STUDENT HANDOUT

Disaster

On September 1, 1923 at 11:58 AM an earthquake with a magnitude of 7.9 occurred in a bay just south of Tokyo. Tokyo and Yokohama, a relatively young port city with a strong international influence, were the closest large population centers. After the earthquake a tsunami with an 11 meter high crest hit Yokohama and surrounding areas. Fires spread throughout Tokyo and Yokohama, and with water mains broken by the quake there was no way to fight them. The earthquake led to a 2 meter uplift on the coast, and a 4.5 meter horizontal displacement of land.

Even though it lasted only 14 seconds, it was a huge amount of energy released. 570,000 homes were destroyed, and more than 140,000 people were killed. With telegraph technology connected to radio, news from Japan to the countries of the West moved rapidly. The US and other countries mobilized support for victims of the earthquake within 24 hours.

Japan had annexed Korea more than a decade earlier, and, in the months before what came to be called the Great Kanto Earthquake, a group working for the liberation of Korea had been conducting terrorist attacks. Rumors spread in the aftermath of the quake that Koreans were looting and starting fires. Violent attacks on Koreans, and anyone thought to be Korean, followed. The government tried to protect Koreans, but also covered up any attacks that occurred.

This event, and Japan's dependence upon the West for support in recovery, fueled growing nationalism. This increased the Japanese imperialism and expansionism of the last decades.

Earthquakes were, and still are, common in that part of the Pacific. So are volcanoes. These geological factors shaped the islands, and when US troops fought there in WWII these conditions shaped logistics, and even the path of the war.

There is a diamond shaped continental plate—the Philippine plate--pinned between the much larger Pacific and Eurasian plates. The Pacific plate is moving slowly but relentlessly west, pushing the Philippine plate ahead of it. Where the plates meet the Pacific sinks below both the Philippine and Eurasian plates, and the Philippine plate dives under the Eurasian plate. This pattern of plate convergence is called subduction, and leads to earthquakes and volcanoes. Where the plates come together in the ocean they form volcanoes which can emerge from the ocean,

Mt. Mayon volcano, Legaspi in the Philippine Islands in April 1945. The National WWII Museum, 2008.354.637.

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STUDENT HANDOUT

Disaster

creating islands. From New Guinea to the Marianas and Iwo Jima (on the east side, between the Philippine and Pacific plates), from the Philippines to Okinawa and up (on the west side, between the Eurasian and Philippine plates) to Japan (split by the Eurasian and Pacific plates), all those islands are formed from volcanic activity. Some of those islands are very old, mostly dead, volcanoes, and the coral reefs that surround them (like Tinian, or the Bikini atoll). Others are younger, and form very high tropical peaks (like in the Philippines).

Iwo Jima and its famous landmark, Mt. Suribachi on the southern tip of the island. This is an aerial view showing US landings on the island on 24 February 1945. The National WWII Museum, 2011.102.530.

Iwo Jima, which in its original Japanese name means 'sulfur island,' was formed by slightly different volcanic activity that led to its peculiar geography. There is abundant groundwater on Iwo Jima, all of it very hot and enriched in minerals. The frequent volcanic activity there is mostly steam created by the interaction of groundwater and magma (molten rock).

The geological theory that explained volcanoes and earthquake patterns, called Plate Tectonics, wasn't solidified until the late 1960s. So troops went into this zone, where there were more than two dozen large earthquakes (> 6.0) between 1940 and 1946, without any way to predict what was going on, or any understanding of what each stop on the island-hopping path to Tokyo would bring.

How did the Earthquake of 1923 influence WWII?

How did the geology of the region shape the war?

Put together your knowledge of plate tectonics and the information in the passage above. Draw on the back of this page a cross-section of the crust showing how the Pacific plate, the Philippines plate, and the Eurasian plate interact. Indicate where volcanoes might form and earthquakes occur.

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Saving Soldiers
A Real World Science Lesson Plan

BACKGROUND:
WWII was a time when many discoveries in medicine were put to use.

Penicillin, which was discovered in 1928, was finally developed into a powerful antibiotic that could fight infections. Dried blood plasma, used to treat shock and trauma symptoms, was developed after decades of research on blood.

Malaria was a big problem in WWII, especially in the Pacific campaign. The primary prophylactic for Malaria was quinine. Quinine was harvested from a plant native to South America that was grown in plantations in the South Pacific. The Japanese had controlled that region ever since the US entered the war, so quinine was in short supply. No good medical treatment for malaria was developed—that disease is still problematic today. Development of the pesticide DDT did help cut down on the mosquitoes that are vectors of the disease.

OBJECTIVES:
- Students will be able to explain how Malaria is contracted and the results of the disease.
- Students will develop a theoretical treatment for Malaria.
- Students will be able to describe the development of antibiotic treatments, and how antibiotics are used today.
- Students will differentiate between prokaryotic and eukaryotic cells, and describe potential targets for antibiotics.
- Students will summarize the development of dried blood plasma.
- Students will make a model of blood as a tissue, and be able to describe the components of this tissue.

GRADE LEVEL:
5-8 with enrichment activities for advanced students

STANDARDS:
3rd-5th grades:
- Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost. **NGSS Science and Engineering Practices: Asking Questions and Defining Problems**
- Construct and/or support an argument with evidence, data, and/or a model. **NGSS Science and Engineering Practices: Constructing Explanations and Designing Solutions**
- Develop a model using an analogy, example, or abstract representation to describe a scientific principle or design solution **NGSS Science and Engineering Practices: Developing and Using Models**

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6th-8th grades:

- All living things are made up of cells. In organisms, cells work together to form tissues and organs that are specialized for particular body functions. **NGSS LS1.A**
- Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions. **NGSS Science and Engineering Practices: Asking Questions and Defining Problems**
- Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. **NGSS Science and Engineering Practices: Constructing Explanations and Designing Solutions**
- Develop and/or use a model to predict and/or describe phenomena. **NGSS Science and Engineering Practices: Developing and Using Models**

TIME REQUIREMENT:

Fungus Amongst Us will take an hour to read, discuss, and answer the questions. **Plasma for Trauma** will take about the same amount of time. **Fighting Malaria** could take an hour or more if you want to give students more time. **Blood in a Bag** will take about half an hour, and **Antibiotic Targets** will take an hour.

MATERIALS:

Student Handouts: Fungus amongst us, Plasma for trauma, and Antibiotic targets require only the handouts and paper for student work.

For Blood in a Bag, you'll need for each group:

- 1 quart-sized Ziploc bag
- 2 cups vegetable oil (plasma)
- 20 skittles (red blood cells)
- 10 mentos (white blood cells)
- 10 tic tacs (platelets)
- 1 tsp candy sprinkles (clotting factors and antibodies)

PRIOR KNOWLEDGE:

Students will need to know that there are different kinds of cells in the body, and groups of different cells that work together are called tissues.

INFORMATION FOR TEACHERS:

Have extra paper towels and soap on hand, because this may get messy. You can use glycerin instead of oil, but it is more expensive, and more likely to dissolve the candies.

OUTLINE OF ACTIVITIES:

These activities don't necessarily go together as a single group, but could be used during your life science unit in appropriate places.

1. In **Antibiotic Targets** students learn about the first antibiotics (sulfa and penicillin), which work by actions on the cell walls of bacteria. They learn that since our cells don't have cell walls, they don't affect us in that way. They then design theoretical drugs that might affect bacteria and not us.
2. Similarly, in **Fighting Malaria**, students learn about the life cycle of the plasmodium that causes

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the disease, and develop theoretical treatments and preventions.

3. **Fungus Amongst Us** and **Plasma for Trauma** introduce students to the development of these treatments and the people and issues behind them.
4. In **Blood in a Bag** students make of model of a tissue, and learn about its components and their functions.

ASSESSMENT:

The student products from **Antibiotic Targets** and **Fighting Malaria** will assess knowledge but also student skills at problem-solving and design.

Fungus Amongst Us and **Plasma for Trauma** will provide an opportunity for students to practice making an argument and supporting it with evidence.

Blood in a Bag will allow students to practice making and interpreting models.

EXTENSION/ENRICHMENT:

Depending upon your grade and state standards, you may integrate a larger lesson about cell types with **Antibiotic Targets**, or connect a review of tissues and organs with **Blood in a Bag**.

REFERENCES:

The Mold in Dr Florey's Coat. Eric Lax, Henry Holt, 2005
The Demon Under The Microscope. Thomas Hager, Three Rivers Press, 2006.
History of the US Army Medical Corps **http://history.amedd.army.mil/books.html**

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STUDENT HANDOUT

Fungus Amongst Us

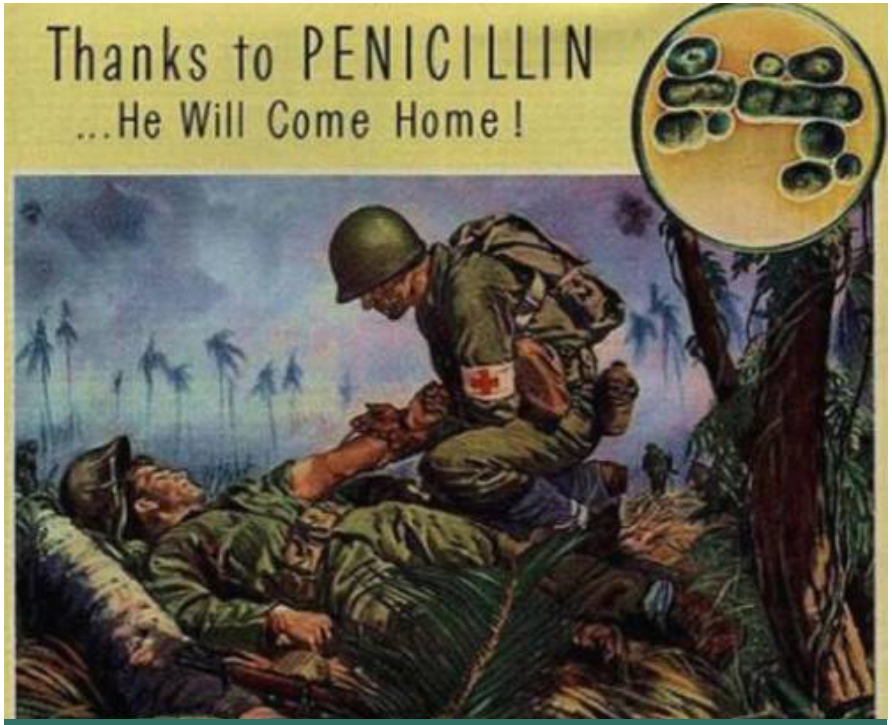
Many people think fungi are gross, but they are how we get bread to rise. They are in beer, and wine, and many cheeses.

Fungus also have saved millions of lives over the last century.

The very first antibiotics were sulfa drugs. In the years after WWI many people were looking for ways to treat infections. Many soldiers had died from what should have been survivable wounds because of infections. Infections were the source of many other deaths as well.

German scientists had been doing experiments with coal tar, a petrochemical. They learned how to make synthetic dyes to replace ones that had previously come from plants and bugs. They also learned that some of these dyes worked well to make bacteria visible under a microscope. These drugs, called sulfonamides, killed bacteria by attaching to their cell walls and changing them.

By the 1930's German chemical companies were making these sulfonamides into drugs. When WWII started they were the only antibiotics available.



Advertisement from Schenley Laboratories Inc.

Some scientists in England, led by Howard Florey at Oxford University, were trying to develop a fungus into an antibiotic. Florey, who was originally from Australia, knew that in 1928 Alexander Fleming had discovered that the fungus Penicillium killed bacteria. Florey's lab was raising Penicillium and pulling out of it chemicals that might be antibiotic. They used these chemicals to treat infections in mice. The infections were so successful that Florey knew he was on the right track.

But the Battle of Britain was on, and the cities of London were being bombed. Resources were tight too. Florey communicated with the government of the US, and got permission to go there and work with a US Dept of Agriculture lab to develop an antibiotic.

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STUDENT HANDOUT

Fungus Amongst Us

To make a long story involving moldy cantaloupe, giant incubation tanks, and lots of smelly fermentation short, Florey's team developed penicillin into a usable drug in spring of 1944. That was just in time for the D-Day invasion, and before many of the worst battles of the Pacific.

A hundred years ago there were no antibiotics in use, and today there might be too many. In the US antibiotics are commonly added to animal feed to prevent illness and promote growth. Antibiotics work on bacteria, not viruses, but often antibiotics are prescribed 'just in case' a patient might have an infection. Since bacteria evolve quickly, there are many strains that are immune to common antibiotics.

Another problem is that pharmaceutical companies, who make medicines and drugs, aren't developing new antibiotics to replace the ones that don't work. Drug development costs lots of money, and they don't make a lot of money from selling antibiotics. Less than a century after the discovery of the first antibiotics we are suffering a new bacterial challenge.

What do you think we should do to face this challenge? Or do you think it is not that big a deal after all? Be sure to support your position with evidence.

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STUDENT HANDOUT

Plasma for Trauma

Charles Drew was studying to be a medical doctor and researcher. He was at Columbia University, at one of the best teaching hospitals in the world. With his advisor John Scudder he studied how to diagnose and treat shock. Shock is a medical condition that follows trauma.

In the late 1930s, when Drew was doing his research, medicine had figured out how to preserve blood and set up blood banks. But the ways that this was done depended upon the area, and so the quality of blood to treat patients often was bad.

Drew decided to develop a protocol to make sure that blood was collected and stored in the best way possible. He developed screenings for donors, the best ways to draw and store blood, and with his advisor developed a new blood bank at their hospital.

The entry of the US into WWII may have surprised some, but it did not surprise everyone. When the Germans invaded Poland in 1939 the National Research Council began and investigation into the country's ability to provide blood for lots of injured soldiers. During the Battle of Britain, the following year, the US began a program called Blood for Britain. The plan to collect and store and the send the blood was written by Drew, who had finished his degree, and Scudder.

An advertisement from Owens-Coring Fiberglass.

After writing the plan, Drew went to Howard University, where he was a professor. He was African-American, and it was the only University that would hire him in the US. Research on separating plasma from blood and using it to treat shock had led to a program to dry plasma. Dried plasma could be stored without refrigeration, and transported to the Battlefront more easily.

Because of his success in leading the Blood for Britain program, Drew was recruited to lead a similar effort to mass produce dried plasma for the Red Cross in New York. He was again successful in setting up a program to save lives from death after trauma.

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STUDENT HANDOUT

Plasma for Trauma

One sad part of history is that segregation affected all parts of life in the US, including the blood program. In spite of its complete irrelevance, race was a factor in who got what blood and plasma. Supplies were segregated just like bathrooms and dining rooms. In his acceptance speech in 1944 for a medical award recognizing his efforts, Drew said " "It is fundamentally wrong for any great nation to willfully discriminate against such a large group of its people. . . . One can say quite truthfully that on the battlefields nobody is very interested in where the plasma comes from when they are hurt. . . . It is unfortunate that such a worthwhile and scientific bit of work should have been hampered by such stupidity."

Once he had the system for plasma production set up, Drew returned to Howard, where his wife and young daughter were. He said his most important ambition was to set up a great surgical education program at Howard. Drew died young, at age 45, in 1950, of trauma in a car accident.

A wounded US soldier receives plasma in the Philippines in 1945. The National WWII Museum, 2008.354.380.

A wounded US soldier receives plasma and other treatment in Cisterna, Italy, May 1944. The National WWII Museum, 2002.337.561.

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STUDENT HANDOUT

Fighting Malaria

Malaria is a disease that has been causing humans problems for centuries. In fact, its name comes from an Italian phrase 'mal aria,' which means 'bad air.' Long before people understood that many diseases are caused by micro-organisms, they blamed them on environmental conditions. They thought that places with bad air, like in poorly-drained swamps, brought on the disease.

We know today, and have since 1880, that malaria is caused by a parasite that is carried by some kinds of mosquitoes. A French army doctor in Algeria discovered it, and was awarded one of the earliest Nobel Prizes for his discovery.

When the US entered WWII the best treatment for malaria was quinine, and the best way to prevent it was to use mosquito nets when sleeping. Malaria was a serious concern for a military that was about to send millions of troops to the tropics, where the mosquitoes who carry the disease live. Not all mosquitoes carry Malaria, just the ones called Anopheles. All mosquitoes live near water, because they lay their eggs in water, and their larvae live in water. When they transform into adults the females search for animals they can bite and get blood from. That is what they eat for food.

Wounded soldiers in a New Britain hospital lie under mosquito nets, August 1944. The National WWII Museum, 2008.354.212.

Quinine was used to treat malaria. It prevents the parasite from digesting hemoglobin in the blood. That is its main source of food. Mosquito nets prevent mosquitoes from biting. In 1939 a Swiss scientist discovered that DDT, a chemical discovered by German scientists, killed mosquitoes and other insects. DDT kills insects by making their nervous system go haywire. It began to be used to kill mosquitoes in 1944.

Even today there are no great treatments or vaccines for Malaria. And as the climate is changing, Anopheles mosquitoes are found in more places. This means more people could be at risk of getting malaria in the future.

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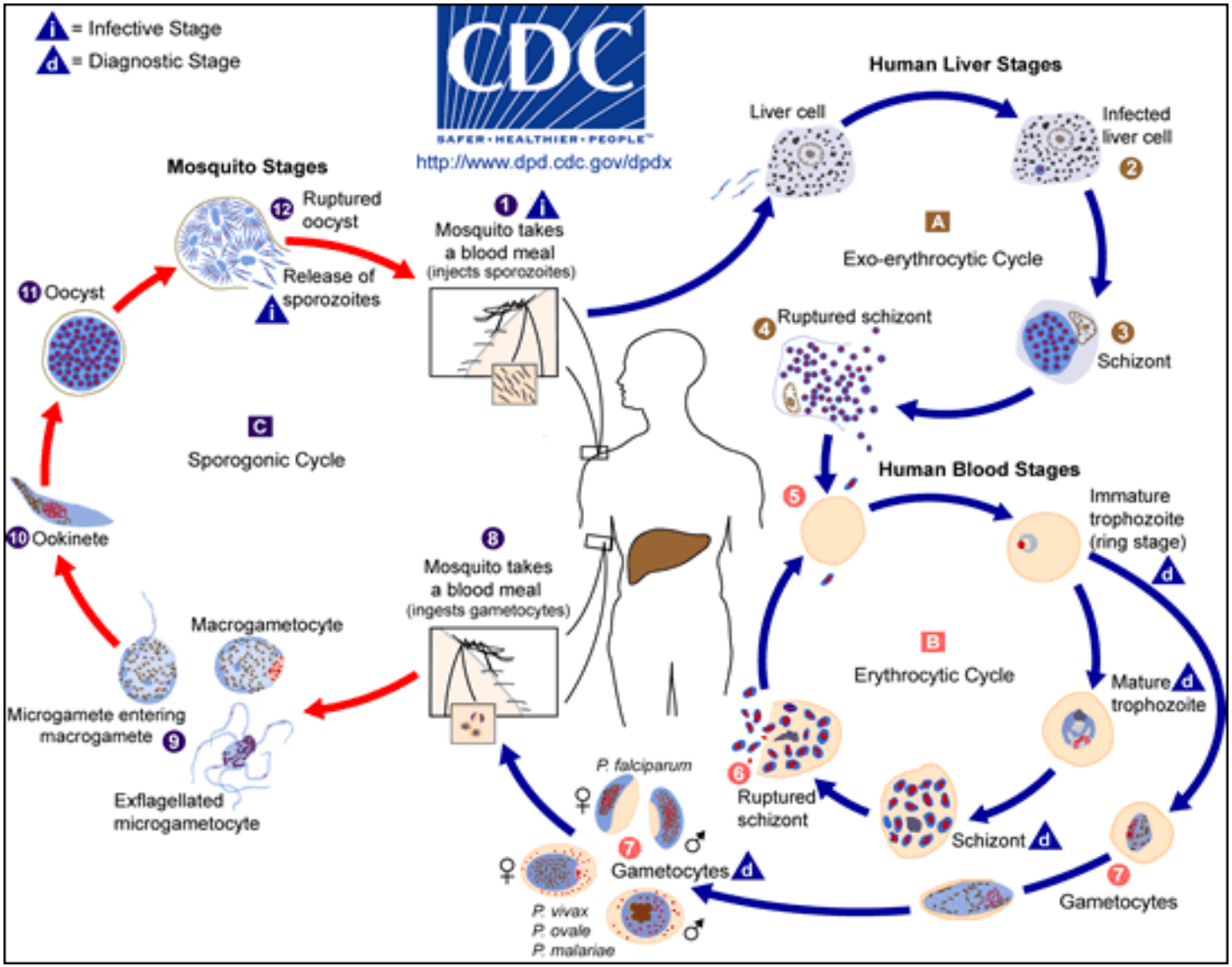
STUDENT HANDOUT

Fighting Malaria

The malaria parasite has a complex life cycle, as shown in this diagram from the US Centers for Disease Control:



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STUDENT HANDOUT

Fighting Malaria

1. **On the diagram showing the life cycle of the parasite that causes malaria, mark where on the cycle the treatment and prevention methods available during WWII affect the parasite.**

2. **Look at the life cycle again. This is really complicated, because the parasite lives in many different places and forms. Find a couple of places where you think there might be a way to stop the parasite.**

3. **With your team-mates pick a place on the cycle where you think the parasite is vulnerable. Design a way to kill off the parasite there. How would you make this happen? How would it work?**

4. **You will need to do some thinking and research to develop your idea. Put together a plan and save lives from malaria.**

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STUDENT HANDOUT

Blood in a Bag

What is blood made of? There's plasma, which is most of the blood by volume. Plasma is water with proteins, clotting factors, and antibodies all suspended in it and ions dissolved in it.

Then there are blood cells, both white and red. Red blood cells bind oxygen are carry it through the body. White blood cells are part of the immune system. There are many fewer white than red cells. There is another kind of cell called platelets, which help in healing and blood clotting. There are even fewer platelets than there are white cells.

A tissue is defined as a bunch of different cells that work together for a function. This means that blood is a tissue.

When people are injured badly, they go into shock. Shock is a bodily response to injury that helps conserve blood. One of the best ways to treat shock is to give the injured person a transfusion of blood. However, blood has lots of immune cells that can cause problems when one person gets another person's blood. A transfusion is like a transplant, and you can do it if you can match blood types. Blood also needs to be preserved in cold until it is used, and has to be a liquid so it is difficult to transport.

In WWII doctors learned how to use just blood plasma to treat shock. Eventually the patient would need a transfusion, but until then plasma would help an injured person stay alive.

Medics practics administering blood plasma to soldiers portraying a patient at Fort Benning, Georgia, 9 October 1944. The National WWII Museum, 2011.065.1712.

Your teacher will give your group:
1 quart-sized Ziploc bag
2 cups vegetable oil
20 skittles
10 mentos
10 tic tacs
1 tsp candy sprinkles

Put them all together to make a model of blood.

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STUDENT HANDOUT

Blood in a Bag

Fill in the table below to show what each component in the model represents:

Component	Represented by	Function
Plasma		
Red Blood Cells		
White Blood Cells		
Platelets		
Clotting factors		
Antibodies		
Ions		

Which of these would an injured person get in blood plasma?

How would this help?

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STUDENT HANDOUT

Antibiotic Targets

Why do antibiotics affect bacteria and not our cells? Why do they affect some bacteria and not others?
Why don't antibiotics work on viruses? Why don't they work on diseases like malaria?
The answer to these questions is in the details of cells and how they are made.

Look at this table describing cells of single-celled organisms and their makeup:

Cell (type)	Cell Wall	Organelles	Notes
Plasmodium (eukaryote, protozooan)	None (has protein coat)	Nucleus, mitochondria, ribosomes, microneme	Parasite that causes malaria
Gram positive bacteria (prokaryote)	Thick peptidoglycan wall	none	Streptococcus, Staphylococcus, more susceptible to antibiotics
Gram negative bacteria (prokaryote)	Thin peptidoglycan inside a membrane	none	E. coli, Pseudomonas, less susceptible to antibiotics
Yeast (eukaryote, fungus)	Chitin	Nucleus, mitochondria, ribosomes	Candida, can cause infections
Algae (eukaryote, plants)	Cellulose	Nucleus, mitochondria, ribosomes, chloroplasts	
Viruses (not really cells)	Protein coat		Rhinovirus and Coronavirus Just DNA and some proteins inside

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STUDENT HANDOUT

Antibiotic Targets

Use the table to answer the questions below. Do you have enough information to fully answer the questions? What else would be good to know?

Soldier pharmacist at Hunter Liggett Military Reservation, March 1944. The National WWII Museum, 2011.065.1944.

Why do antibiotics affect bacteria and not our cells? Why do they affect some bacteria and not others?

Why don't antibiotics work on viruses? Why don't they work on diseases like malaria?

Pick one of the disease-causing organisms and design way to fight it. Can you use what you know about what makes it different from organisms to treat it?

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