crushing the strawberries breaks the cells apart. Within the cell wall, plant cells are surrounded by a cell membrane and a nuclear membrane enclosing the DNA. The membranes contain lipids, or fat. The detergent breaks down the membranes and releases the DNA. It is soluble in water, but not alcohol. When the alcohol is layered on top of the water the dissolved DNA will go back to a solid form or precipitate. The salt causes the DNA to clump together and precipitate.

Extras

http://www.nclark.net/DNA_RNA

How to Extract DNA

Step 1

a. Place 4 ripe strawberries, stems removed, in heavy-duty zip-lock plastic bag with 20 ml cold water.
b. Mash vigorously until strawberries are an unrecognizable strawberry liquid!

Step 2

a. Strain the strawberry liquid into a container, using double layer of cheesecloth, strainer or coffee filter.
b. Measure the amount of strawberry liquid into a beaker.
c. Add 1 gm (1/5 t.) salt per 15 gm (1 tablespoon) liquid retrieved, and stir.
d. Add 5 gm (1 teaspoon) liquid detergent for every 15 gm (3 tablespoon) of liquid and gently swirl to mix . Do not create bubbles.
e. Place on ice and let mixture rest for 10 minutes.
f. Pour mixture into small glass containers (or test tube).

Step 3

a. Add a pinch of enzyme (meat tenderizer)
b. Stir very carefully. Stirring too hard can break up the DNA.

Step 4

a. Tilt your container and slowly pour cold rubbing alcohol down the side so that it forms a layer on top of the strawberry mixture. Pour until you have about the same amount of alcohol in the container as the strawberry mixture. Alcohol is less dense than water, so it floats on top.
b. Look for clumps of white stringy material where the strawberry/water and alcohol mixture meet.

Step 5

a. Use a craft stick to collect some of the stringy clumps. You have just extracted DNA!
b. Take some out of the liquid and take a closer look using a slide and microscope.

What do you think happened?

9) Microbes and Disease

Infectious Disease Agents

Time Needed

2 Sessions

You Need This Stuff

<u>Per Group</u>

- Paper and supplies for art projects
- Sheet of paper on which to create an activity concept map
- 4 copies of one Disease Information sheet (all members of a group receive the same disease sheet)
- Group concept map (ongoing)
- *Optional:* 6 copies of the 3-2-1 student sheet

What is it About?

Organisms that cause diseases are called "pathogens," from the Greek word pathos, or suffering. Most pathogens are microbes, such as bacteria, protozoa, fungi or viruses. Sometimes, we call these tiny pathogens "germs." Pathogens cause communicable, or infectious, diseases (diseases that can spread from one organism to another). Some diseases are harder to catch than others, because different pathogens are transferred from one organism to another in different ways (through droplets in air or in fluids, through contact with a surface containing the pathogen, from insect bites, etc.). Some pathogens can make you a lot sicker than others, and some can kill.

A widespread outbreak of a disease is called an "epidemic." An epidemic that spreads broadly throughout the world is referred to as a "pandemic." This activity highlights six microbe-based diseases with major global historical impacts: cholera, plague, malaria, smallpox, HIV/AIDS and tuberculosis.

Of course, microbes do not cause all diseases. Invertebrates, such as hookworms, tapeworms, etc., also can make people and animals sick. Other illnesses, such as arthritis, diabetes, heart disease related to atherosclerosis, and some kinds of cancer, are not caused by infections. But in some cases, diseases thought to be unrelated to microorganisms have been found to be infectious after all. Stomach ulcers are a good example. Scientists now know that the most common cause of peptic ulcers is infection by a bacterium called *Helicobacter pylori*.

What's The Question?

What types of microbes cause disease?

Before You Start

Divide the class into six groups of four students. Each group will work with one disease (i.e., one group investigates and presents information about TB, another group works with plague, etc.). Make four copies of each Disease Information sheet. Make 36 copies of the 3-2-1 sheet (six copies per group). As each group presents information on a specific disease, all other groups will complete a 3-2-1 sheet for that disease. Gather a variety of materials for students to use in their art projects. Place materials in a central location.

What To Do

1. Ask students, *Do you think diseases have changed history? Do any diseases affect society today?* Tell students that they will be learning about diseases that have had impacts worldwide.

2. Provide each group with a set of disease information sheets for a single disease. Each student should receive his or her own copy of the sheet.
3. Instruct each student to read the information on his or her sheet. Depending on students' reading levels, you may need to provide assistance with the readings.
4. Have students within each group jointly create a concept map to summarize the important ideas from the group's Disease Information sheet and discuss which type of microbe (bacteria, fungus, protozoa, or virus) causes the disease. Then have each group use its newly-created concept map to prepare a presentation about its assigned disease.
5. Have each group work collectively to create a piece of art that illustrates the assigned disease, and then have students explain how the artwork represents the chosen disease(s).

Wrapping Up

Ask a student representative from each group to present the group's artwork in class, along with related information from the readings or other sources.

Extras

Have students create world maps illustrating where each of the six diseases highlighted in this activity still may be found. Geographic maps can be downloaded free from the United Nations Cartographic website at www.un.org/Depts/Cartographic/english/htmain.htm/.

Distribute six copies of the Microbes: 3-2-1 sheet to each group. Have each group present information on the disease they read about. After the presentations, allow all groups, including the one that just presented, five to six minutes to complete a 3-2-1 sheet on the presentation. Repeat the process until all student groups have made their presentations.

Microbes: 3-2-1

Group ______________________ Disease ______________________

Which type of microbe causes the disease?

☐ Bacteria ☐ Virus ☐ Protozoa ☐ Fungus

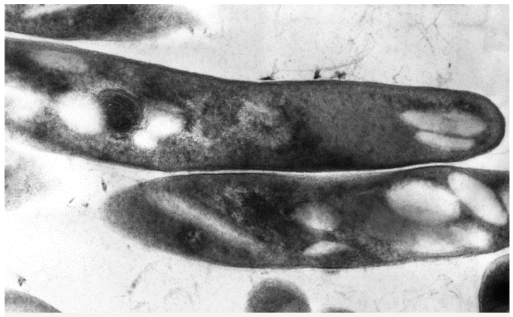
3) What are three new things you learned?

2) What are two things that surprised you?

1) What is one question you have?

Tuberculosis

Tuberculosis, a disease also known as "TB," has affected humans for thousands of years. For most of that time, there was no known cure and very little understanding of the disease. In the past, TB sometimes was called "consumption," because it seemed to devour people from the inside.



Microbe that causes TB. (Source: CDC\Elizabeth "Libby" White.)

TB is one of the deadliest diseases known to man. At one point, it was the leading cause of death in the U.S. Its dark history is reflected in novels, artwork and dramas. Back in the 1800s, some people even thought TB was caused by vampires. It's true! The symptoms of TB look like characteristics often associated with vampires (red, swollen eyes that are sensitive to bright light, pale skin, and worst of all, coughing up blood). In fact, some people thought TB sufferers caught the disease from dead family members who visited at night.

An Invisible Enemy

We have come a long way since then, and scientists have developed effective treatments against TB. Caused by the Mycobacterium tuberculosis bacteria, TB can be deadly for people who do not get proper treatment. The disease most often infects the lungs, because it is transmitted through the air we breathe. However, it can attack any body organ or system.

How TB Spreads

TB spreads from person to person through the air. When someone who is infected with tuberculosis sneezes, coughs, talks or spits, TB bacteria are released into the air. Anyone nearby who breathes in these bacteria can become infected. If a person with TB does not receive treatment, he or she could infect an average of 10 to 15 people each year.

People infected with TB bacteria may not show symptoms or develop the disease. In fact, only about 10% of otherwise healthy people infected with TB bacteria ever become sick. The other 90% are said to have a latent TB infection. These people do not get sick and do not transmit the disease.

However, some people with latent TB infection do become ill when they get older. Therefore, they may choose to take antibiotics right away to prevent the disease from occurring later in life.

Babies and young children have an increased risk for catching TB because their immune systems are not yet mature. Other people at higher risk for contracting (catching) TB are those with weakened immune systems, such as people with HIV (the virus that causes AIDS), diabetes, cancer, kidney disease or other serious medical conditions. People who abuse drugs or alcohol also are more likely to develop this illness.

Where Things Stand Today

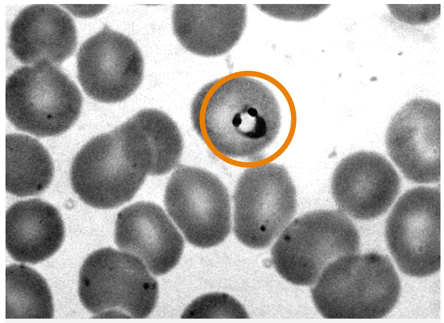
Until the 1940s, there was no cure for TB. But with education, improvements in public health care and the creation of new antibiotics, the numbers of deaths from TB dropped dramatically in the U.S. and Europe. To cure the disease, patients were required to take antibiotics for six months.

However, over time, drug-resistant forms of TB began to emerge. Doctors discovered that some patients stopped taking their medicine as soon as they felt better, instead of completing the course of antibiotics designed to kill all of the bacteria. In these cases, the surviving TB bacteria changed, or mutated, so that the original antibiotic became less effective. Eventually, the antibiotic-resistant TB bacteria were passed on to other people, who then developed forms of TB that were even more difficult to treat.

There are many reasons why TB still exists, including lack of medical facilities, cost of antibiotics and poor hygiene. The disease remains a very serious health problem today. Each year, almost nine million new cases of TB are reported worldwide, and nearly two million people die from the disease. Without better treatment, it is estimated that over the next 15 years, almost one billion people will become infected with TB bacteria, more than 150 million will become sick, and more than 36 million people will die.

Malaria

What do you know about malaria? In the United States, we don't hear much about this disease, because it was eradicated (removed completely) from our country in the 1950s.



Microbe that causes malaria inside a red blood cell. (Source: CDC\Dr. Mae Melvin.)

But malaria still is a serious threat in warmer and poorer regions of the world, including India, Africa, Central and South America, and tropical parts of Asia. The World Health Organization reports that each year, 300–500 million new cases of malaria are diagnosed, and more than one million people—mostly young children—die from it.

A Microscopic Parasite

Malaria is a life-threatening disease caused by *Plasmodium,* a parasite in the protozoan group. A parasite is an organism that lives in, with, or on another organism (or host), from which it obtains nutrients and to which it causes harm. The malaria parasite is carried by female *Anopheles* (ah-NOF-il-eez) mosquitoes. The symptoms of malaria—severe headache, high fever, shaking, vomiting and chills—appear about 9 to 14 days after an infected mosquito bites a human. There are four strains (forms) of malaria. All are very serious, and one strain often is fatal.

Once a person is infected, the parasite attacks and destroys red blood cells. It also blocks blood vessels leading to the brain or other organs. If medicine isn't obtained, or if that particular strain of malaria is resistant to (not killed by) the medicine, a malaria infection can quickly become deadly.

The Cycle of Malaria Infection

We know that when a female *Anopheles* mosquito bites a person who already has malaria, the mosquito takes in malaria parasites and becomes a carrier. When the mosquito bites someone else, it transmits parasites to (infects) that person. But it's not clear if the parasite kills the mosquito. It is possible that the mosquitoes are not affected by the malaria parasite.

Once the *Plasmodium* parasite enters a person's bloodstream, it travels to the liver, where it begins to grow and multiply. During this incubation period, before the parasite has fully developed, the person will not feel ill, and may not even know he or she is infected. When the parasite moves from the liver to the blood stream, the person will begin to feel symptoms. At this point, the disease has developed enough to infect any *Anopheles* mosquito that may bite this newly infected person, and the cycle of infection continues.

People also can get malaria from having a blood transfusion or organ transplant, or by sharing used needles. A pregnant mother infected with malaria can give the disease to her child. But malaria cannot spread from casual contact between people. You can't get it if someone sneezes on you.

Still a Deadly Disease

During the 20th Century, malaria was eliminated from most parts of the world that are not hot year-round. But it was not wiped out everywhere, and it may be making a comeback. Evidence suggests that Anopheles mosquitoes have become resistant to pesticides that previously killed them. Meanwhile, vaccines that once prevented infection, along with the drugs used to treat malaria, are becoming less effective. Some experts think malaria may be moving into new parts of the world, including places where it once had been eliminated.

Although scientists believe most deaths from malaria are preventable, this disease remains a major global health concern. It also is preventing development in some of the poorest countries in the world. For example, in Africa, on average, a child dies from malaria every 30 seconds. And even if a child survives malaria, he or she often is left with learning problems or brain damage.

The U.S. is not entirely free from malaria. Approximately 1,200 infections and 13 deaths from malaria are reported here each year, mostly among travelers and immigrants from parts of the world where malaria remains a problem. Further, *Anopheles* mosquitoes still exist in the U.S., so it is possible for the mosquitoes to reintroduce malaria into the U.S.

Plague

When you hear about "the plague," you probably think of the Middle Ages, when the Bubonic form of plague killed millions of people throughout Europe, Asia and Africa. In Europe, as many as 2.5 million people—one third of the population—died between 1347 and 1350. It has been said that there weren't enough people left alive to bury the victims. At the time, people didn't know what caused plague and no cure was available. So there was panic whenever an outbreak occurred. Many works of literature and art depict the terror surrounding the plague and the horrible effects it had on the population.

Microbe that causes Plague.
(Source: CDC-Oregon State Public Health Laboratory\Larry Stauffer)

Maybe you think plague is gone and part of history, like the Middle Ages. If so, you'll be surprised to learn that it is alive and well. Today, we have protective vaccines and medications that cure people with plague, so it takes far fewer lives than other deadly diseases. But the name alone continues to cause fear. And although we know much more about plague than medieval people did, it continues to kill people even today.

Rodents!
Plague is a disease that affects animals and humans. It is caused by the bacterium, *Yersinia pestis.* This bacterium was named after Alexandre Yersin, the scientist credited with discovering how the disease spread during an epidemic in 1894. (How would you like to have a deadly bacterium named after you?)

Yersinia pestis bacteria are carried by fleas and the wild rodents on which they live (often rats and squirrels). Plague outbreaks are rare these days, but still can happen in places where infected rodents and their fleas live in people's homes. In the Middle Ages, it was much more common for homes to be infested with rats and fleas—which is one reason why so many people were infected with plague then.

There are three different kinds of plague. Bubonic plague is an infection of the lymph nodes, which are glands located throughout the body that help to fight off illness by acting as filters for bacteria and viruses. Septicemic plague is an infection of the blood. Pneumonic plague is an infection of the lungs. The type of plague a person gets depends on how he or she was infected in the first place. Septicemic plague can cause a victim's skin to turn very dark purple. That's why plague sometimes was called the "Black Death."

The most recent outbreak of plague in the U.S. was in 1924. But it still exists here, mostly in the Southwest and Midwest. And while only about 2,000 cases of plague are reported worldwide each year, it remains a very serious disease. If you get plague and don't get treatment, it can kill you.

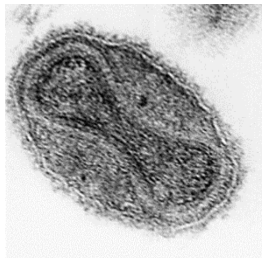
One Small Pest = A Huge Health Risk Most often, plague is spread when an infected flea bites a person, or when someone handles an animal infected with plague. It also is possible to catch plague through the air, if someone with pneumonic plague sneezes near you.

A few days after infection, sudden fever, chills, headache, nausea, weakness, and painful, swollen lymph nodes may develop. These are symptoms of plague. The disease advances quickly, so it is important to see a doctor as soon as possible after infection. Most plague patients who are treated quickly and properly with antibiotics will recover fully. But if left untreated, plague can invade the lungs and bloodstream. Once in the lungs, plague can be spread by sneezing or coughing, and it is far more difficult to cure. About half of all people with this kind of plague die.

A Disease that Won't Die
Plague is not likely to be eradicated (eliminated). Even with new technology, improved conditions, and good healthcare in most modern cities, plague and *Yersinia pestis* bacteria remain strong opponents. In fact, overcrowding, combined with a lack of proper sanitation and pest control in some poorer countries, has increased the chances for another plague outbreak. Like the fleas that carry it, this disease is tough to kill.

Smallpox

Smallpox has been in the news quite a lot recently. Maybe you heard about it first after the terrorist attacks in 2001. Since then, there has been a lot of talk about the possible use of "biological weapons," including smallpox, to infect and even kill a large number of people.



Microbe that causes smallpox. (Source: CDC\Dr. Fred Murphy and Sylvia Whitfield.)

An Ancient Nemesis

Smallpox is a very contagious disease caused by the Variola (smallpox) virus. Scientists believe it originated in humans in India or Egypt more than 3,000 years ago. Since then, smallpox has been one of our deadliest diseases. Smallpox epidemics once spread throughout entire continents. (An epidemic is a widespread outbreak of a disease.) Many of those who got smallpox died, and some those who survived were blinded and physically marked by the disease with scars. The name, "smallpox," refers to the bumps that infected people get on their faces and bodies, and in their throats, mouths and noses. There are two common forms of smallpox: Variola major and Variola minor. (The word, "variola," comes from the Latin word for "spotted.") Both forms lead to sores on the skin, fever, headache and other flu-like symptoms. However, Variola major is a far more deadly disease. It is estimated that 30% of the people who have caught this illness have died.

Smallpox affects only humans. It does not make animals sick, and it is not transmitted by insects. There is no cure for smallpox, but there now is a vaccine that can prevent infection, even up to four days after a person has been exposed to the Variola virus. However, some people should not get the vaccine, including pregnant women and people with skin problems, a weakened immune system or some other medical problems.

Chicken pox is not a mild form of smallpox. Although it causes similar (but less disfiguring) sores, it is caused by a different virus.

It's in the Air

Most often, smallpox is transmitted when a person infected with the disease sneezes or coughs near someone else. If the infected person has a fever and rash, he or she is able to spread smallpox to others until the very last blister heals. The disease is easiest to spread during the 7–10 days after the rash first appears. Although smallpox is deadly, it takes direct and fairly prolonged face-to-face contact to spread smallpox to another person.

It also is possible to catch smallpox from contaminated objects, such as blankets or clothing. In very rare cases, smallpox has been spread through the ventilation systems of buildings, trains and other closed places.

Usually, it takes 12–14 days for a person who has been exposed to smallpox to be able to spread the disease. During this time, the virus is multiplying inside the person and usually causes no symptoms.

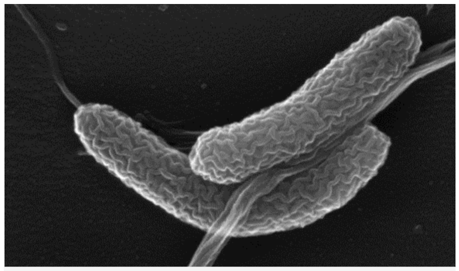
Some Risk Remains

Following a worldwide vaccination program, smallpox was eliminated globally by 1980. The last U.S. case was in 1949. But smallpox still exists in laboratories, so it is possible that another outbreak could occur. Since the disease has been eradicated (eliminated) for more than 25 years, almost no one has been vaccinated against it recently. Therefore, very few people have immunity. If there is an outbreak, it might not be possible to vaccinate every person exposed to smallpox in time to prevent them from being infected. This combination of factors makes any future smallpox epidemic extremely dangerous.

Cholera

Are you familiar with the phrase, "Don't drink the water"? It's usually heard when someone is traveling, especially outside of the U.S. Our water treatment system is very good, so the water in our homes usually is healthy to drink. Also, laws in this country help to ensure that our food sources generally are safe.

But this is not the case everywhere. When you visit some countries, you may be warned not to drink water from the faucet, not to drink beverages containing ice, and not to eat any food unless you have cooked or peeled it. There's a good reason for these warnings. Sometimes, uncooked food and untreated water can make you sick!



Microbe that causes cholera.
(Source: Courtesy of Louisa Howard, Electron Microscope Facility, Dartmouth College.)

Something in the Water and Food
Every year, many people around the world get dangerous diseases from food and water that are not safely prepared or treated. One of these diseases is cholera, an infection of the intestines caused by the bacterium, *Vibrio cholerae*. We don't have many cases of cholera in the U.S. In fact, it has been rare in much of the world for 100 years or more. Unfortunately, it still affects millions of people in Asia, Africa, and other places that suffer from poor hygiene, unsanitary conditions, and lack of money for proper medical care and medicine.

Many people who get cholera do not feel ill. Some experience nothing more serious than a bad case of diarrhea. But about 10% of cholera victims suffer life-threatening symptoms, including continuous diarrhea, vomiting and leg cramps. These people lose body fluids so quickly that they become severely dehydrated, and even may go into shock. Without medication, they can die within hours.

Wash Your Hands, Please
Cholera is spread by contaminated (dirty or spoiled) water and food. Most often, contamination happens when human and/or animal waste (feces) gets into our water or food. It's disgusting, but that's the way it usually happens.

Vibrio cholerae bacteria infect the intestine and remain in the body for one to two weeks. If an infected person who is preparing food doesn't wash his or her hands after using the bathroom, he or she might spread the bacteria to the food. Anyone who eats this food might get sick. Other kinds of intestinal diseases are spread in the same way. That's why you often see signs in restaurant bathrooms, reminding employees to wash their hands before returning to work.

In places with poor sewage systems or improper water treatment, human waste can get into the water supply. In these places, many people can become sick with cholera. That's how some outbreaks happen.

But cholera isn't always caused by human waste. *Vibrio cholerae* bacteria can exist naturally in salty rivers and coastal waters, where shellfish (crabs, clams, oysters, etc.) live. If shellfish

are boiled for less than 10 minutes, steamed for less than 30 minutes, left unrefrigerated for several hours, or eaten raw, they can cause cholera and other diseases.

The Danger Today
Cholera outbreaks have occurred throughout the world for thousands of years. Stories from ancient Greece, and even earlier, report epidemics of cholera-like illnesses. The disease was common in the U.S. in the 1800s, but it no longer is a major concern, because we have modern water treatment, food preparation and sewage systems.

Cholera is easy to prevent with good sanitation and water treatment. It can be cured by giving fluids along with antibiotics, if necessary. But some countries do not have the resources needed to fight a cholera outbreak, so this disease continues to present a very real threat to human life.

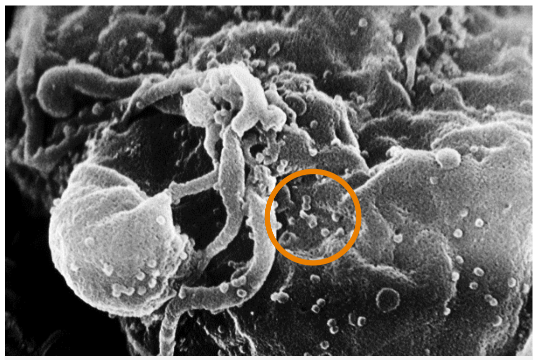
The most recent cholera pandemic (worldwide outbreak) began in Asia in 1961. It spread to Europe and Africa and, by 1991, to Latin America, where there had been no cholera for more than 100 years. This outbreak has killed thousands of people and continues to spread. Cholera can be a risk for anyone traveling to places where outbreaks are occurring.

HIV/AIDS

Everyone has heard of HIV and AIDS. You might even know someone infected with HIV. But what, exactly, is HIV? What's the difference between AIDS and HIV? And why is it important for you to know about it?

The Difference Between HIV and AIDS

HIV (human immunodeficiency virus) is the very serious—and always deadly—virus that causes the disease called AIDS (acquired immunodeficiency syndrome). Scientists and doctors aren't sure exactly when or where the HIV virus developed, but they know it has been present in the U.S. since the late 1970s. They also know that the HIV virus kills specialized blood cells needed by the body's immune system to fight disease.



The multiple round bumps are HIV. (Source: CDC\P. Feorino, E.L. Palmer and W.R. McManus. Image: Cynthia Goldsmith.))

Over time, as the virus kills more and more of these blooc carry the virus (referred to as H ability to battle infections and diseases. People infected with HIV often develop specific illnesses or types of infections associated with this virus. At that point, they are considered to have AIDS. Microbes that might not make another person sick can be life threatening for people with AIDS, because their immune systems are weakened.

A simple blood test can show if a person has the HIV virus. On the other hand, doctors have to look for specific symptoms, such as a decrease in the number of certain blood cells, to determine if a patient's illness has progressed to AIDS. It may take years for these symptoms to appear or for a person to begin feeling ill, so HIV is considered to have a long incubation period (length of time between when the disease-causing microbe enters the body and when symptoms develop). Thus, it is possible for someone to have the virus in his or her body and not know it. All the while, this person could be spreading HIV to others.

Facts, Myths and Hope

You can become infected with HIV if you come in close contact with body fluids, such as blood, of someone who has the virus. Most often, HIV is spread through unprotected sex or by sharing needles for drug use. HIV-positive mothers can infect their babies during pregnancy or birth, or by breast-feeding. It also is possible to become infected if dirty needles are used when getting tattoos or piercings.

You cannot get HIV or AIDS through saliva, sweat or tears; from mosquitoes; or from an animal bite, such as from a dog or cat. Some animals can carry viruses that are similar to HIV, but these viruses do not affect humans.

Twenty years ago, about half of all people with HIV developed AIDS within ten years. But in the last decade, powerful new drugs have been created to slow the progress of HIV. Other medicines also are being developed to prevent or treat AIDS-related illnesses. The side nent are very serious, but many people infected with HIV now are able live longer than they would have in the past.

A Universal Problem

Unfortunately, not everyone is able to get the new medicines, and millions of people continue to die from AIDS every year. By the end of 2003, more than 500,000 people in the U.S. had died from AIDS—about as many people as live in Las Vegas or Oklahoma City. In 2006, about 2.9 million people around the world died from AIDS; 39.5 million people were living with HIV; and 4.3 million people became newly infected with HIV. Today, about one of every 300 Americans over the age of 13 is HIV-positive.

HIV doesn't care who you know, how old you are, how wealthy or poor you may be, the color of your skin, your gender, or your sexual orientation. If you do risky things, you may become infected. And once you're infected, you have HIV forever. While new drug treatments are helping some people with HIV live longer, more normal lives, there is no cure for this disease.

10) Diagnosing Microbial Diseases

Three Case Studies

Time Needed

1 Session

You Need This Stuff

Per Class

- 270 letter-size plain envelopes
- 18 sheets of white, self-stick folder labels, 3-7/16 in. x 2/3 in., 30 labels per sheet (Avery™ #5366, 5378 or 8366)

Per Group

- Set of prepared Allison envelopes (15 envelopes per set)
- Set of prepared Carlos envelopes (15 per set)
- Set of prepared Stephanie envelopes (15 per set)
- Copy of *Looking at Case Studies* group sheet
- *4 copies of Disorders and Symptoms* student sheet
- Copy of *What is Wrong with Allison?* group sheet
- Copy of *What is Wrong with Carlos?* group sheet
- *Copy of What is Wrong with Stephanie* group sheet

Alternatively, Students can do part of the activity online at https://dl.dropbox.com/u/2017824/DD-OM/DiseaseDiagnosis.html (Works best in Chrome, Firefox, or Safari)

What is it About?

Based on a US survey, physicians see between 50-100 patients per week[1] with a variety of medical issues. The physician and their staff follow basic procedures in order to collect as much information as possible to help the patient. Typically, medical histories are collected about past illnesses, family members with diseases, current living conditions and medication use. Medical history is not enough information for a doctor to make a diagnosis so a physical examination is conducted. Based on this exam, further test can be given to gather more information about a patient, such as a blood test or x-ray. When certain symptoms are present, doctors can compare that to know symptoms of known diseases to make a diagnosis. If a microbe is the cause of an illness, a specific treatment may be called for.

Many different microorganisms can infect the human respiratory system, causing symptoms such as fever, runny nose or sore throat. Even the common cold, which may range from mild to serious, can be caused by any of more than 200 viruses! Colds are among the leading causes of visits to physicians in the United States, and the Centers for Disease Control and Prevention (CDC) reports 22 million school days are lost in the U.S. each year due to the common cold. Usually, cold symptoms appear within two to three days of infection and include: mucus buildup in the nose, swelling of sinuses, cough, headache, sore throat, sneezing and mild fever (particularly in infants and young children). The body's immune system, which protects against disease-causing microbes, almost always is able to eliminate the viruses responsible for a cold.

Flu (or influenza) often is more serious than the common cold. Caused by one of three types of closely related viruses, flu can come on quickly, with chills, fatigue, headache and body aches. A high fever and severe cough may develop. Flu may be prevented in some cases through a vaccine. However, since the viruses that cause flu change slightly from year to year, a new vaccine is required each flu season. Influenza was responsible for three pandemics (worldwide spread of disease) in the 20th Century alone.

Malaria is a disease that is not common in the United States. It mostly affects people in warmer and poorer regions of the world. The disease is caused by a parasite in the *Plasmodium* genus (a protist). The symptoms of Malaria can resemble diseases like the flu and other viral infections making it difficult to diagnose especially in regions where the disease is uncommon. This is why a patient's travel history can be critical for accurate diagnosis. Malaria can be treated by various medications that target the

[1] http://www.medscape.com/features/slideshow/compensation/2011

infective parasite. Many antibiotics that target bacteria are not effective in treating the disease.

Tuberculosis (TB) is an infection caused by the *Mycobacterium tuberculosis* bacteria. It most commonly affects the respiratory system and is typically spread from person to person through the air. Around 90 percent of people who are infected with the TB bacteria don't experience symptoms. These people are said to have a latent TB infection and do not infect others. In many cases the bacteria may remain inactive forever. Sometimes if the immune system is weakened or as individuals age the latent TB infection can become ill with the disease. Treatment for TB includes antibiotics. Unfortunately many strains of antibiotic-resistant TB have mutated making it more difficult and costly to treat.

Antibiotics do not kill viruses, and therefore, are not helpful in fighting the common cold or flu. But these diseases can make a person more susceptible to bacterial infections, such as strep throat, a common infection by a *Streptococcus* bacterium. Symptoms of "strep" infections include sore throat, high fever, coughing, and swollen lymph nodes and tonsils. Diagnosis should be based on the results of a throat swab, which is cultured, and/or a rapid antigen test, which detects foreign substances, known as antigens, in the throat. Strep infections usually can be treated effectively with antibiotics. Without treatment, strep throat can lead to other serious illnesses, such as scarlet fever and rheumatic fever.

Symptoms similar to those of a cold can be caused by allergens in the air. Health experts estimate that 35 million Americans suffer from respiratory allergies, such as hay fever (pollen allergy). An allergy is a reaction of an individual's disease defense system (immune system) to a substance that does not bother most people. Allergies are not contagious.

What's The Question?

Can you diagnosis diseases based on case study stories and symptoms?

Before You Start

Photocopy *Looking at Case Studies, What is Wrong with Allison, What is Wrong with Carlos, What is Wrong with Stephanie, and Disorders and Symptoms* student sheets (one copy for each group) to be distributed in order.

Have students work in groups of four.

Photocopy the label template sheets onto eighteen sheets of white, self-stick labels, such as Avery™ #5366, 5378 or 8366, which contain 30 labels per sheet.

Use one page of photocopied labels to create each set of envelopes. Place a Question label on the outside of one envelope and stick the corresponding Clue label on the inside flap of the same envelope. Close the flap, but do not seal the envelope. Make eighteen sets of 15 envelopes (One set of each case study – Allison, Carlos, and Stephanie – per group).

Optional: Instead of using self-stick labels, copy the label template page onto plain paper and cut out each question and clue. Tape one question to the outside of an envelope and the corresponding clue to the inside flap of the envelope.

What To Do

1. Begin a class discussion of disease by asking questions such as, *How do you know when you are sick? What are some common diseases? Are all diseases alike? Are all diseases caused by a kind of microbe? Do some diseases have similar symptoms?*
2. Tell your students that in this class session, they will be acting as medical personnel trying to diagnose patients. Give each group a copy of the *Looking at Case Studies* sheet. Have students take turns reading the case in their group. Groups should record their ideas about what might be wrong with Allison.
3. Have each student group list four possible questions that a doctor might ask a patient like Allison. Write these questions on the board and discuss with the class.

4. Have groups identify three possible diseases that Allison may have, based on the story, class discussion and their own experiences.
5. Guide the discussion so students understand that some illnesses with very similar symptoms have different causes and, therefore must be treated differently.
6. Give each student a copy of the *Disorders and Symptoms* sheet and briefly introduce the six illnesses to the entire class. Compare these illnesses to the ones that students suggested. Ask, *Are there any similarities?*
7. Explain that students will use the chart to diagnosis Allison and two other individuals. The goal is to diagnose all three patients correctly using the least number of questions/clues.
8. Give each group of students set of the Allison Case Study Questions/Clues envelopes and *What is Wrong with Allison* group sheet. Warn students not to open the envelopes until they are instructed. Tell students each envelope contains information that a medical doctor might need about a patient. All information is important to the diagnosis. However, only certain information will help to distinguish among six possible diseases. Tell students their task is to decide, without opening the envelopes, which envelopes contain information that might help them distinguish among the six conditions.

   Students may open as many envelopes – one at a time – as needed. The challenge is for students to use as few envelopes as possible to diagnosis Allison's illness. Each group should keep a tally of the number of envelopes opened. Remind students that in real life, a physician would conduct a complete examination and gather all possible information before making a diagnosis.
9. Allow time for groups to work. Provide assistance to students who may not understand the information contained in the envelopes. If the medicine and body temperature envelopes have been opened, make sure students understand that some medications, like Tylenol™, will mask the presence of mild fevers.
10. Have each group check its diagnosis and the reasoning to the teacher. (Allison's disease is a common cold. If students have arrived at other conclusions, discuss the evidence they used and challenge students to look at more questions/clues.)
11. When they've diagnosed the case correctly, collect the Allison Questions/Clues envelopes.
12. Explain that students will now move onto a more complicated disease. Tell them that they will follow the same process that they used with Allison in order to diagnose Carlos. Hand out the Carlos Questions/Clues envelopes along with the *What is Wrong with Carlos* student sheet. Emphasize that they will still need to refer to the *Disorders and Symptoms* sheet.
13. Allow time for groups to work. Provide assistance to students who may not understand the information contained in the envelopes.
14. Have each group check its diagnosis and the reasoning used to arrive at its decision. (Carlos's disease is Malaria. If students have arrived at other conclusions, challenge students to look at more questions/clues.)
15. When the group has diagnosed the case correctly, collect the Carlos Questions/Clues envelopes.
16. Tell them that they will follow the same process to diagnose Stephanie. Hand out the Stephanie Questions/Clues envelopes along with the *What is Wrong with Stephanie* student sheet. Remind them that they will still need to refer to the *Disorders and Symptoms* sheet.
17. Have each group check its diagnosis and the reasoning used to arrive at its decision. (Stephanie's disease is Tuberculosis. If students have arrived at other conclusions, challenge students to look at more questions/clues.)
18. When the group has diagnosed the case correctly, collect the Stephanie Questions/Clues envelopes. Have groups tally their scores across all three patients to determine who was able to diagnose the case using the fewest questions.

19. Discuss how the characters stories might have affected diagnosis. For example, remind students that Malaria is transferred through mosquito bites, so it's important to know that Carlos was exposed to tropical mosquitos.

Wrapping Up

Expand the discussion to address the importance of not taking antibiotics for viral diseases. Ask, *Since Allison has a cold, should her doctor prescribe antibiotics? Would it be okay to take leftover antibiotics?* Help students understand that antibiotics are effective for bacterial infections, but do not help against viral infections like colds.

Also, mention that if antibiotics are prescribed for a bacterial infection, it is important to follow the doctor's instructions and to take all the medication, even if symptoms start to improve before the medicine is gone. Otherwise, the disease may reoccur. Taking antibiotics incorrectly or using them inappropriately (such as taking leftover medicine without a doctor's guidance) can contribute to the development of antibiotic resistant forms of bacteria, which cannot be killed by existing anti-biotics (see Antibiotic Resistant Bacteria, sidebar, p. 43).

Extras

Refer to the http://www.cdc.gov/ for information about health, disease, and safety topics.

Looking at Case Studies

Allison is an active, healthy girl. She loves to play outside with her dog. She missed only one day of school last year. But when she woke up this morning, Allison had a headache and a sore throat. She wasn't hungry, so she just had juice for breakfast.

Allison's mom felt her forehead, and said Allison seemed a little too warm. Her mom decided to take Allison to their family doctor, because Allison's cousin had a strep throat infection.

What do you think could be causing their symptoms?

____

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____

____

Acting as their doctor, your team will use clues to figure out what is making each person ill. List four questions that you think a doctor might ask.

1. ______________________________

____

2. ______________________________

____

3. ______________________________

____

4. ______________________________

____

Based on class discussion, what are three likely diseases Allison may have?

1. ______________________________

____

2. ______________________________

____

3. ______________________________

____

Disorders and Symptoms

ILLNESS	SYMPTOMS	CAUSES	TREATMENT
Common Cold	• Headache • Cough • Sore throat • Sneezing • Clear mucus in the nose	Viruses	Rest, drinking plenty of fluids
Flu	• Headache • Sore throat • Muscle aches • Tiredness (fatigue) • Dry cough • Diarrhea and/or vomiting • High and sudden fever	Viruses	Rest, drinking plenty of fluids (if caught early enough can be treated with special antiviral medication)
Malaria	• Fever • Chills • Headache • Body aches • Vomiting • Shaking • Sweating	Protist	Medications recommended by a doctor
Nasal Allergy	• Itchy eyes and throat • Clear mucus in nose • Frequent sneezing or coughing • Irritated or sore throat • Headache	Reaction by the body to substances in the air, such as pollen or dust	Medications recommended by a doctor
Strep Throat	• Red, painful sore throat • White patches on tonsils • Fever • Headache • Stomach pain • Vomiting	Bacteria	Rest, drinking plenty of fluids, antibiotics prescribed by a doctor
Tuberculosis (TB)	• Coughing up yellow or green mucus or possibly bloody mucus • Weakness or fatigue • Shortness of breath • Loss of appetite • Weight loss • Slight fever • Chills • Night sweats • Pain in chest, back, and/or kidneys	Bacteria	Rest, drinking plenty of fluids, antibiotics prescribed by a doctor. It is important to take all medication as prescribed, failure to do so can lead to more antibiotic resistant strains of TB which are harder and more expensive to treat

What is Wrong with Allison?

1. Review the table of Disorders and Symptoms to familiarize yourself with the six illnesses listed. Allison has one of these six illnesses.
2. Read the question on the outside of each envelope, but do not open the envelopes yet. On the inside flap of each envelope is a clue, or answer, to the question on the outside. However, only some of the questions and clues will help you.

   As a group, try to select the fewest number of questions (and clues) possible to help you distinguish among the illnesses above and diagnose Allison's illness. Open only one envelope at a time.

   a. According to your group's analysis, Allison has ____________________________________ .

   b. How many questions/clues did your group use? ____________________________________

   c. Which question numbers (1 through 15) did your group select? ____________________

3. Answer the following questions.

   a. Which information helped you to diagnose Allison's illness? Explain why or how this information helped.

   ____

   ____

   ____

   ____

   ____

   b. Why would it be important to know if Allison had been given aspirin or Tylenol™?

   ____

   ____

   c. Would antibiotics be helpful to Allison? Why or why not?

   ____

   ____

What is Wrong with Carlos?

Carlos is a college student in the U.S. who travels to his native country of Guatemala to visit family every summer. He loves to be outdoors and plays soccer in the fields near his family's home, even if it is wet and swarming with mosquitos. Upon returning from a recent trip to Guatemala, he started to feel very cold. The next morning, his roommate noticed Carlos sweating and that he felt very warm even though the apartment was cool. They decided to go to the health clinic on the college campus to determine what was wrong.

a. Read the question on the outside of each envelope, but do not open the envelopes yet. On the inside flap of each envelope is a clue, or answer, to the question on the outside. However, only some of the questions and clues will help you.

   As a group, try to select the fewest number of questions (and clues) possible to help you distinguish among the illnesses above and diagnose Carlos's illness. Open only one envelope at a time.

   a. According to your group's analysis, Carlos has ____ .

   b. How many questions/clues did your group use? ____

   c. Which question numbers (1 through 15) did your group select? ________________________

b. Answer the following questions.

   a. Which information helped you to diagnose Carlos illness? Explain why or how this information helped.

      ____

      ____

      ____

      ____

      ____

   b. Would antibiotics be helpful to Carlos? Why or why not?

      ____

      ____

What is Wrong with Stephanie?

Stephanie has been an active, healthy girl. She has been visiting her Great-Grandmother in a nursing home, and frequently plays board games with the other residents. She also loves spending time with her friends and playing beach volleyball.

Lately Stephanie's been feeling lousy and tired. It started around 3 weeks ago and hasn't gone away. Her mom decided to take her to the doctor to figure out what's wrong.

c. Read the question on the outside of each envelope, but do not open the envelopes yet. On the inside flap of each envelope is a clue, or answer, to the question on the outside. However, only some of the questions and clues will help you.

   As a group, try to select the fewest number of questions (and clues) possible to help you distinguish among the illnesses above and diagnose Stephanie's illness. Open only one envelope at a time.

   d. According to your group's analysis, Stephanie has__________________________________ .

   e. How many questions/clues did your group use? _____________________________________

   f. Which question numbers (1 through 15) did your group select? ______________________

d. Answer the following questions.

   c. Which information helped you to diagnose Stephanie illness? Explain why or how this information helped.

   ____

   ____

   ____

   ____

   ____

   d. Would antibiotics be helpful to Stephanie? Why or why not?

   ____

   ____

1. Does Allison have a headache?	1. Yes, she has a headache.
2. What is Allison's body temperature?	2. Her body temperature is 98.6°F (normal).
3. What is Allison's weight?	3. She weighs 104 lbs.
4. What is Allison's height?	4. She is 59 inches tall.
5. What is Allison's blood pressure?	5. Her blood pressure is 120 over 80 (normal).
6. What is the condition of Allison's nose?	6. She has lots of clear mucus (runny nose) and has difficulty breathing through her nose.
7. What is the appearance of Allison's throat?	7. She has no redness or white patches.
8. Are bacteria that cause strep throat present? (A doctor or nurse would swab her throat and run a rapid antigen test for bacteria.)	8. There are no disease-causing bacteria present in her throat.
9. Does Allison have a cough?	9. Yes. She has a congested cough (a cough) with mucus).
10. Does Allison's body ache?	10. No. Her body does not ache.
11. Has Allison vomited in the past 24 hours?	11. No. She has not vomited.
12. Has Allison taken any medicine?	12. No. She has not taken any medicines. (This is important because medications, like Tylenol™, can mask symptoms.)
13. What did Allison eat yesterday and this morning?	13. Yesterday, she ate waffles, syrup, milk, pizza, apple juice, tacos, tortilla chips, beans, candy and ice cream. Today, she had orange juice.
14. What is the weather like outside?	14. The weather is cold and rainy.
15. Have any of Allison's friends or family members been sick?	15. Her cousin had strep throat two weeks ago. Two classmates have colds. Her Dad has a headache and her brother vomited last night.

1. Does Carlos have a headache?	1. Yes, he has a headache.
2. What is Carlos' body temperature?	2. His body temperature is 101.2 (fever)
3. What is Carlos' weight?	3. He weighs 155 lbs.
4. What is Carlos' height?	4. He is 68 inches tall.
5. What is Carlos' blood pressure?	5. His blood pressure is 88/55 (low).
6. Has Carlos had chills in the past 24 hours?	6. He had the chills the day before.
7. What is the condition of Carlos' nose?	7. His nose is clear.
8. Has Carlos been sweating recently?	8. He was sweating all night despite the cool temperature.
9. Does Carlos have a cough?	9. No. He does not cough.
10. Does Carlos have muscle pains?	10. His body does ache.
11. Has Carlos vomited in the past 24 hours?	11. Yes, he has vomited.
12. Has Carlos taken any medicine?	12. No. He has not taken any medicines. (This is important because medications, like Tylenol™, can mask symptoms.)
13. What did Carlos eat yesterday and this morning?	13. Carlos wasn't hungry after returning from his flight. He has only had some water.
14. What is the weather like outside?	14. The weather is warm with clear skies.
15. Have any of Carlos' friends or family members been sick?	15. Carlos' aunt was not feeling well in Guatemala when he left. Her house was next to the soccer field.

1. Does Stephanie have a headache?	1. No, she doesn't have a headache.
2. What is Stephanie's body temperature?	2. Her body temperature is 100.6 (Slight fever)
3. How much does Stephanie weight?	3. She's been slowly losing weight over the past few weeks and now weighs 92 pounds.
4. What is Stephanie's height?	4. She is 58 inches tall.
5. What is Stephanie's blood pressure?	5. Her blood pressure is 120 over 80 (normal)
6. How well has Stephanie been sleeping?	6. She sleeps alright, but has been having chills and night sweats.
7. What is the appearance of Stephanie's throat?	7. She has no redness or white patches.
8. Are bacteria that cause strep throat present? (A doctor or nurse would swab her throat and run a rapid test.)	8. No, the strep test came back negative.
9. Does Stephanie have a cough?	9. She has been coughing consistently for three weeks. The coughs are producing yellow mucus.
10. Does Stephanie's body ache or have pains?	10. Her body doesn't ache, but she does have pain in her chest when she breaths.
11. Has Stephanie vomited in the past 24 hours?	11. No, she has not vomited.
12. Has Stephanie taken any medicine?	12. No, she has not taken any medicines. (This is important because medications, like Tylonol ™, can mask symptoms.)
13. What did Stephanie eat yesterday and this morning?	13. For the past 3 weeks, Stephanie hasn't had much of an appetite. All she's eaten is oatmeal and sandwiches.
14. What is the weather like outside?	14. The weather is sunny and warm.
15. Has any of Stephanie's friends or family members been sick?	15. Her best friend was out of school with strep throat two weeks back. Over a month ago she was visiting her cousin in the hospital daily for a week.