THE IMMUNE SYSTEM

Student Pages

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What is it?

Our body’s immune system protects us from germs like viruses, bacteria, fungal infections and parasites. Our immune system is made up of special organs, vessels and many different types of unique cells that each play a very important role in keeping us healthy. We call the cells of the immune system white blood cells. There are four major types of white blood cells: Macrophage, Neutrophils, T cells, and B cells.

Macrophage (mack’-row-fage; from the Latin macro = big, phage = eat) are white blood cells that eat germs that have been covered by antibodies. Their job is to patrol the body looking for germs. When they find an infection, they send a signal to our T cells, and our T cells send the other white blood cells to the infection.

Neutrophils (new’-tro-fills) are the white blood cells that are the “first responders” to infections. We have more neutrophils than any other type of white blood cell.

T cells are the most important white blood cell; they coordinate the activities of all of the other white blood cells and are essential for fighting disease. There are two major types of T cells: Helper T cells (T_H) and Killer T cells (T_K). Helper T cells send signals that activate the rest of your immune system to fight a germ. Killer T cells patrol the body and eliminate infected cells.

B cells also play an important role in protecting our bodies; they produce and release special proteins called antibodies. Antibodies stick to the surface of germs in our bodies, thus disabling them and also making them a target for another type of cell called macrophage. Each B cell and its antibodies can only recognize one kind of germ. Antibodies will only stick to germs, except in rare cases of autoimmune diseases where the antibodies mistake our own healthy cells for invaders.
**memory** - Your immune system can remember what a germ looks like after it has been exposed to it. This way, you don’t get sick from the same thing twice.

**neutrophil** - See white blood cells.

**organism** - A living thing. Plants, animals and bacteria are organisms. A rock is not an organism because it is not alive.

**T cells** - See white blood cells.

**toxins** - Toxins are poisons that make us sick. Some bacteria release toxins in our body.

**viruses** - Viruses are usually smaller than a cell and cannot live on their own. They need to infect another organism and live in its cells.

**white blood cells** - There are many different kinds of immune cells; T cells and B cells are the white blood cells that do most of the fighting against germs. Here are some examples of white blood cells:

- **neutrophils** are the “first responders” to infections. They can call other immune cells when they find an infection.

- **macrophages** can “eat” germs or infected cells.

- **B cells** can also eat germs but they make antibodies which are special flags that stick to the germs and help the body get rid of them.

- **T cells** have many functions but, in particular, they can activate other immune cells, like B cells, to help fight disease. They can also directly kill infected cells.

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**The Immune System**

**What does it do?**

*Your immune system remembers!* “Memory” T and B cells can remember all the germs they’ve found…for your whole life! This way, if that germ comes back your body can get rid of it very quickly! This is why you can only get sick from a disease one time (like Chicken Pox). You might be thinking, “But I’ve had lots of colds!” The “common cold” is actually caused by many different types of viruses that all cause the same symptoms, which is why you can “catch a cold” more than once. Because there are so many types of viruses that cause the common cold, there is no vaccine for the common cold.

Vaccines work by showing your body what a single germ looks like — like a “Most Wanted” sign. They help your immune system learn what a particular germ looks like, so it doesn’t make you sick. The vaccine helps your B cells produce antibodies against that germ and become Memory B cells that will remember that germ. This is how vaccines give you immunity.

**Metabolism and the Immune System**

Our bodies need lots of energy to live our day to day lives. We need energy to power our immune system and to do everything from reading, running…even sleeping and eating! All of the processes in your body that involve getting or spending energy are known as metabolism. A high metabolism occurs when your body is both getting a lot of energy and using a lot of energy, whereas a low metabolism occurs when the body does not have a sufficient quantity of energy to use. Our bodies get energy from food. A healthy diet is one that supplies our bodies with a balanced amount of sugars, fats, proteins, vitamins and all other nutrients we need to function properly.

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See and do more with the immune system online!

Learn more about the Immune System online at:
http://www.sepa.duq.edu/regmed/immune
Your body needs a great deal of energy to help you complete your day-to-day activities, such as doing homework, playing soccer, or even reading a book! For any of these activities, even when you’re just sleeping, all of your cells need energy to continue being healthy. So, your body is constantly busy getting energy by eating food, storing the food energy (calories), and then spending it. All of the processes in your body that involve getting or spending energy are known as your metabolism. A high metabolism occurs when your body uses energy, whereas a low metabolism occurs when the body does not have a sufficient quantity of energy to use.

So where does your body get all of this energy from? Well, eating a healthy diet helps to provide your body with a great deal of its energy. The food you eat is broken down into smaller parts like sugars, fats, proteins, and other nutrients in a process called digestion. The broken-down nutrients are absorbed by the body, mostly in your intestine, and are then transported to every cell and tissue in your body with the help of your blood vessels. A special chemical helps cells absorb sugar from the bloodstream – it is called insulin. Sugar is one of the main sources of energy for the body so without insulin, most of the cells in your body would starve!

Our body uses chemicals like insulin to carefully regulate the amount of sugar in our body. Too much or too little can be harmful! Our body constantly decides how much sugar to store for later, how much sugar to have in our bloodstream for quick use, and how much sugar our cells need to live and stay healthy.

In some cases, like in the case of Type 1 Diabetes (Juvenile Diabetes), the body does not have enough insulin, so the cells can’t absorb sugars as well and the sugar level in the blood starts to rise. The body becomes tired, weak, dehydrated and blood pressure lowers, causing a coma if not treated quickly.

**Keywords**

- **metabolism** - all the processes in our body that get and use energy.
- **nutrient** - a substance used in an organism’s metabolism which must be obtained from its environment.
- **sugar** - a nutrient needed for energy that can be found in many different forms, such as glucose, fructose, and sucrose (cooking sugar).
**Materials**
- 3 twelve-ounce plastic pop bottles or 4 equal graduated cylinders (350–400 mL)
- 3 balloons
- 1 funnel
- 1 plastic tray
- Masking tape
- Marker
- 1 packet of rapid rise active dry yeast
- 1 ¾ cup sugar
- 1 ½ cup warm water
- ½ teaspoon measuring spoon
- ¼ cup measuring cup
- ½ cup measuring cup
- Measuring tape
- Activity #1 Worksheets 1-7

**What will You Be Doing?**
Similar to the human body, the single-celled organism, yeast, also has a metabolism. Just as your body breaks down sugars in food to provide you with energy, so does yeast. One of the results of sugars getting used for energy by yeast is the release of a gas called carbon dioxide (CO₂). So, the more carbon dioxide that is being released by yeast, the more energy the yeast is using to keep itself healthy!

Using yeast, water, kitchen sugar, and balloons, you will explore and observe the level of energy use (metabolism) of the yeast depending on how much food it has available!

**Set-Up**
Work with your partner to gather all materials listed above. Remember to read the directions carefully before starting your work!

**Instructions**
1. Using the masking tape and marker, make 3 labels for your bottles. Each label will include the following information:
   - Label #1- Bottle #1: Water, ¼ cup sugar, ½ teaspoon yeast
   - Label #2- Bottle #2: Water, ½ cup sugar, ½ teaspoon yeast
   - Label #3- Bottle #3: Water, ¾ cup sugar, ½ teaspoon yeast

2. Starting with Bottle #1, measure the following amounts of each ingredient and place them inside using the funnel:
   - ½ teaspoon active dry yeast
   - ¼ cup sugar

3. Using Bottle #2, measure the following amounts of each ingredient and place them inside using the funnel:
   - ½ teaspoon active dry yeast
   - ½ cup sugar

4. Finally, take Bottle #3 and measure the following amounts of each ingredient, placing them inside using the funnel:
   - ½ teaspoon active dry yeast
   - ¾ cup sugar

5. Next, designate which partner will measure and fill each bottle with ½ cup warm water and which will place a balloon over the opening of each bottle.
   - Partner #1: Measure ½ cup warm water and add it to Bottle #1 using the funnel.
   - Partner #2: After Partner #1 adds the warm water, Partner #2 will need to quickly place the balloon on top of the opening of Bottle #1 and pull it down so it is securely over the mouthpiece. If your balloon will not stay on the bottle, you should use masking tape to secure it to the opening.

6. Partners #1 and #2 will continue the procedures stated in Step 5 for Bottle #2 and Bottle #3, adding the ingredients and covering each bottle with a balloon.

7. Mix the contents of each bottle gently by jiggling the bottles. Use the measuring tape to quickly measure the circumference of each balloon. Record
What is Yeast?

Dry yeast is a single-celled, microscopic living organism often used in cooking as a leavening agent to help mixtures rise. Its main purpose in cooking is to convert sugars or starches into carbon dioxide. Using yeast as a leavening agent gives breads and other baked goods their airy texture. Dry yeast often comes in envelopes or jars. In this form, the organisms in the yeast are alive but inactive because they lack moisture. Once moisture is added, like water, the yeast is reactivated creating energy in the form of carbon dioxide.

Follow-Up

Answer the following reflection questions on Worksheet #6:

- Which bottle released the most gas into the balloon?
- What does the amount of gas released tell you about each yeast culture?
- How was the metabolism of the yeast in Bottle #1 different than in Bottle #3?
- What do you think caused the difference in metabolisms between those two bottles?
- Was your hypothesis correct?
- If yeast metabolism is fueled by energy from sugar, what would happen to your metabolism if you had a high blood sugar level? A low blood sugar level?

What will happen to the balloons?

your results on Worksheet #2 under Initial observations. Then, using the equation provided, find the radius of each measurement. Finally, use the radius to calculate the diameter of each balloon using in the second equation provided.

8. After measuring and calculating the balloons’ circumferences and diameters, record what is happening to each balloon. Write down what you see on Worksheet #3 and draw a picture of your observations.

9. Place all three of your bottles on your plastic tray. With your partner, move your tray and bottles to a warm, flat surface to sit for one hour (under a window works well). Create your hypothesis! After returning to your seats, go to Worksheet #4: and write down what you think will happen to each bottle. Predict what will happen to the balloon on each bottle after one hour.

10. After one hour, return to your tray. Use the measuring tape to measure the circumference of each balloon. Record your results on Worksheet #3 under Observation After 1 Hour. Then, using the equation provided, find the radius of each balloon. Finally, using the radius and the second equation provided, find the diameter of each balloon. Record your answers on Worksheet #2 in the area provided.

11. Finally, look at each of your bottles and each of your balloons. Record your final observations on Worksheet #5.
Extension Activity: Sugar Vs. Sugar!

Discussion

In groups of four, work together to brainstorm and identify seven sources of good sugars and seven sources of bad sugars. Record your group’s ideas on Worksheet #7. After your list is complete, identify whether these sources of good and bad sugar are found in an Adult Diet, a Kid’s Diet, or Everyone’s Diet by marking the appropriate box with an “A” for Adult Diet, “K” for Kid’s Diet, or “E” for Everyone’s Diet. Once each group’s lists are compiled, work with your teacher to make a class list of the top five “good sugars” and top five “bad sugars” identified by you and your classmates.

Activity

Option #1: If time permits, let your bottles sit overnight! When you return to your classroom the following morning, observe and record any changes you notice from when you left your bottles the day before. These observations will be recorded on Worksheet #1. Draw a picture to show the changes you see.

Then, create a flip book using the four images you drew during this activity to show how the amount of CO₂ (carbon dioxide) gas released from each of the bottles changed over time. Make sure to include the appropriate diameter measurement in each picture! The final two pages of your flip book will each contain a graph showing the changes in circumference and diameter for each of the balloons. Chart #1 will document the changes in circumference in Balloons #1-#3 while Chart #2 will document the changes in diameter in Balloons #1-#3.

Your flip book should include the drawings you created on the following worksheets:

- Worksheet #3
- Worksheet #4 (Now Box)
- Worksheet #5
- The image from today
- Two charts: one documenting the changes in circumference of the balloons and the other documenting the changes in diameter of the balloons.

Option #2: Using the information you and your classmates discussed about sources of “good” sugar and “bad” sugar, design and create posters about choosing healthy foods! In groups of four, you will brainstorm an idea for your group’s poster, create a slogan for your idea, and design and produce a poster that promotes healthy foods. After creating these posters, present them to your classmates and hang them in your classroom, school halls, or cafeteria to promote and encourage healthy food choices for other students in your school!

Hyperglycemia:

(hyper = too much, glycemia = sugars) when the level of sugar in the blood is unnaturally high. Can be caused by the ingestion of unhealthy sugars.
Let’s Review….Natural Sugars are Better for You!

So what does all this information about sugar, metabolism, and its affects on health mean? As you saw, the balloons that contained the most sugar had the greatest productions of energy. But, yeast are simpler organisms than human beings; if you gave a human being that much sugar, their metabolism level would not be sustained and would quickly drop! But why? The human body has a very delicate mechanism that controls the use and storage of its sugars to allow for all the things we like to do, like run, learn, jump rope, and play video games! Too much sugar can overwhelm the body’s ability to store and use sugar appropriately!

As you read above, eating too many foods that contain high levels of sugar - especially refined (white) sugar - can lead to serious health problems including a weakened immune system, diabetes, and hyperglycemia. These problems occur because refined sugars are absorbed too quickly and force the body to work extra hard to keep a healthy balance of sugar in the blood. All that extra sugar gets turned into fat! When you eat too much sugar, it causes a rapid spike in your energy level and then and rapid drop, or “crash,” which makes you feel tired and yucky. Even though humans are much more complicated than yeast, sugars affect your metabolism just like they did in the balloon experiment.

A balanced diet that contains food with natural sugars is the healthiest because your body can control the balance of sugar more easily! A diet that follows these guidelines provides your body with more even levels of energy and less stress on your organs and immune system.

What healthy sources of sugar do you eat most often?

Read more about diabetes:
◊ http://www.sepa.duq.edu/regmed/autoimmune/autoimmuneintro.html

Discover more about sugars:
When white blood cells patrol your body, how do they tell the difference between your own cells and germs they find in their search? Well, different types of cells have different shapes. These different shapes allow your white blood cells, especially B cells and T cells, to tell the difference between what belongs to the body and what’s harmful to the body. These two types of white blood cells have this ability because they have special receptors on their surfaces that match to a single, very specific target (antigen).

If a white blood cell comes across an unknown cell, it tries to identify whether it belongs to the body or whether it is harmful. The white blood cell uses its receptor to see if the shape on the unknown cell fits into its receptor. If this cell turns out to be a germ or an infected cell, the white blood cell becomes activated and the germ or infected cell is eliminated. This process allows the white blood cell to properly identify the unknown cell. If it weren’t for receptors, your white cells wouldn’t be able to know what is harmful and what is not!

**T and B cells are specific.**

This means that each T and B cell can only recognize one kind of germ or infected cell. To account for all the possible harmful cells that may enter your body, your body has to produce many, many different types of receptors. In other words, your body has to make billions of receptors that could possibly match any germ on the planet! With so many receptors being produced, there is a greater possibility that when a white blood cell comes into contact with a harmful substance, it will create an effective match and eliminate the intruder.

**Vocabulary**

**Antigen** - the shape on each cell or particle that white blood cells use their receptors to identify. Each antigen has a particular shape depending on what kind of cell it comes from.

**Receptor** - the part of the white blood cell that binds to the antigen.

**Specificity** - T and B cells are specific because each cell has a receptor that can only bind ONE kind of antigen from ONE type of germ.
So what happens when you are exposed to a germ? Your body makes millions of copies of the T and B cells that match the germ. These cells fight the infection until the germ is gone.

But what happens afterwards? Well, your body makes a special effort to keep some of the T and B cells that were specific for that germ. That way, the next time you come across the same germ, your body is already ready to find and get rid of it.

The Immune System Remembers!

This means that not only do receptors allow B cells and T cells to identify specific germs, but they also help these white blood cells remember the types of germs that have entered your body.

The B cell uses a receptor to recognize the cells it finds. B cells can remember a germ they’ve encountered before by keeping the receptor that matches the germ. “Memory B” cells can remember a germ for your whole life!

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Materials

- Salt Dough (makes enough dough for one group of four students):
- Measuring cups
- Measuring spoons
- 4 bowls
- Water source
- Hot tap water*(microwaved)
- 2 cups flour
- 1/2 cup salt
- 3/4 cups hot water
- Worksheets #1-#5: Activity #3

Note* for safety: teacher should heat and handle hot water.

Activity Summary

You will be exploring the role of shape-matching in the immune system using salt dough clay. Working with a partner, you will mold clay “receptors” to fit a unique object, or “antigen” (like an eraser or other small object) - this is the target for your receptor. After the clay hardens overnight, these “receptors” and their “antigens” will be mixed up and redistributed. You and your classmates will walk around and try to match your receptors with the correct target. When a match is made, you and your partner will raise your hands and say, “Perfect Fit!” to signal that a match has been made.

The shapes of some targets will have very detailed and unique shapes making it easy to tell them apart from other targets. These kinds of targets will make the best fits with their receptors because it is certain that it is the correct target. The shapes of other targets might be less detailed and easily mistaken for another target. These make bad fits with their receptors because you can’t be sure if the target is the correct one. After you and your classmates complete a class collection of targets, your teacher will help you to identify whether each target will make “good fits” or “bad fits” with the receptors.
Set-Up Day 1

STUDENT SET-UP: Working with a partner, you will need to gather all materials before beginning. **Remember** to read all of the directions carefully before starting the activity.

1. You and your partner will first need to find one small object in the classroom with a unique 3D shape. For example, this could be an eraser, a coin, a small toy, a Lego, etc.
   
   **Remember**, you and your partner choose ONE item together. You do not each need to find an object. Once you and your partner have found an item, sit down at your seats and wait for the remaining pairs of partners to find their objects.

2. Create your **hypothesis**! On Worksheet #1 for Activity #3- A Perfect Fit!, write down the name of your target and predict if it will be a good fit or a bad fit. Explain why and give an example of a good fit and a bad fit.

3. Now, each pair of students will hold up their object and tell the class their prediction and the teacher will create a list on the board of all the objects and predictions. Fill out Worksheet #2 for Activity #3- A Perfect Fit by identifying each item as a “good” target (i.e.-one that will snugly fit with a receptor) or a “bad” target (i.e.-one that will be difficult to match because its shape could match many receptors). For example, it would be hard to tell the difference between a pencil and a pen, but not difficult to tell the difference between the tip of the pencil and the eraser.
   
   **Remember** that an item is a “good fit” if it is very detailed and has a unique shape. A “bad fit” occurs with an item that is less detailed or easily mistaken for another target.

4. Partner #2: Collect the ingredients and supplies needed to make the salt dough.

5. Working together, Partner #1 and Partner #2 will complete the following steps as a pair to create your salt-dough:
   
   a. Carefully measure 2 cups of flour and place into bowl #1
   b. Carefully measure 1/2 cup of salt and place into bowl #2
   c. Get teacher’s assistance to carefully measure 3/4 cups of hot water (be careful!)
   d. Combine the flour from bowl #1 and the salt from bowl #2 and place them in a large mixing bowl (bowl #4).
   e. Then, slowly and carefully add the water from bowl #3, kneading the mixture until it becomes sticky. (Note: If your mixture becomes too runny, add a little more flour. If it becomes too crumbly, add more water.)
   f. When your dough is completely mixed, Partner #1 will form the dough into a baseball-sized ball. Make sure you have enough dough to really squish your target into the dough without changing the overall shape of your dough-ball.

6. Partner #1 will press half (½) of your chosen object into the salt-dough, leaving an imprint of the object. Once pressed inside, the object will form a “pocket” in the shape of your object!

7. Help your partner to remove the object from the salt-dough receptor you created
and place the receptor in a safe spot to dry overnight.

**Instructions - Day 2**

Now that the salt-dough is dry, it's time for you and your partner to find the “targets” that match! If you chose an object yesterday to use during this activity, today you will switch roles and choose a salt-dough receptor to use during this activity. On the other hand, if you made a receptor yesterday out of salt-dough, you will choose a target to match to a receptor during today’s activity.

1. After completing your new role of choosing either a receptor or target, take your object, walk around the room, and try to find the missing half of the pair!

2. When your object makes a correct match with another student’s object, both you and the other student should raise your free hand and say, “Perfect Fit!” So, if you have a receptor (the dried, salt-dough ball) you will be looking for the specific target (the one that fits inside the indentation on the salt-dough ball). On the other hand, if you have a target you will be looking for the receptor (dried, salt-dough ball) it fits inside. Don’t worry! If you can’t find the match right away, do not get frustrated. Keep trying!

3. Once all of your classmates have made a “Perfect Fit,” your class will work as a group to see if the hypothesis for the item you used today was correct. To do so, you will use the list of the predictions for each target that you and your classmates compiled during yesterday’s class. On Worksheet #3, you will need to record what item you used today, its prediction as a good or bad fit from yesterday, its actual results today as a good or bad fit, and reasons why you think the outcome was the same or different from yesterday’s prediction.

4. On Worksheet #4, create a labeled drawing of the match you created with your new partner today. In the additional space provided, draw and label one object you observed during today’s activity that did not create a good match.

**Reflection**

Working with a partner, you will complete Worksheet #5 by discussing how the characteristics of the binding process (specificity, ability to recognize, and memory) affect the process of identifying matching antigens and receptors.

After completing the first question, you and your partner will answer the second question by identifying and describing three real life situations where this kind of “perfect fit” must occur (e.g., only the right key will open a lock) or where unique recognition occurs (e.g., recognizing a friend’s face, no one has a face like theirs).

**Discussion**

Working in groups of 4-5 students, discuss the following questions and develop answers based on your results from the A Perfect Fit! Activity.

- Why is specific binding between targets and receptors important to the immune system?
- What processes does this mechanism rely on?
- During the activity, a salt dough receptor was matched to a specific object from
All of your white blood cells work together to eliminate germs from your body. In this board game, you will use your brains and the white blood cell “money” in your “Blood Bank” to fight 10 common diseases while you learn more about the Immune System. As you move throughout the game board, you will encounter viruses and bacteria, so watch out! You will also learn more about staying healthy, vaccines, antibiotics, and steps you can take to prevent the spread of disease.

Lesson Preparation

1. Working in groups of 4-5, work together to complete the following tasks:
   ◊ Tape together the board
   ◊ Cut out the currency and game pieces
   ◊ To complete each task, you and your group members will decide which two group members will cut out the currency and game pieces, and which two group members will assemble the game board.
   ◊ For extra strength, those two group members can glue the game board pieces to poster board or cardboard and let dry overnight.
   ◊ If you’d like to re-use the game without reprinting, laminating is a good way to protect it.

Before You Begin

1. Before beginning the game, you and your classmates will learn about different key terms used during this game. As a class, work to create a correct definition of each key term with your teacher.

2. Quiz your classmates before beginning the game so you are comfortable with these new words.
**Play the Game!**

1. Once you and your group members have built your game board and created your game pieces, take turns reading the instructions for the game aloud as a class. Ask your teacher any questions if you are unsure about any instructions.

2. Break into your gaming groups of four to play the game.

**Get Home from the Hospital!**

Try to make it all around the board from the Hospital to your Home square and collect the most Disease Cards and White Blood Cells!

- Each player picks a color that corresponds to their Home and a Hospital Squares. Place your playing piece on your Hospital square.
- Select one player to be the “banker”. He or she will manage the money in the “Blood Bank.” To begin the game, the banker gives each player 500 White Blood Cells.
- To start, each player will put their game piece on the “Hospital” square. Then, roll the die to see which player goes first. The person with the highest number will begin the game, and continue clockwise from the first player.
- Player #1 will roll the die and move forward that number of squares on the board. For example, if they rolled a 5, then they would move ahead five squares. Once Player #1 lands on the correct square, they will follow the directions on the board.
- As you land on different types of squares, follow the directions in the “Rules” on the next page.
- Each additional player will take their turn and follow the same rules.
- The game is over when someone reaches their Home square.
- The player who gets Home first gets a bonus of 50 White Blood Cells.
- To figure out who wins, every player must add up their White Blood Cells “dollars” and the values on the bottom of each of their Health Cards and Disease Cards to find their total. Whoever has the most White Blood Cells wins!

**Discussion/Review**

Working in small groups, you and your classmates will be assigned one of the questions below and will create a group poster to answer your question!

- What are common things that can harm your body?
- What are some examples of diseases caused by virus?
- What are some examples of diseases caused by bacteria?
- What do antibiotics work well against?
- What types of cells make antibodies?
- What does it mean to be specific?
- What kinds of cells give the immune system memory?
- Name three kinds of cells that make up the immune system.

Make sure to clearly explain your answer on the poster and provide specific examples to support that answer. Don’t forget to draw some pictures as well. Once your poster is finished, your group will then present your question and your group’s poster to your classmates.
The Rules

- **If you land on a Disease Card square:**
  - Draw a card from the Disease Card pile.
  - Read the card aloud and try to answer the question correctly. If you get it correct, you prevent yourself from getting sick by using your knowledge, so you win that Disease Card, and your turn is over.
  - If your answer is incorrect, you will have to use your White Blood Cells to “fight” the disease. Pay the Blood Bank the amount of White Blood Cells at the bottom of that card.
  - When you have successfully “paid for” a disease, you win the card for that disease, and your turn is ended.
  - If you don’t know the right answer and don’t have enough White Blood Cells to pay for it, go to your Hospital.

- **If you land on a Health Card square:**
  - Draw a card from the Health pile.
  - Read the card aloud, then collect the amount of White Blood Cells listed on the card from the Blood Bank.

- **If you land on a Yay! square:**
  - When a player lands on a Yay! square, they are awarded 50 White Blood Cells from the Blood Bank for participating in a health activity to keep their immune system strong.

- **If you land on an Eew! square:**
  - When a player lands on an Eew! square, they must pay 50 White Blood Cells to the Blood Bank for doing something that hurts their immune system.

- **If you land on a space occupied by another player: You **Make Me Sick**!**
  - If a player lands on a space occupied by another player, they can “infect” them with one of their Disease Cards.
  - To infect another player, choose one of your Disease Cards and read the question to the other player.
  - If the player answers correctly, they have prevented the disease by being smart and do not get sick. They win the disease card, and stay on their square. The player who asked the question shares the square with the other player.
  - If the other player does not answer correctly, they must pay the amount of White Blood Cells to the player asking the question. Since they could not use their knowledge to fight the disease, they get sick! and must return to their Hospital. The player who asked the question takes over that square.

- **If you get sent to the Hospital:**
  - If a player runs out of White Blood Cells and can’t pay for a disease card, they get sick! and go back to their hospital.
  - To leave the hospital, you must “pay” for treatment by reading 2 Health cards about new ways to stay healthy and earn 100 White Blood Cells in return.
  - If you land on a different player’s hospital, nothing happens.
Answer Sheet for You Make Me Sick!

1. 1 - A virus is a germ that can’t live on its own, but bacteria can. 2 - Viruses have to infect cells to live.

2. The common cold has symptoms of a runny nose, cough, sneezing and fatigue.

3. 1 - Antibodies mark the virus so that special cells called macrophage will “eat” the virus. 2 - Antibodies cripple viruses so they can’t infect cells, 3 - Antibodies will also immobilize the germ they are covering.

4. A vaccine is like a Most Wanted sign that helps your immune system learn to recognize a new germ by exposing it to a neutralized version of the germ.

5. True

6. The lungs

7. Cover your nose and mouth when you sneeze or cough.

8. Virus

9. False

10. The skin

11. They give you immunity – they show your immune system what the germ looks like.

12. True

13. Bacteria are single-celled organisms. They can be good (you have some helpful bacteria in your intestine that help digestive food!) or bad.

14. Fever makes your body temperature too high for the bacteria so they die.


16. Sore throat, fever, difficulty swallowing.

17. Yes

18. Nerve cells (neurons) – these cells make your muscles move and send signals between your body and brain.

19. Nope. Puncture wounds like those caused by nails are ideal places for tetanus to grow. Always clean wounds with antibacterial soap and water.

20. A bacteria (a toxin released by a bacteria)

21. Yes

22. Neutrophils – they are the “beat cops” of the immune system and are often the first to the site of infection.

23. Wash hands before and after touching your eyes.
24. Pink eye is caused by bacteria!
25. True
26. Itchy red bumps or rash, fever, runny nose
27. When a disease is contagious, it means that it can be easily spread to other people.
28. B cells
29. Paralysis
30. Virus
31. Macrophage
32. True
33. 1- Bacteria make copies of themselves outside of your cells, but viruses make copies of themselves inside your cells. 2 - Bacterial infections can be treated with antibiotics, but viral infections cannot. 3 - Bacteria rarely infect your cells, viruses must infect your cells to replicate.
34. Ear ache, congestion, ear “popping”.
35. B cells produce antibodies. Antibodies are flags that help your body kill germs.
36. False, Ear Infections can be caused by bacteria or viruses.
37. True
38. Nausea, abdominal pain, vomiting, diarrhea, fever or headache.
39. A toxin is a poison that is made by a living thing – like a bacteria or plant. Poisons found around the house, like cleaning supplies, are made by humans and are not toxins.
40. The T cells are the “Police Chiefs” of the immune system.
**Key Terms**

**Antibodies:** Special “red flags” that stick to toxins, bacteria and viruses. They cover any invaders to tell the immune system to get rid of the germs or toxins.

**Bacteria:** Bacteria are single-celled organisms that can be good or bad. Our Immune System fights off the bad ones. We use Antibiotics to get rid of bad bacteria.

**Cell:** All living things are made of cells. Living things can be made up of only one cell like bacteria or millions and millions of cells like human beings. There are many different kinds: hair cells, skin cells, plant cells, etc. We are made of many different types of cells, but some organisms are only one cell, like bacteria.

**Contagious:** When a disease can be easily spread to another person, it is contagious.

**Disinfectant:** Chemicals that kill germs on the outside of your body, like soap.

**Germ:** An organism that infects our bodies and makes us sick (causes disease). The two most common types of germs are bacteria and viruses.

**Immune System:** Tissues, cells and organs that detect and fights infections caused by germs in our bodies to keep us healthy. Your Immune System is always learning. You can’t live without it!

**Immunity:** When your white blood cells can get rid of certain germs in your body before they ever have a chance to make you sick.

**Infection:** When a disease-causing organism (a germ) enters our bodies and makes us sick.

**Organism:** A living thing. Plants, animals and bacteria are organisms. A rock is not an organism.

**Sickness:** We feel sick when a germ infects our cells and our immune system is fighting hard to get rid of it. For example, a fever makes your body too hot for germs to survive, and runny noses, sneezing and coughing are all ways the body uses to get the germs out of the body.

**Toxins:** Some bacteria release toxins in our body. Toxins are poisons that make us sick. Our immune system can neutralize toxins with special “shields” called antibodies.

**Vaccines:** Vaccines give you immunity. They are like Most Wanted signs for your immune system. They help your immune system learn what the germs look like, so they can find them faster, so you don’t get sick. Your immune system will remember what those germs look like for the rest of your life.

**Viruses:** Viruses are very small (usually smaller than a cell) that cannot live on their own; they need to infect another organism and live in their cells.

**White blood cells:** There are lots of different kinds of immune cells; T cells and B cells do most of the fighting against germs.

- **B cells** make antibodies, which are special flags that stick to the germs and help the body get rid of them.
- **Macrophage** can “eat” the germs or infected cells.
- **T cells** are the “commanders” of our immune system and can activate other immune cells, like B cells, to help fight disease.