**The Scary Truth: Microbes**

# Introduction

To begin this chapter on the importance of hand washing to prevent the spread of infection, we will first conduct an experiment just to see how easily microbes on our hands are spread. So, what are microbes? They are microscopic organisms that are too small to be seen with the naked eye; therefore we must study them with a microscope. They are found in the water, soil, air, the human body, and other surfaces. The most common are bacteria, viruses, and fungi [1]. In this chapter we will only focus on bacterial pathogens that one can contract.

Experiment 1: The Infectious Hand

Materials

* Glo Germ
* Back light
* 1 Stuffed Animal

Procedure

1. Cover the stuffed animal with Glo germ powder
2. Pass the stuffed animal around from student to student for 5 minutes
3. After the 5 minutes, turn the black light on and examine hands for glowing germs
4. Wash hands with soap and water
5. View hands under black light again to examine if hands were washed thoroughly
6. Place 2 grams of Glo germ on a long table
7. Blow on the Glo germ once
8. View with black light and measure the distance the furthest spot travelled on the table
9. Record your findings

Now that we have seen how easy microbes are spread and how far they travel, we will discuss the different forms of microbes. Bacteria are single-celled prokaryotic organisms. They do not have a nuclear membrane, mitochondria, Golgi bodies, or endoplasmic reticulum. Bacteria require different environments to be able to survive. Some prefer warm and moist environments while others prefer cool and dry environments. If bacteria are not supplemented with their optimal growth environment, reproduction will slow down and the cells may eventually die if conditions are harsh. Some pathogens have modifications that make them survive through harsh conditions, which makes it more difficult to treat when an individual becomes infected. Most bacteria are harmless, but there are some bacteria that cause infections such as the common cold, tuberculosis, tonsillitis, and diarrhea. In fact, we would not survive without bacteria because they are necessary to carry out our daily functions, which will later be discussed.

Viruses are not living cells—they are actually made up of proteins that invade and infect other healthy cells and begin to reproduce, causing diseases. The cells that the virus invades are known as host cells. Without hosts, the virus would not be able to reproduce and survive. A common virus that we all know and hate is the flu virus, known as influenza.

Although we will not be discussing fungi in this chapter, fungi are still very important. Fungi are eukaryotic organisms that can be unicellular or multi-cellular. Fungi are similar to bacteria. Some are naturally found on the skin and are beneficial to our health, while others can be harmful. Edible forms of fungi include mushrooms and yeast. Harmful forms of fungi cause infections such as athlete’s foot and inflammation of organs [1]. However, without the help of mold, a form of fungi, penicillin would not have been discovered [1].

# The Good Microbes

 After conducting the previous experiment, it is apparent how easily microbes are spread from surface to surface and how far they travel. However, not all microbes are bad. The human body produces normal flora, known as microbiota that is a community of microbes that live in and on an individual. Microbiota is controlled by personal hygiene (such as soap, deodorant, mouthwash, and detergent), diet, medications, source of water, and environmental toxins.

## Digestion

For digestion and bowel support, lactic acid bacteria aid with the breakdown of food [1]. Probiotics in the gut also aid in the digestion of food. In fact, probiotic supplements are recommended to help maintain a healthy gastrointestinal system. Probiotics are a mixture of yeast and bacteria and along with helping to provide a healthy regular bowel function it can also improve intolerance to lactose.

## Immunity

Microbes also protect the host and assist in immunity. The microbes cover the surface of individuals and protect the host against infections. Not only do they cover the surface of our skin and create smaller areas for infections to enter, but they also compete for a supply of nutrients.

## Food

Of course microbes are not only beneficial to our health, they are also responsible for many foods and medicines we use today. Food such as cheese, yogurt, and yeast products (such as bread and beer) would not be possible without microbes. Microbes are actually used to help flavor some of our favorite foods. Microbes are introduced into foods where they break down particles to create certain flavors by creating sugars, fatty acids, and amino acids. These products give food a desired taste or smell [2].

## Medicine

The secretion of bacteria and fungi creates antibiotics. The first antibiotic was actually created by accident when mold contaminated bacteria cultures and ended up inhibiting growth and killing them. Today, this antibiotic is known as penicillin and is one of the most widely used antibiotics [3].

Vaccines would also not be possible without the use of microbes. Some vaccines are created by a weakened or deactivated version of the disease and when it is injected into the body, it creates an immune response without making the host sick. When the host is in contact with this disease again, the body’s memory cells recognize the disease and have a heightened immunity and will only have mild to no symptoms that will present.

# The Bad Microbes

 As we learned before, the human body needs a healthy supply of microbes in order to function. However, if this supply is disrupted it can lead to dysbiosis. This is when the necessary organisms are eliminated and harmful organisms take over. This can happen by heavy use of antibiotics or improper use of antibiotics. The antibiotics kill off healthy organisms along with the infected organisms and create an unstable environment where pathogens take over. In this next section, we will go over a number of pathogens and their infections they cause.

## Staphylococcus

 *Staphylococcus* is naturally found on our skin and mucosal surfaces, but some species can be very dangerous. Infections usually occur on the skin, soft tissues, bone, and urinary tract. Transmission is from person-to-person contact and contaminated items such as bedding and clothing. It is also commonly found in patients that have had surgical procedures, those who are on antibiotics for long periods of time, and presence of a foreign body. *S. aureus* causes scalded skin syndrome (peeling of the skin), toxic shock syndrome, food poisoning, and wound infections. *S. aureus* can even cause more serious cases such as pneumonia, and bacteremia which is an infection of the blood that spreads to the rest of the body. *S. epidermidis* also causes bacteremia and urinary tract infections, similarly to *S. aureus*. It is also commonly found in surgical wounds, infections from the use of catheters, and prosthetic devices. *S. haemolyticus* also causes bacteremia and urinary tract infections, as well as bone and joint infections. The last two pathogens we will discuss are S. saprophyticus and *S. lugdunensis.* These both cause urinary tract infections like the others we have discussed. *S. lugdunensis* also causes bacteremia, endocarditis, and arthritis. A problem that healthcare providers are facing today is antibiotic resistant *Staphylococcus aureus*. Antibiotic resistance is when antibiotics change in a way that antibiotics are no longer effective. Methicillin resistant *Staphylococcus aureus* (MRSA) is now the most common cause of community-acquired skin and soft-tissue infections. Vancomycin resistant *Staphylococcus* *aureus* (VRSA) is now also appearing.

## Streptococcus

If you see the word *Streptococcus* and think, “step throat” you are absolutely correct. This is just one of the many infections *Streptococcus* can cause. Person-to-person contact or respiratory droplets spread *Streptococcus* infections. *Streptococcus* is split up into groups, depending on their cell wall. Group A, known as *S. pyogenes* is responsible for pharyngitis (strep throat), skin and soft tissue infections, such as the flesh eating disease known as necrotizing fasciitis, bacteremia, rheumatic fever, and kidney inflammation. *S. agalactiae*Group B Strep, causes pneumonia, urinary tract infections, wound infections, and skin and soft-tissue infections. Group C, *S. dysgalactiae,* causes pharyngitis and acute glomerulonephritis, which is inflammation of the kidneys. Groups F and G, *S. dysgalactiae* also causes pharyngitis and acute glomerulonephritis.

## Bacillus

Bacillus has two important species that we will discuss; *B. anthrasis* and *B. cereu*s. *B. anthrasis* itself has 3 routes of infection; inhalation, cutaneous, and gastrointestinal. When *B. anthrasis* is inhaled, the signs are usually unspecific. Before the patient knows it, they have gone septic and complain of fever and extremely large lymph nodes, known as lymphadenopathy. Cutaneous infections begin as a painless papule, but turns into a painful, large ulcer covered with a black scab and lymphadenopathy will also occur. Gastrointestinal infections form ulcers at the site of infection, such as the mouth or stomach, and lead to lymphadenopathy and sepsis. These three infections are all virtually 100% fatal if they are not treated. *B. cereus* also has three diseases it is known for, gastroenteritis, ocular infections, and severe pulmonary disease. Two forms of the disease characterize gastroenteritis caused by food poisoning, which are known as the emetic form and the diarrheal form. The emetic form is a short period of vomiting, diarrhea, and abdominal cramping. The diarrheal form is a long onset of diarrhea and abdominal cramping. Ocular infections occur after a traumatic injury takes place and the bacteria are introduced. This is characterized by the rapid destruction of the eye and leads to complete loss of light perception within 48 hours. Pulmonary disease is similar to the *B. anthrasis* and occurs in immunocompetent patients, those who have a normal immune response.

## Listeria

 Recent food recalls, such as Blue Bell ice cream, have broadcasted the scare of the listeria infection. Listeriosis is caused by the consumption of undercooked processed meat, unpasteurized or contaminated dairy products, unwashed raw vegetables, and smoked seafood. The disease originates in water, soil, vegetation, and animals. The illness begins with flu-like symptoms—vomiting, diarrhea, abdominal cramping, muscle aches, stiff neck, confusion, loss of balance, and can even cause convulsions. To help prevent the spread of listeriosis, safe food preparation and hand washing is extremely important.

## Mycobacterium

 The last pathogen we are going to talk about is actually resistant to disinfectants, detergents, antibiotics, and host immune response—in other words, you do not want to acquire this. The primary infection is pulmonary and occurs in immunocompromised patients. The most commonly heard of infection is *M. tuberculosis* (TB)*.* Those who work in the healthcare field must have a skin test to test to see if they have been exposed or infected. Symptoms include fatigue, weight loss, fever, and pulmonary issues in which the patient has a chronic cough and will begin to spit up blood. To test whether a patient has TB, three tests must be performed. An Xray of the chest showing pulmonary disease, a positive skin test, and positive lab work are considered a clinical diagnosis.

Experiment 2: Growing Bacteria on TSA Plates—SICK!

Now that we have learned a few types of pathogens we can come in contact with, we will conduct our second experiment to show how dirty hands are and how effective sanitizing techniques are. The procedure is given below. After incubating the TSA plates, students should see how effective the different hand washing techniques, such as soap and water, sanitizer, and not washing hands are.

**Materials**

* 4 Tryptic Soy Agar (TSA) Plates
* Hand Sanitizer
* Soap

**Procedure**

1. On the first and second TSA plate, both partners press down unwashed hand onto 2 TSA plates. These will serve as the control plates.
2. On the third TSA plate, have partner A press down hand that has been treated with hand sanitizer onto the plate
3. On the fourth TSA plate, have partner B press down hand that has been washed with warm soap and water
4. Incubate the 4 TSA plates inverted at 37 degrees Celsius for 48 hours.
5. Observe plates for the changes in growth

# Discussion

 In this chapter, we learned the different types of microbes and how they can be both helpful and harmful to humans. After conducting the two experiments and learning about the different diseases and infections that can be spread from person-to-person, we can conclude how important it is to have clean hygiene for not only our safety, but for those around us. In this chapter you learned:

* What microbes are
* Where microbes are found
* What conditions microbes favor
* Common pathogenic microbes, how they are spread, and the illnesses they cause
* The benefits of microbes and why we need them
* The importance of good hand washing

Resources

[1] "What Are Microbes?" *National Center for Biotechnology Information*. U.S. National Library of Medicine, 15 Jan. 2015. Web. 17 Mar. 2017.

[2] Miller, Greg. "These Funky Microbes Make Your Favorite Foods More Delicious." *Wired*. Conde Nast, 29 Aug. 2013. Web. 17 Mar. 2017.

[3] Wiliam, Sydney Australia. "Skwirk Interactive Schooling." *, Microorganisms Used by Humans, Small World (Microbiology), Science Year 9, NSW | Online Education Home Schooling Skwirk Australia*. Red Apple Education, n.d. Web. 17 Mar. 2017.

http://www.sciencedirect.com.argo.library.okstate.edu/science/article/pii/S0899588516300788