Introduction

We are surrounded!! Surrounded by gazillions of things that might make us sick, including bacteria, viruses, and parasites that we may get from other people. When an illness can be passed from person to person, it is infectious. Diseases are transferred from person to person in a variety of ways—through the air in droplets when one sneezes, or by direct bodily contact, or by touching a surface such as a doorknob that was recently handled by a sick person.

Through millions of years, humans have evolved to combat pathogens, bacteria, viruses, or parasites that make us sick. The myriad responses to infection are partly the job of the lymphatic system. Different types of white blood cells recognize and phagocytize foreign invaders, produce antibodies, and kill already infected body cells. Lymphocytes collect in the lymph nodes where they filter lymphatic fluid and clone themselves in response to specific invaders. This is why lymph nodes become enlarged when you are ill.

The study of the transmission of disease in populations is called epidemiology and it forms the basis for public health strategies and interventions. An epidemiologist determines the origin of an outbreak of infectious disease, for example, so that the source (such as a contaminated well or food) is identified and the public educated about how to prevent infection.

5-minute Discussion: Discuss the following questions with your group and be ready to share your thoughts with the class.

1. What is the difference between infectious disease and other types of diseases?
2. Give two examples of pathogens
3. What are some ways white blood cells fight disease?
4. Why do lymph nodes enlarge when you are sick?
5. What do you suppose would be the job of an epidemiologist if there was a mysterious outbreak of food poisoning in the County of San Bernardino?
Brainstorm:
1. With your group, brainstorm a list of as many diseases as you can.
2. You will be listing your diseases on the board. Do not repeat diseases.
3. Your group will be assigned some of the diseases. Your job is to discuss whether it is infectious or not based on the description given above.
4. When done, in the column next to the disease indicate whether it is infectious or not (yes or no).

5-minute discussion:
1. Discuss with your group what you think the difference between nonspecific and specific defenses is.
2. Discuss the different parts of the body that are used in the defense to fight off pathogens.
3. Provide details of how that defense protects against pathogens.
4. Be prepared to share with the class

5-minute discussion: Discuss the question below with your group and be prepared to share your answer:
Why do you think it is beneficial adaptation for a pathogen to make its host very sick without killing the host?

Activity 1: Structures of the Lymphatic System

Use the human torso model and locate the following structures:

- Tonsils
- Lymph Nodes
  - Cervical
  - Axillary
  - Inguinal
- Thymus Gland
- Spleen
**5-minute discussion:** Discuss with your group and be prepared to share your reasoning with the class.

A. Why do you suppose the tonsils are located in the back of the throat?

B. Why would a person with leukemia have a sense of abdominal fullness?
Activity 1: Antiseptic Technique:

Introduction: Bacteria are everywhere. Over time, they have evolved the ability to inhabit almost every surface on the planet, becoming the most versatile type of organism known. They are invisible to the naked-eye due to their small size, and can be resistant to many types of stresses that would kill the average human. Bacteria have been found living in the deepest parts of the ocean, in volcanic vents, in boiling hot springs, and even deep in polar ice caps. Many species of bacteria thrive by inhabiting other organisms, sometimes in a parasitic fashion, but more often in a harmless commensalistic way. The bacterial populations are kept in check by the natural defenses of the host, such as the immune system, and washing habits. When these natural defenses fail, bacteria can quickly become a problem.

<table>
<thead>
<tr>
<th>Types of Symbiosis</th>
<th>Effect on Organisms 1</th>
<th>Effect on Organism 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mutualism</td>
<td>(+)</td>
<td>(+)</td>
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<tr>
<td>Commensalism</td>
<td>(+)</td>
<td>(0)</td>
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<tr>
<td>Parasitism</td>
<td>(+)</td>
<td>(-)</td>
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When bacterial populations grow explosively in the absence of the host’s natural defense mechanism, the effects can be hazardous to the host. Many species of bacteria create toxins that cause little, if any, damage when population levels are low, but when uncontrolled population growth occurs, these toxins can be life threatening. In addition, the by-products of bacterial metabolism can also become dangerous. Waste products that do not normally accumulate in large quantities can build up rapidly, causing a number of problems for the host.

Part I: You have just been exposed to a deadly disease!

We can use a UV (black) light to see the “germs”.

Reflection: What surfaces were contaminated? Were there any surprises? What questions or thoughts popped into your mind?
**Go wash your hands**

**5-Minute Discussion:** Discuss with your group their answers to the following question and jot down responses for class discussion.

A. How do you normally wash your hands? What do you use? How long? How do you know they are clean?

**Reflection:** How did you do? Were there any surprises? What are your thoughts?

One of the best ways to prevent bacterial spread and infection, according to the United States Centers for Disease Control (CDC), is the use of proper sanitary techniques. Perhaps the most critical step in this prevention is the use of proper hand washing. When improperly washed, your hands are one of the most easily colonized areas of your body. Since the majority of human behaviors involve the use of the hands, bacteria can easily spread throughout our populations. Properly washing your hands can greatly cut your chances of acquiring an infection. It is estimated that nearly four billion dollars are spent each year fighting bacterial infections in hospitals, a problem caused by improper hand washing and sterilization, and acquired antibiotic resistance in bacteria. Most people do not wash their hands well or often enough, at great cost to the American public.

Proper hand washing requires the use of water as hot as you can stand (without causing burns), soap, and lots of rubbing. The soap and water serve to destroy bacteria, but more important is the friction caused by the rubbing of the hands together, which soughs off bacteria in great numbers from the skin. The fewer bacteria on your skin, the less likely it will be for you to get an infection! Make sure you rub all surfaces of your hands vigorously, including between your fingers, around your fingernails, and the backs of your hands. Since bacteria can grow so rapidly, it is very important to remove as many as possible. Washing for two minutes has been shown to be the most efficient method for cleaning the hands. Longer periods of time do reduce the bacterial load, but at a much lower rate per minute. The greatest gains come in the first two minutes.

**Did you know?**

Many of the bacterial species that inhabit the skin of a healthy adult human serves to protect us against infection by more pathogenic species. The presence of these bacteria, those known as normal fauna of the skin, prevents colonization by other potentially dangerous species.
What do scientists from the CDC say is the proper hand washing technique?

1.
2.
3.
4.

Since hand washing is often ignored, any surface that people touch can be heavily infected with bacteria. Door handles, faucets, desktops, pens, pencils, phones, and other common items can be easily contaminated with bacteria during the course of a day. There are many solutions that can be used for routine cleaning of every day items to combat bacterial spread through contact with inanimate objects, such as bleach, alcohol, and various detergents. Each solution destroys bacterial cells on the surface and effectively reduces the risk of contamination. In a laboratory setting it is very important to wash counters and lab benches before and after every use, especially if working with micro-organisms, to prevent the spread of potentially dangerous microbes. Washing these surfaces also helps to reduce the risk of secondary bacterial exposure, another common problem in laboratories. Sponges and dish rags are known to be common reservoirs for bacterial contamination, and should be discarded or disinfected after use. One use disposable surface cleaning tissues are available to help prevent the spread of bacteria.

***Wash your hands are remove all “germs.” Check with the UV light that none are left.

**Part III:** Surface contamination

1. Examine the objects in the container. Leave them in the container to avoid contaminating them.

**5-minute discussion:** While handling and examining the objects in the container, think of ways the object can act as a reservoir for bacterial colonies. Discuss with your group and be ready to share with the class: Which object(s) do you think will be the most easily colonized by bacteria? Why? What is your reasoning?

2. Examine your hands with the UV light. Are there any “germs” present? Where do you think they came from?

3. Use the UV light to examine your objects. Are they infected? What about the bench itself?

**Wash hands are remove any remaining “germs” from your hands.**
**Part IV: Sneezing and coughing**

1. In another container, there are some “disinfected” items. Leave them in the container to avoid accidental infection.
2. You will be divided into two groups
   a. Group 1: You will put some “germs” in the crook of your arm like you sneezed or coughed into the crook of your arm.
   b. Group 2: You will rub “germs” into the palm of your hand only (like you coughed or sneezed into your hand)
3. A disinfected group member will use the UV light to determine the spread of your germs on your person and the objects in the container.
4. Group 1 will pick up and touch the objects.
5. Group 2 will pick up and touch the objects.
6. The disinfected group member will use the UV light to check for the spread of the germs on your hands and on the objects.
7. Wash your hands and remove the residue…check with UV light

<table>
<thead>
<tr>
<th>Results:</th>
<th>Record the results of your groups trial above and your thoughts.</th>
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| Individual reflection: | Why is this important in real life (give examples)? Be specific. |
Activity 2: Epidemiology

Epidemiology is only one branch of the study of disease. Specifically, it is the study of the spread of disease. Diseases such as the flu, the common cold, or intestinal infections are often transferred from person to person by bodily contact, or by touching an object the person has touched. This exercise is designed to demonstrate how an epidemiologist might track the spread of a communicable disease back to the original source. We will use starch, which does not cause disease, as a model for examining how microbes may be passed from person to person.

Procedure:

1. Each person will receive a dish that is identified with a number and filled with a clear liquid. This clear liquid will represent your bodily fluids! All but one of the dishes will contain plain water. The exception will be one containing a solution of sodium hydroxide (NaOH). This solution represents the "disease" we will be tracking. Write down your name on Table 7.1.

2. You will exchange fluids with another person in the room. Pour the liquid back and forth between your cups to thoroughly mix the liquids. This will simulate sexual contact and will represent the pathway of infection for this disease. Write the name of the person with whom you exchanged fluids.

3. Wait until everybody in the room has “done it” once before going on the next round. Repeat your exchange of fluid with a new person. Keep track of your contacts’ names and the order in which you came in contact with them. Repeat with 1 more time with a different person.

4. Once everyone has finished, bring your dish to the front of the room for “diagnosis.” We will use Phenolphthalein, an organic compound used as an acid-base indicator (interestingly, an active ingredient in laxatives) to test for the presence of the "disease" by placing a few drops in your cups. Phenolphthalein is colorless in an acidic solution and pinkish in a basic solution. Contact with the "disease" will be indicated by a pinkish color change formed in the presence of the base NaOH (transition occurs around pH 9).

5. If you were diagnosed with the disease, report the names of those you shook hands with on the board. Update your list as names are added. You will use this information to determine the initial carrier of the disease.
Table 7.1 Microorganisms and Disease Lab Data Sheet

<table>
<thead>
<tr>
<th>Names of those you contact:</th>
<th>Your Name:</th>
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<tr>
<td>1</td>
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<table>
<thead>
<tr>
<th>Contacts</th>
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<tbody>
<tr>
<td>Names of those present:</td>
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**Next Step:** From your collected data on previous page, you now must figure out who the source of the communicable disease is and answer the questions that follow.

**Note:** only one person was initially “infected”.

**Hint:** best clues will come from looking at people who exchanged fluids with a sick person, but who are not sick themselves. This will indicate that the sick person contracted the disease after that contact and also shows that this person was not the source of the infection. You need to find the path of infection rather than just guessing who the source was.

**Answer the following questions with your group,** based on results in Table 7.1.

1. How can you determine who was the initial carrier of the "disease"?

2. Is it possible to know precisely who the initial carrier was?
   
   a  Why or why not?

3. How would the results differ if everyone chose how many contacts to have, including the option to have no contacts?
   
   a  How does this better resemble real life?

4. How would results differ if you only have a 20% or 50% chance of contracting the disease after being exposed?
   
   a  How does this relate to the concept of susceptibility (versus resistance)?
5. How would the results differ if people were continuously entering and leaving the group?

   a. What if there were subgroups that didn't have much exchange, perhaps because of religious or cultural differences.

   b. Why are sick people sometimes quarantined?

6. Think about modes of transmission. How would the spread of a disease differ if the pathogen is airborne, foodborne, waterborne, requires physical contact like a handshake, or intimate contact like sex, or a kiss?

   a. Which of the listed ways diseases are spread, would be the most deadly mode of transmission if a terrorist was trying to intentionally create an epidemic?

7. Are STDs (sexually transmitted diseases) usually spread between strangers or people we know well? Explain your thinking.

   a. Why is it important to know your partner's complete sexual history before you decide to have sex?

   b. If he/she won't tell you, or if you suspect an active history, consider that you are effectively sleeping with all of his/her former partners. To protect yourself, is it reasonable to propose that you both get tested for STDs before having sex?

   c. BTW: It's safe to assume that everybody lies about sex!
8. Why does international air travel increase the risk of a rapidly spreading pandemic?

a. Why are airports, train and bus stations, schools, restaurants, movie theaters, and shopping malls likely locations for a disease to spread?

b. If a disease breaks out in a major city, why is this worse than in a small town?

9. If a vaccine is in limited supply, why do first responders (police officers, firefighters, paramedics, nurses, doctors) get the first doses?

a. Is this fair? Why or why not?

10. Many diseases, such as the common cold, don't have visible symptoms during their most infectious stage. Why? What would happen if they did?

11. Describe a situation where certain people (the old, the young, the immune compromised) are more "at risk" than others to a disease. Why isn't everybody equally susceptible?

a. Why does getting vaccinated protect people who are too young or otherwise unable to get vaccinated?

12. How would the results differ if the infected person dies very quickly or very slowly after contracting the disease?

a. Which disease will be more evolutionarily successful -- one that kills quickly or one that kills slowly? Why? If you try to "think like a disease" what is your primary objective if you want to be successful? What is the purpose of the host? Explain.
13. If we expanded this simulation to 4 days, but infected people either die or get better after 2 days, based on a heads/tails coin flip, how much harder might it be to track the course of the epidemic?

14. What if a vaccine becomes available that prevents infection? Research the concept of "herd immunity" and the percentage of people that need to be vaccinated for it to be effective. Do this measles simulation [http://fred.publichealth.pitt.edu/proj/measles/](http://fred.publichealth.pitt.edu/proj/measles/) in your own city or state; then, report your findings below:

15. Discuss a couple ways in which these activities has increased your awareness of the presence of various germs.