

Section Preview of the Student Book for

Cell Biology, 2nd Edition

Activities 2-4

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2 Cells and Disease

IN THE PREVIOUS activity, you learned about some of the factors that influence world health and disease. A **disease** is any breakdown in the structure or function of an organism. Scientists who study a particular disease gather information about how that disease affects the organism. They look at all levels of the organism, from molecules and cells to organs and the whole organism. Some scientists, like cell biologists, use microscopes to study the structure and function of cells in the full array of organisms, from humans to plants to insects to microbes. A **microbe** is a microscopic cellular organism or a virus, and some microbes cause infectious diseases. One way to detect and study many diseases is to compare blood from healthy and sick individuals under a microscope. In this activity you will examine samples of blood from healthy and diseased people.

Challenge

▶ How do observations of cells help doctors and scientists diagnose and study diseases?

MATERIALS

FOR EACH GROUP OF FOUR STUDENTS

- prepared slide, "Patient A Blood"
- prepared slide, "Patient B Blood"

FOR EACH PAIR OF STUDENTS

- microscope
- prepared slide, "Typical Human Blood"

FOR EACH STUDENT

- 6 Student Sheet 2.1, "Disease Information"
- 3 sticky notes

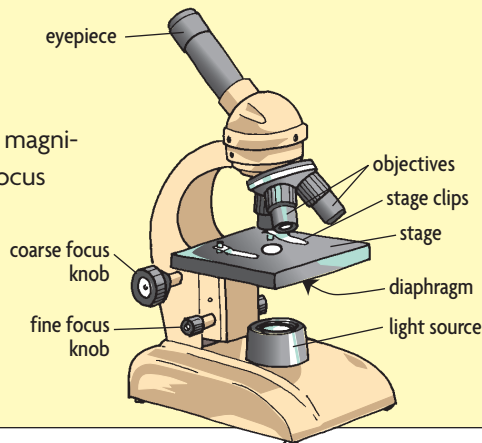
Focusing a Microscope

Be sure that your microscope is set on the lowest power before placing your slide onto the microscope stage. Place the slide on the microscope stage. Center the slide so that the sample is directly over the light opening, and adjust the microscope settings as necessary. If the microscope has stage clips, secure the slide in position so that it does not move.

Observe the sample. Focus first with the coarse-focus knob, and then adjust the fine-focus knob.

After switching to a higher power magnification, be careful to adjust the focus with the fine-focus knob only.

Return to low power before removing the slide from the microscope stage.



Safety

Always carry a microscope properly with both hands—one hand underneath and one holding the microscope arm. Because you are working with live organisms, be sure to wash your hands thoroughly after you finish the laboratory.

Procedure

Part A: Using the Light Microscope

1. Your teacher will demonstrate the different parts of a microscope, as shown in the figure above.
2. In your group of four, review the rules for handling a microscope. Demonstrate your knowledge of the parts of a microscope, according to your teacher's instructions.
3. Review the guidelines for focusing a microscope shown above.

Part B: Observing Blood

You are a doctor who has recently seen two patients who reported similar symptoms. From your examination of each patient you have gathered more information, which is shown below.

HISTORY FROM PATIENT A:

- Patient reports periods of feeling sick, but feels well most of the time.
- Patient recently returned from working in Africa with the Peace Corps.
- Patient reports frequent fevers, chest pains, and lung infections throughout youth and adulthood.

- After a two-hour hike a few months ago, she became so tired and out of breath that physical movement was difficult. She experienced joint and muscle pain in her arms and legs.

SYMPTOMS SEEN ON EXAMINATION TODAY:

- Vision problems and yellowing of eyes and skin.
- Abdominal area is tender to the touch.

HISTORY FROM PATIENT B:

- Patient reports becoming sick shortly after returning from a trip to Africa in the past month.
- Patient reports severe headaches and fatigue for the past few weeks.
- Patient reports a fever and muscle and joint pain in the past week.

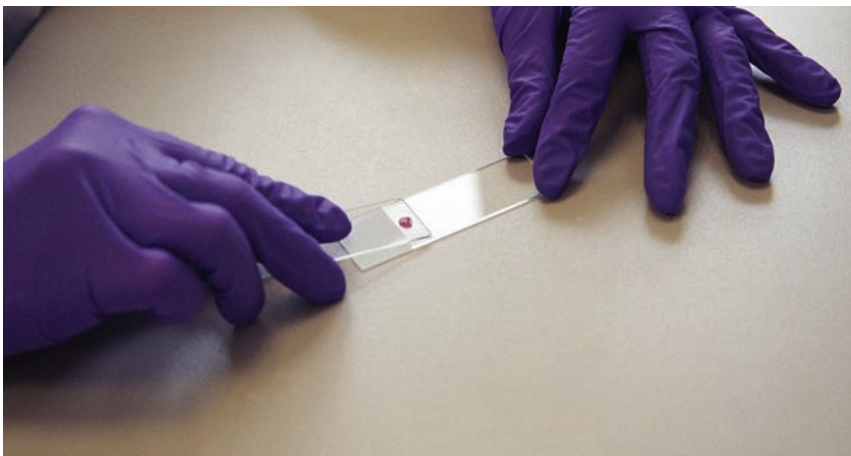
SYMPTOMS SEEN ON EXAMINATION TODAY:

- Yellowing of the eyes.
- Abdominal area is tender to the touch.

4. Prepare a chart with four columns labeled as shown below.

<i>Observations of Blood Samples</i>			
<i>Slide</i>	<i>Shape of cells</i>	<i>Color of cells</i>	<i>Number of cells in field of view</i>

With your partner, obtain a slide labeled “Typical Human Blood.” This blood sample will serve as your reference. As you observe on medium or high power, record your observations in the chart.



A lab technician prepares a blood sample for viewing under the microscope.

5. Based on the patient's report and the examination, the patient's symptoms suggest one of four possible diseases. Read the descriptions of those diseases below. For each disease, draw a sketch of what you predict you would observe in a blood sample under the microscope as compared to the typical human blood you just observed.

Possible Diseases		
DISEASE	SYMPTOMS	DESCRIPTION
Polycythemia vera	weakness, disturbed vision, headache, dizziness, enlarged liver, abdominal pain due to an enlarged spleen	An abnormality in the bone marrow causes an overproduction of red blood cells, almost double in some cases. This increases blood volume and thickness, leading to life-threatening blood clots.
Sickle cell disease	joint and muscle pain, anemia, vision problems, abdominal pain, yellowish color of skin and eyes, and frequent infections	An inherited genetic mutation (error) changes the hemoglobin protein, causing the proteins to stack on one another within the red blood cells. This produces a sickle- or banana-shaped blood cell. Sometimes under the microscope the sickle cells appear flattened.
Spherocytosis	yellowish color of skin and eyes, abdominal pain from an enlarged spleen, pale skin, and weakness	A genetic disorder causes the red blood cells to become small, spherically shaped and fragile. These cells are destroyed by the spleen. It is often diagnosed in childhood.
Malaria	fever, headaches, extreme fatigue, mild yellowish color of skin and eyes, abdominal pain, and body aches	An infectious disease, malaria is caused by a single-celled parasite of the genus <i>Plasmodium</i> and is carried by mosquitoes. A <i>Plasmodium</i> appears as an irregular purple spot containing dark dots when a sample is stained and viewed under a microscope.

6. Decide with your group which pair will first observe Patient A's blood and which will first observe Patient B's.
7. Observe, and draw what you see on the slide sample at medium or high power.
8. Switch patients' slides with the other pair in your group. Repeat Step 7 for the other patient.
9. In your science notebook, write hypotheses for which disease is affecting each patient. Include the information from the slide samples you observed and the "Possible Diseases" table to support your hypotheses.
10. Follow your teacher's directions for reading the case study about malaria. As you read, follow the "Read, Think, and Take Note" strategy. To do this:
- Stop at least three times during the reading to mark on a sticky note your thoughts or questions about the reading. Use the list of guidelines below to start your thinking.
 - After writing a thought or question on a sticky note, place it next to the passage in the reading that prompted your note.
 - Discuss with your partner the thoughts and questions you had while reading.

Read, Think, and Take Note: Guidelines

As you read, from time to time, write one of the following on a sticky note:

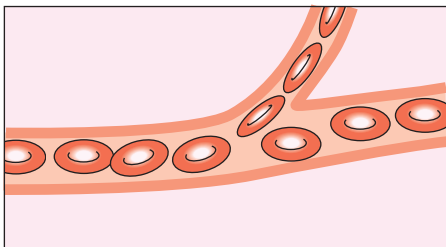
- Explain a thought or reaction to something you read.
- Note something in the reading that is confusing or unfamiliar.
- List a word that you do not know.
- Describe a connection to something you learned or read previously.
- Make a statement about the reading.
- Pose a question about the reading.
- Draw a diagram or picture of an idea or connection.

11. Complete the information for malaria on Student Sheet 2.1, “Disease Information” after you read the case study.

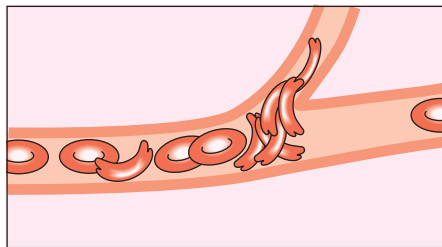
Analysis

1. Compare each patient’s blood sample to a normal blood sample. What abnormalities do you observe?
2. Based on your observations, which patient has an infectious disease? Explain how you know.
3. Observe the diagrams below. Which patient would you diagnose with sickle cell disease? Explain, using evidence from this activity.

Patient 1



Patient 2



4. How do microscope observations of cells help doctors and scientists diagnose and study diseases? Give specific examples from this activity.

5. From what you learned about malaria in the case study
 - a. A **trade-off** is an exchange of one thing in return for another, giving up something that is a benefit or advantage, in exchange for something that may be more desirable. What are the trade-offs of using insecticides to kill the mosquitoes?
 - b. What are the benefits of using insecticides to kill mosquitoes that might be carrying *Plasmodium*?
6. Based on the malaria case study, how does resistance develop in a population of disease-causing microbes?

KEY VOCABULARY

cell	noninfectious disease
disease	protein
infectious disease	protist
malaria	sickle cell
microbe	trade-off
mutation	vector

CASE STUDY

Malaria

MORE THAN THREE billion people worldwide live in areas where malaria transmission is a risk. Most of the deaths from malaria are in children. In the 1950s and 1960s, world health experts began an effort to wipe out malaria. Although their techniques reduced malaria for a while, they ultimately failed. Today, malaria still exists, and is even spreading to parts of the world where it was thought to have been wiped out or was not a high risk.

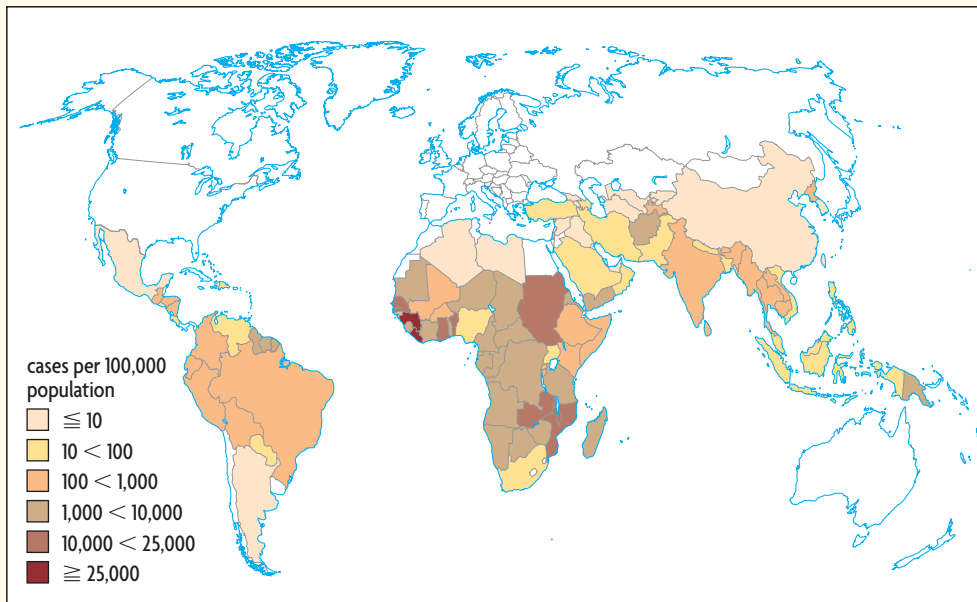
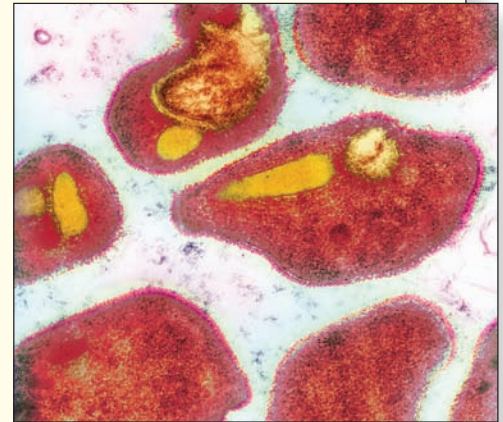
SYMPTOMS AND DISEASE MECHANISM

People once thought that malaria was caused by inhaling the fumes from stagnant water,

Burden of Disease		
	NUMBER OF NEW CASES PER YEAR	NUMBER OF DEATHS PER YEAR
Worldwide	200–300 million	450,000
United States	1,500–2,000	0–10

such as that in swamps. In 1880, a French army doctor first observed parasites inside the red blood cells of malaria patients. It has since been found that the cause of malaria in humans is one of several species of the single-celled parasitic protist *Plasmodium*.

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Plasmodium parasites in the blood (above)
Locations where malaria occurs (left)

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Shortly after the discovery of *Plasmodium*, scientists determined that female mosquitoes, which breed in standing water, are the vectors for malaria. A **vector** is an organism that does not cause the disease itself, but spreads disease-causing microbes from one host to another.

The symptoms of malaria can be mild to deadly and include fever, chills, fatigue, an enlarged liver, an enlarged spleen, anemia (reduced number of red blood cells), seizures, coma, and kidney failure.

The following traces the steps of malaria infections:

1. A mosquito becomes infected with *Plasmodium* when it bites and sucks the blood of a human infected with *Plasmodium*.
2. When the infected mosquito bites a person it injects *Plasmodium* in its saliva into that person.
3. The *Plasmodium* travels from the point of the mosquito bite through the bloodstream to the liver and infects liver cells. The *Plasmodium* then begins to reproduce inside the liver cells. Sometimes *Plasmodium* remains in a person's liver and causes no symptoms. Other times the liver cells burst, releasing *Plasmodium*.
4. The *Plasmodium* travels back into the bloodstream from the liver, where it invades red blood cells and then reproduces. The infection is active at this point, and the person experiences symptoms.
5. The red blood cells eventually rupture, which releases the parasites back into the bloodstream where they might be picked up by another mosquito.

MALARIA PREVENTION AND TREATMENT

In the 1950s and 1960s, world health officials hoped to eradicate malaria worldwide with the chemical DDT (dichlorodiphenyltrichloroethane). DDT is a powerful insecticide that kills many insects, including mosquitoes. From 1947 to 1951, in areas where malaria was present in the United States, DDT was applied inside millions of households and over miles of swamps, fields, and forests. Through these DDT applications, malaria protists were effectively wiped out in this country. However, less concentrated efforts in other malaria-ridden parts of the world, and widespread spraying of DDT to kill all sorts of other insects, created *Plasmodium*-carrying mosquito populations that are now resistant to DDT.

Resistance develops if a few mosquitoes in a population are genetically able to withstand

The female Anopheles mosquito is a vector for malaria.



the toxic effects of DDT. When more DDT is applied, more mosquitoes that are sensitive to DDT die. The resistant mosquitoes, however, survive and reproduce greater numbers of resistant mosquitoes until they are a significant proportion of the population, making DDT ineffective.

Scientists also learned that DDT harms other organisms in the environment and is a threat to wildlife, especially birds. One effect of DDT on birds is eggshell thinning, causing the shells to break too soon and the embryo inside to die. Some evidence also suggests that DDT might cause cancer or neurological problems in humans. Today, DDT is banned for agricultural use worldwide, but it still is used in some places to control *Plasmodium*-carrying mosquitoes and prevent them from biting people.

DDT or alternative insecticides are typically sprayed on the inner walls of homes and on protective nets that are draped over sleeping areas, discouraging mosquitoes from coming near.



Studies have shown that insecticide-treated nets are an effective and low-cost tool to control mosquitoes. A large study in Tanzania, where there is a high rate of malarial transmission, investigated the effect of insecticide-treated and untreated nets on infection in children aged one month to four years. The results, summarized below, show that both reduce the risk of death from malarial infection, but that there is greater success with the insecticide-treated nets.

Treatment of malaria infections centers on several drugs that kill the *Plasmodium* parasites that cause malaria. Some drugs attack the parasites when they are present in the blood, while others kill them when they are in the liver. Currently, physicians prescribe combinations of drugs that act together to kill *Plasmodium*.

CHALLENGES TO PREVENTION AND TREATMENT

There are two problems health officials must overcome to make mosquito-net programs more successful in preventing malaria. First, nets that are manufactured and sold pretreated with insecticide must be retreated within

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Effectiveness of Mosquito Nets

PREVENTION METHOD	PERCENT REDUCTION IN RISK OF DEATH
Insecticide-treated nets	27
Untreated nets	19

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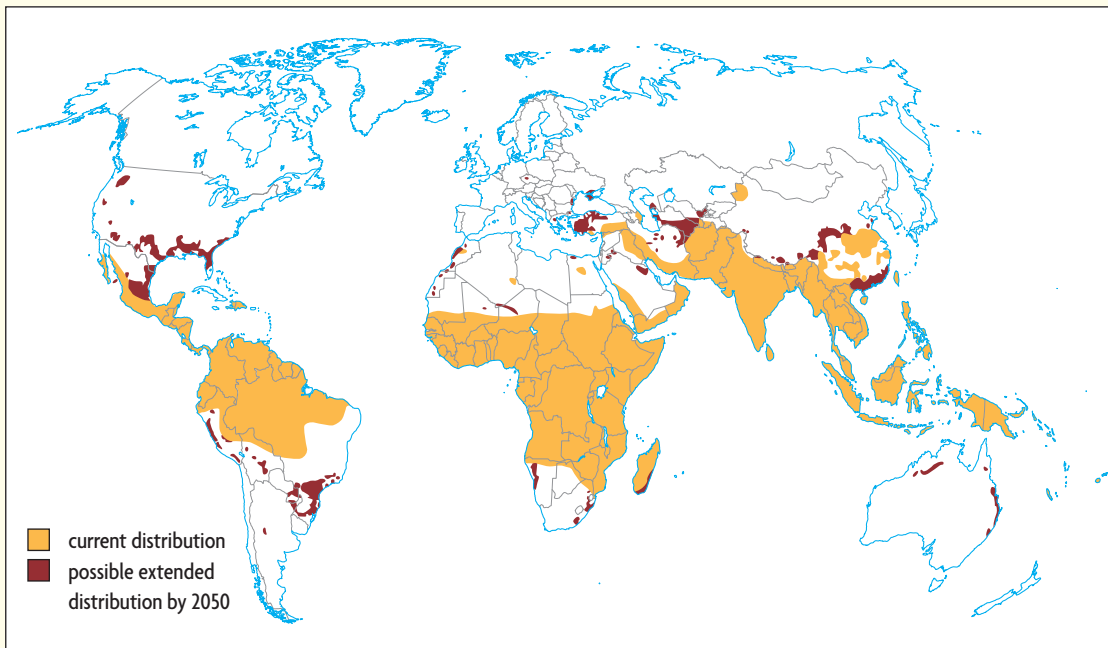
6 to 12 months for them to remain fully effective. Also, the nets, even though relatively low in cost, are still too expensive for some people living in countries with few economic resources. They must rely on programs that donate or reduce the price of the nets and retreatment kits.

There are also major challenges emerging with the drugs that treat malaria. In some areas, two types of *Plasmodium* that cause malaria have become resistant to the medication available for treatment, which means it no longer kills the parasite. The resistance of *Plasmodium* to

drugs arises in the same way that mosquitoes acquire resistance to DDT. Since *Plasmodium* is less likely to develop resistance to several drugs at once, a combination of drugs is often given to patients. This approach often succeeds—as long as patients take all of the required doses of the medicine. But multidrug treatment is costly, and health care workers must monitor patients to make sure they complete their courses of treatment. In addition, it is often difficult to get all the right medicines to isolated communities.

Another potential challenge is the movement of malaria to

areas with temperatures that were once too cold for the mosquitoes and *Plasmodium*. If the climate of an area changes in a way that favors the breeding and survival of mosquitoes and *Plasmodium*, the risk for malaria in that area increases. Scientists are working with models to predict how climate change could affect the risk of malaria around the world. The model below shows malaria returning to parts of the United States. The effect of climate change on malaria distribution continues to be a point of discussion in the scientific community. ■



A model prediction of the effect of climate change on malaria distribution worldwide

3

What Is a Cell?

ALL LIVING THINGS are made of one or more cells. The **cell** is the basic unit of life and is where many life processes occur. Organisms made up of a single cell are called **single-celled organisms**. Bacteria and protists are examples of single-celled organisms. Other organisms, such as humans, dogs, and plants, are made up of trillions of cells, and therefore, are **multicellular organisms**. In this activity you will observe microscope slides of cells from various single-celled and multicellular organisms.

Challenge

► What are the similarities and differences in cells from various living organisms?



A Paramecium, shown above, is a single-celled organism. Grass, dogs, and people, shown at left, are multicellular organisms.

MATERIALS

FOR EACH GROUP OF FOUR STUDENTS

prepared slide of human cheek cells
 prepared slide of animal sperm cells
 prepared slide of typical *Bacillus* bacteria
 prepared slide of typical *Coccus* bacteria
 prepared slide of plant leaf cells
 prepared slide of plant stem cells
 prepared slide of plant root cells
 piece of onion
 piece of *Elodea* plant
 mixed protist culture
 bottle of Lugol's solution
 cup of water
 dropper
 pair of forceps

FOR EACH PAIR OF STUDENTS

microscope
 microscope slide
 microscope slide with a well
 coverslip
 paper towel
 colored pencils

FOR EACH STUDENT

Student Sheet 2.1, "Disease Information" from Activity 2
 safety goggles
 3 sticky notes



Safety

Wear safety goggles while working with chemicals. Do not touch the chemicals or bring them into contact with your eyes or mouth. Wash your hands after completing the activity.

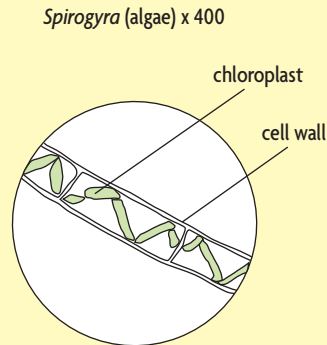
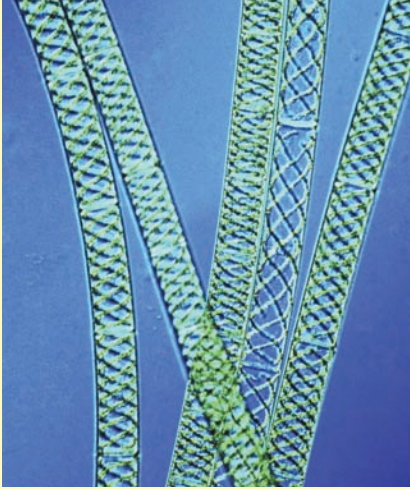
Be careful not to let the objective lenses hit the microscope slides.

Procedure

1. In your science notebook, use a full page to draw a diagram of what you think a typical cell is like, including its various parts. On your diagram, write labels for as many parts of the cell as you can. If you know the function of the part, write a brief description of it next to the label.
2. Review the Microscope Drawing guidelines on the next page.
3. View the prepared slide of human cheek cells. Select two cells at high power and sketch them in your science notebook.
4. Repeat Step 3 for the prepared slide of animal sperm cells.
5. In your group of four, decide which pair will prepare a slide of onion and which will prepare a slide of *Elodea*.

Microscope Drawing Made Easy

Below is a picture taken through a microscope of the alga *Spirogyra*. The diagram to the right shows what a biologist or biological illustrator might draw and how he or she would label the drawing.



SOME TIPS FOR BETTER DRAWINGS:

- Use a sharp pencil and have a good eraser available.
- Try to relax your eyes when looking through the eyepiece. You can cover one eye or learn to look with both eyes open. Try not to squint.
- Look through your microscope at the same time as you do your drawing. Look through the microscope more than you look at your paper.
- Don't draw every small thing on your slide. Just concentrate on one or two of the most common or interesting things.
- You can draw things larger than you actually see them. This helps you show all of the details you see.
- Keep written words outside the circle.
- Use a ruler to draw the lines for your labels. Keep lines parallel—do not cross one line over another.
- Remember to record the level of magnification next to your drawing.

6. With your partner, follow the instructions below to prepare your slide.

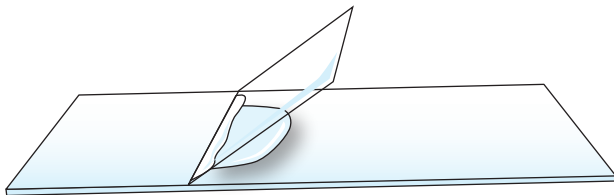
IF YOU ARE PREPARING ONION:

- Place one drop of water and one drop of Lugol's iodine solution on the slide.
- Use forceps or your fingernail to peel off a piece of the very thin inner layer of the onion.
- Place the piece of onion into the drops on the slide.

IF YOU ARE PREPARING ELODEA:

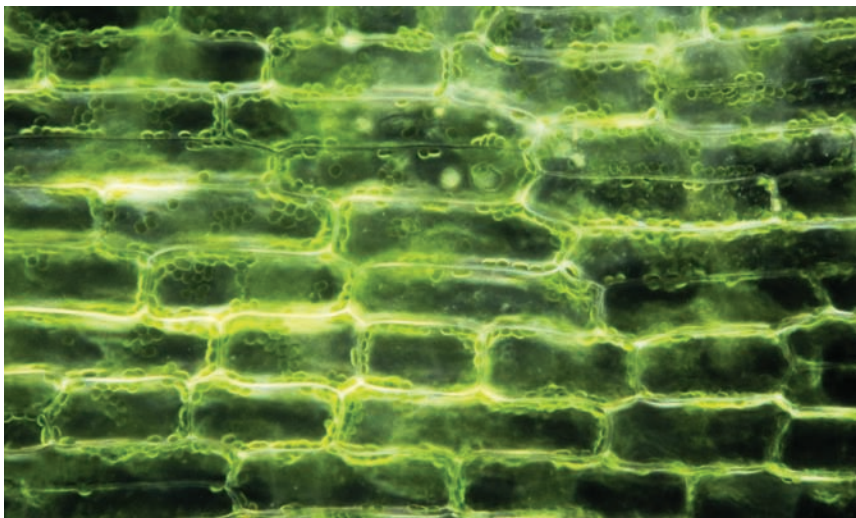
- Place 1–2 drops of water on the slide.
- Select one small, thin, light-green leaf.
- Place the leaf into the drops on the slide.

7. Carefully touch one edge of the coverslip to the water, at an angle. Slowly allow the coverslip to fall into place. This should prevent trapping of air bubbles under the coverslip.



Placing the coverslip

8. Observe the plant cells that you just prepared. Draw what you see at high magnification. Be sure to label your drawing with the name of your plant. When you have finished, do the same for the plant cell slide that was prepared by the other pair in your group.



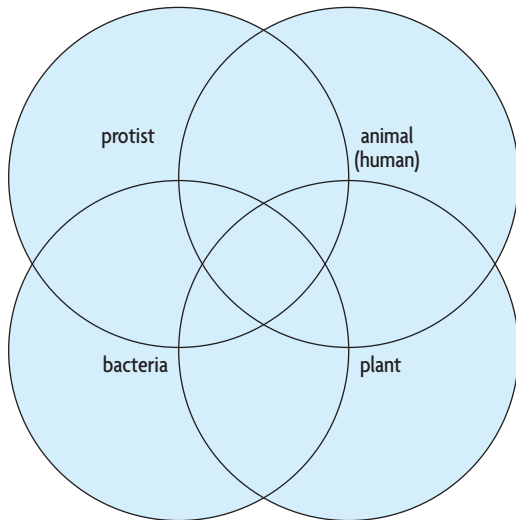
Plant cells

9. Observe, and draw at high magnification, the prepared slides of plant leaf, stem, and root cells.
10. With your partner, place 1–2 drops of the mixed protist culture on a clean microscope slide with a well. Observe and draw at high magnification two different types of protists.
11. View the prepared slide of typical *Bacillus* bacteria, focusing on one or two cells at high magnification. Draw one or two of the bacteria cells. Be sure to label your drawings with the name of the sample.
12. Repeat Step 11 for the prepared slide of typical *Coccus* bacteria.
13. Clean up according to your teacher’s instructions.
14. Go back to the drawing of a cell that you made in Step 1. Add or change any information on that drawing based on your work in this activity.
15. Follow your teacher’s directions for reading the case study about tuberculosis (TB). As you read, follow the “Read, Think, and Take Note” strategy.
16. Complete the information for tuberculosis on Student Sheet 2.1, “Disease Information,” after you read the case study.

Analysis

1. Compare the four different types of cells (animal, plant, protist, bacteria) you observed. What structures do they have in common?
2. Compare the three types of specialized plant cells (leaf, stem, and root). What similarities and differences did you observe?
3. When you compare the *Plasmodium* protist you observed in Activity 2 and the two protists you observed in this activity, what similarities and differences do you notice?
4. When you compare the two types of bacteria you observed, what similarities and differences do you notice?

5. In your science notebook, create a larger version of the Venn diagram shown below. Use what you have learned about cells to record the unique features of the cells of each group of organisms in the appropriate space. Record any common features between groups in the spaces created by overlaps.



6. Based on the Venn diagram you created, what features are common to all cells?
7. One focus of TB treatment is ensuring that people who are being treated are closely monitored by health care workers. Explain why this is important, citing evidence from the tuberculosis case study.

KEY VOCABULARY

antibiotic	multicellular organism
bacteria	protist
cell	single-celled organism
latent	tuberculosis
macrophage	

CASE STUDY

Tuberculosis

TUBERCULOSIS IS A disease that has appeared in the human population for centuries. Evidence of TB infection has been found in the skulls of Egyptian mummies estimated to be at least 3,000 years old. TB is caused by the *Mycobacterium tuberculosis* bacterium and was common in Europe and North America in the 18th and 19th centuries. It declined in those regions as living conditions, nutrition, and treatment improved. Worldwide today, however, it is estimated that at least one-third of the human population is infected with TB bacteria.

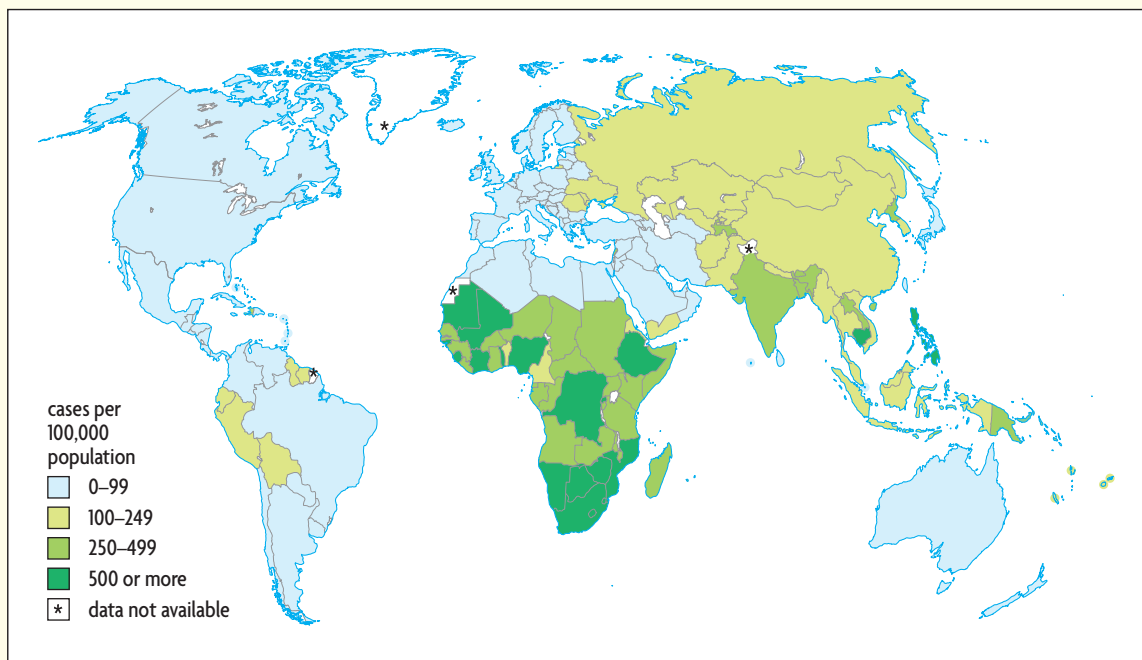
Burden of Disease			
	TOTAL NUMBER INFECTED	ESTIMATED NUMBER OF DEATHS PER YEAR	ESTIMATED NUMBER OF NEW CASES PER YEAR
Worldwide	2 billion	1.5 million	9–10 million
United States	10–15 million	500–600	10,000

SYMPTOMS AND DISEASE MECHANISM

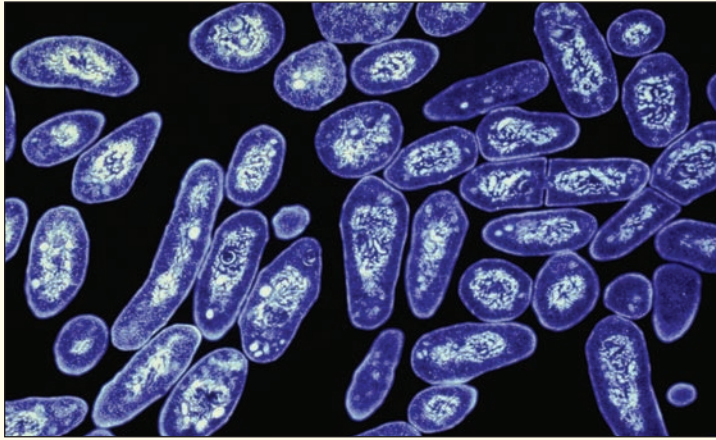
The physical symptoms of TB include appetite and weight loss, coughing, night sweats, fever, fatigue, and chills. TB usually infects tissue in the lungs, but can also infect other organs in the body, including the brain, kidneys, and spine. Since TB is an extremely infectious disease that

can be passed through a cough, sneeze, or even talking with an infected person, people are at higher risk of infection if they live in densely packed urban areas or may be exposed to infected individuals in crowded, closed environments, such as hospitals, prisons, clinics, or airplanes.

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Global distribution of tuberculosis cases



Mycobacterium tuberculosis bacteria

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TB infection is latent or active. In a latent infection, the person has a positive skin or blood test for TB, but a normal chest X-ray. The bacteria are alive inside the body, but they are inactive. A person with a latent infection does not feel sick, has no symptoms, and cannot transmit the TB bacteria to others. Sometimes the latent form becomes active, and symptoms develop. Only 5–10% of people who are infected with TB bacteria, however, ever become sick or infectious. Antibiotic treatments after a person has tested positive for TB reduce the risk of latent TB becoming active, if the person takes the drugs for many months.

The following traces the steps that lead to a tuberculosis infection:

1. An uninfected person inhales TB bacteria in droplets that were released into the air by an infected person, whether minutes or hours earlier.
2. The bacteria enter the lungs, and if they are not immediately killed by the body's immune system, they are ingested by macrophages, a type of white blood cell. The macrophages do not destroy the bacteria.
3. Most of the time, the bacteria are held in check by the immune system. In this case, the infection is referred to as a latent infection.
4. If the infection becomes active, the TB bacteria multiply and travel to the blood. Possible reasons for a latent infection to become active include a weakened immune system, often due to HIV/AIDS infection, malnutrition, cancer, or aging. The bacteria might

spread to other organs, but they can only be transmitted out of the body and to other people by the infected person's exhaling them from the lungs.

TUBERCULOSIS PREVENTIONS AND TREATMENTS

While there is a vaccine available to prevent TB, its effectiveness is limited. Worse, the vaccine has caused HIV-positive children to develop a TB infection. Health experts think that being able to accurately detect active TB infections is more beneficial than vaccination to prevent infections.

In 1943, a man critically sick with TB was the first to be given an antibiotic to treat TB. Impressively, the bacteria quickly disappeared, and the man recovered. Now there are a number of antibiotics to treat TB, and they are usually prescribed in combinations of

two to four different drugs. Two of the most commonly prescribed today are isoniazid and rifampin. Isoniazid interferes with a bacterium's ability to make a compound needed in its cell walls. Rifampin prevents the bacterial cells from making proteins.

CHALLENGES TO PREVENTION AND TREATMENT

ANTIBIOTIC RESISTANCE

Like *Plasmodium*, TB bacteria have become resistant to many antibiotics. As with malaria, people who do not have access to timely and effective medical care or who don't complete a full course of treatment contribute to the resistance problem. In 2014, the World Health Organization (WHO) was notified of more than 480,000 cases of multidrug-resistant tuberculosis. Multidrug resistance in TB means that the bacteria are

resistant specifically to the two main antibiotics, isoniazid and rifampin. Because WHO is not notified of all cases, experts think that there are many more cases. The cost of treating multi-drug-resistant TB infections can be 1,000 times more expensive than treating non-resistant TB infections.

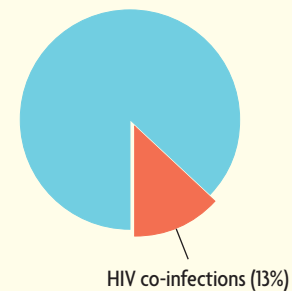
HIV/AIDS AND TB CO-INFECTION

Another reason for the high numbers of TB infections is the relationship between TB and HIV/AIDS. These two diseases are so closely tied to one another that they are often referred to as a co-infection.

HIV weakens the immune system, which then allows latent TB to become active and infectious or makes the patient more vulnerable to TB droplets inhaled from the air. A person who is infected with HIV/AIDS

is 50 times more likely to develop active TB in a given year than is an HIV-negative person. Also, the disease progresses more rapidly and deaths are higher in people infected with both HIV and TB than those who are infected only with TB. The primary cause of death in people infected with TB and HIV is the TB. Yet the vast majority of people with HIV worldwide have not been screened for TB. ■

HIV/AIDS co-infections as a percentage of the 9 million new TB cases per year



4

What Do Cells Do?

UNDERSTANDING NORMAL CELL structures and their functions helps scientists understand what goes wrong to allow diseases, including the infectious diseases caused by microbes, to progress. Although there are many differences between cells of various organisms, such as plants, animals, and microbes, there are some key similarities in all cells.

One structure common to every cell is a cell membrane that separates it from the outside environment. Similarly, every cell has genetic material in the form of DNA, and a large number of proteins and other molecules that carry out the chemical reactions needed for a cell to live, grow, and reproduce. Some cells contain structures that are surrounded by a membrane, which creates a barrier between the inside of the structure and the rest of the cell. These membrane-bound structures are called **organelles**.

In this activity, you will learn about some common cell structures and their functions in the cell.

Challenge

- What are the functions of the structures in cells?

MATERIALS

FOR EACH PAIR OF STUDENTS

computer with Internet access

FOR EACH STUDENT

Student Sheet 4.1, “Structure and Function of Cells”

Procedure

Part A: Computer Simulation

1. Visit the *Science and Global Issues* page of the SEPUP website at sepuplhs.org/sgi. With your partner, go to “What Do Cells Do?” and use Student Sheet 4.1 to guide you through the simulation.

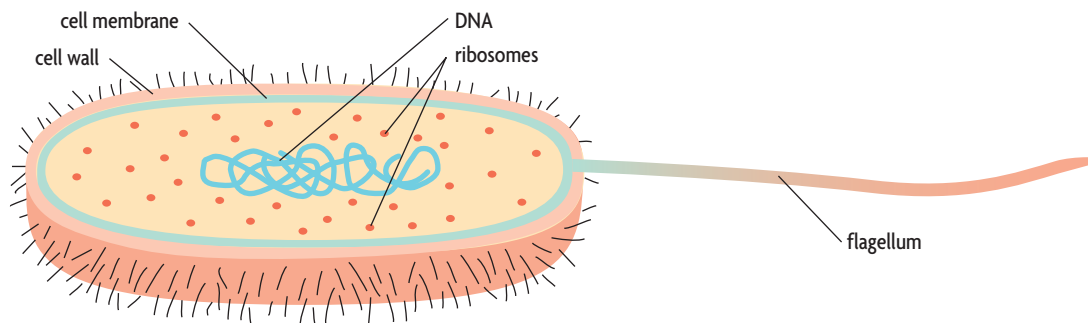
Part B: Comparing Cells

2. Read the following information about bacterial cells. This will prepare you to compare the cells of bacteria with those of animals and plants, which you investigated in Part A.

Reading

Bacterial Cell Structure

A bacterial cell does not have a nucleus or other membrane-bound structures. The genetic information of bacterial cells is stored in a large circular chromosome in the cytoplasm. The cell membrane of a bacterial cell performs the functions of many of the organelles of other organisms' cells. For example, to generate energy, a bacterial cell uses specific enzymes located in its cell membrane. Some bacterial cells can also perform photosynthesis at the cell membrane. The ribosomes in bacteria differ from ribosomes in eukaryotes in size and molecular composition, but like the ribosomes in eukaryotes, they carry out protein synthesis. In bacteria, as in eukaryotes, the cytoplasm also contains numerous enzymes that speed up reactions, such as the ones involved in digestion. Bacteria have an outer cell wall that makes them rigid and gives them shape. The cytoskeleton of prokaryotic cells serves some of the same functions as the eukaryotic cytoskeleton, but is made of different proteins. To move around, some bacteria use long tail-like structures called flagella, or short hair-like fibers called cilia. Although these flagella and cilia may appear similar to those of eukaryotes, they are made of different proteins and produce motion by a different mechanism than that of eukaryotic cilia and flagella.



Antibiotics

There are a number of antibiotics that can treat bacterial infections. The chart below shows how some antibiotics kill bacterial cells or keep them from reproducing.

Four Classes of Antibiotics	
ANTIBIOTIC CLASS	MODE OF ACTION IN BACTERIAL CELL
β -lactams	Interfere with cell wall structure
Tetracyclines	Interfere with protein synthesis
Quinolones	Interfere with the copying of bacterial DNA
Sulphonamides	Interfere with the production of an enzyme needed to copy the bacterial DNA

- Use your understanding from the simulation and the reading above to make changes and additions to the Venn diagram you created in the simulation



Penicillium mold produces an antibiotic that has saved many lives.

Analysis

1. Label each of the following cell types as eukaryotic or prokaryotic:
 - Animal
 - Plant
 - Bacteria
2. **a.** Describe the structures an animal cell must have for it to produce a protein.
- b.** Explain how these structures work together to produce a protein.

KEY VOCABULARY

bacteria	Golgi apparatus
cell membrane	lysosome
cell wall	nucleus
cilium, cilia	organelle
cytoplasm	prokaryotic cell
cytoskeleton	ribosome
endoplasmic reticulum (ER)	vacuole
eukaryotic cell	vesicle
flagellum, flagella	