Name _____

Spread of Pathogens

Purpose: Understand the role of microorganisms in disrupting the health of organisms.

Why we should care: Plagues caused by infectious diseases have ravaged human populations throughout history. Even today, populations must deal with life-threatening diseases in localized areas or even on a global scale. Understanding what caused the diseases and how they spread has been the key to controlling these outbreaks and saving lives. We are currently dealing with the reality of COVID-19. Understanding the disease and how to control the spread is the key to fighting misinformation and panic.

Instructions: As you go through this reading color code your reading. Highlight or underline vocab and important information as follows:

- ✓ Highlight (or underline) the vocab and material you already know in green
- ✓ Highlight (or underline) the vocab and material you didn't already know in red

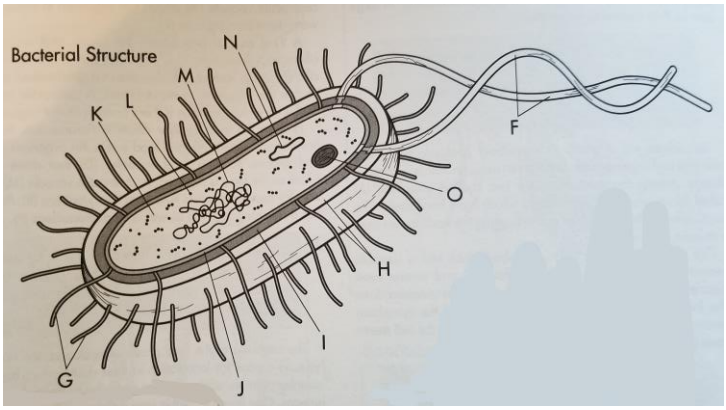
Introduction

A pathogen is defined as any microorganism or virus that can cause an infectious disease. Microorganisms are single-celled organisms, such as bacteria, protists, and fungi. Viruses are not included as microorganisms because they are not actually living organisms. An infectious disease is caused by microorganisms or viruses, like the cold virus (which happens to be a type of coronavirus) or strep throat; unlike non-infectious diseases, like diabetes, which is caused by lifestyle, the environment, or gene mutations.

1. What is a pathogen? _____
2. How are infectious and non-infectious diseases different? _____
   _____
3. Which type of disease (infectious or non-infectious) do you think would be harder to control in a population?
   _____
   _____

Pathogens can be separated into 4 groups:

Bacteria are prokaryotic organisms do not have a nucleus. The DNA is found in the nucleoid region of the cell. They may or may not have a cell wall around the cell membrane. Bacteria often cause diseases by producing toxins that are secreted by the bacteria or released when the bacteria break apart. When this happens, the toxins damage cells and causes infectious diseases. Bacteria can often be treated with antibiotics. Examples of bacterial diseases are strep throat, cholera, tetanus, and botulism. You have also probably seen necrotizing fasciitis (flesh-eating bacteria) on some of your favorite medical dramas.



Bacterial Structures

- Flagellum .....F
- Pili (Fimbriae) ....G
- Capsule .....H
- Cell Wall I
- Cell Membrane .....J
- Cytoplasm .....K
- Ribosomes L
- Chromosome.....M
- Plasmid .....N
- Endospore .....O

Figure 1: Basic bacterial structure

4. What is the difference between prokaryotes and eukaryotes? _____
   _____
5. How do bacteria cause disease? _____
   _____

Fungi are eukaryotic organisms that have a nucleus, are heterotrophic, and have a cell wall made of a carbohydrate called chitin. We often think of fungi as the different types of mushrooms we can find on the ground or in the store, but there are also single-celled fungi. Fungi can cause disease in three ways. First, some produce toxins to protect themselves and they are considered poisonous if eaten. Second, some can be parasites; they not only take nutrient from the host but will also invade nearby tissues. Last, some people are allergic to the spores produced by the fungus and these can cause an immune response when inhaled.

Figure 3: Ringworm and athlete's foot are both cause by parasitic fungus

Figure 2: Some mushrooms are highly toxic, and some are not. It can be tough to tell the difference.

6. What does heterotrophic mean? _____
7. List the 3 ways fungi can cause disease:
   a. _____
   b. _____
   c. _____

Protists are also eukaryotic and belong to the Kingdom Protista. Unlike the other kingdoms, some protists have very little in common. Most diseases are cause by protozoa or animal-like protists. These can be spread by a vector, such as a mosquito, or through contaminated food or water. These protozoa become parasites, taking nutrients while harming the host. Medical treatment is generally needed, or people won't recover. Malaria and Chagas disease are spread through insect vectors and the protist enters the host through the insect bites. Giardia is found in food or water contaminated with animal or human feces; the parasite enters the body when people ingest it. This is why hikers are warned against drinking from streams when hiking; clear water does not mean free of parasites.

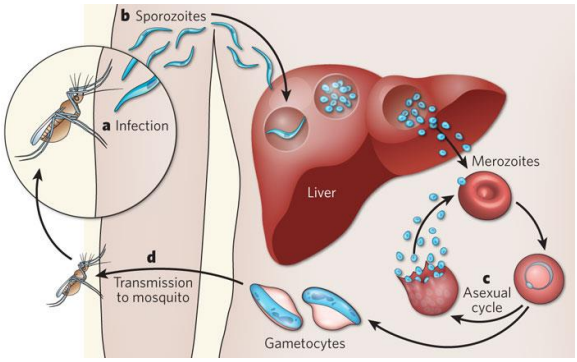
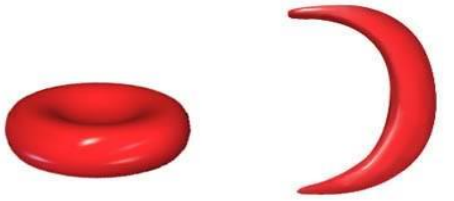


Figure 4: Life cycle of the malaria causing protozoa

8. What is a vector? _____

9. Look at Figure 4. The protozoa that causes malaria infects red blood cells and notice it destroys the red blood cell. Why would this be life threatening? _____
_____



Normal red blood cell Sickled red blood cell

10. People who are carries for sickle cell anemia, a disease which causes crescent shaped blood cells, have some normal red blood cells and some that are sickle cell shaped. These people are immune to malaria. Since the malaria-causing protist infects red blood cells, why do you think they would be unable to contract malaria?
_____
_____
_____

Viruses are not living cells; but a <u>nucleic acid</u>, either DNA or RNA, surrounded by a protein coat called a <u>capsid</u>. Some viruses may also be surrounded by an <u>envelope</u> made of phospholipids lipids and proteins. The envelope helps protect the virus from the host's immune system. Viruses will infect a host cell and use the host cell to make new viruses. The new viruses will break out of the host cell and go to infect other cells. The fact that viruses cannot reproduce on their own is one reason they are not considered alive. Examples of viruses are HIV, which causes AIDS, chicken pox, influenza, and the coronaviruses that causes the common cold and COVID-19. The picture below shows a bacteriophage that infects bacteria

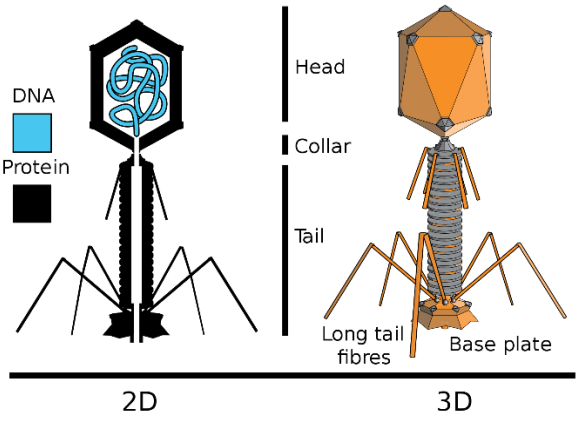


Figure 6: Bacteriophage-virus that infects bacteria

A…Genome

B…Capsid

D…Envelope

E…Tail

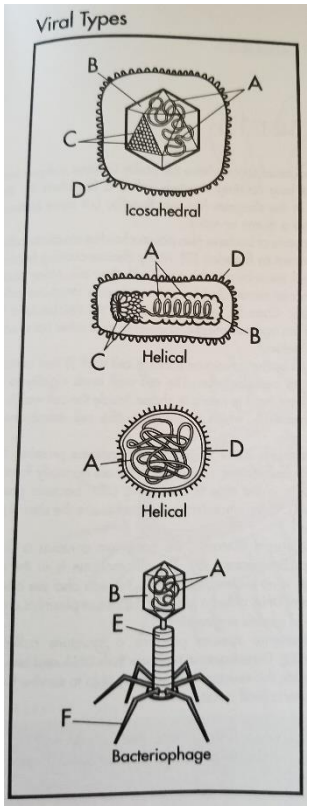


Figure 5: Notice the parts that all the viruses have in common

11. Explain the general structure of a virus. _____
_____

12. Considering viruses aren't made of many parts and they use the host cell to make new viruses; what part of the virus do you think actually enters the cell to infect it? Explain your reasoning? _____
_____
_____

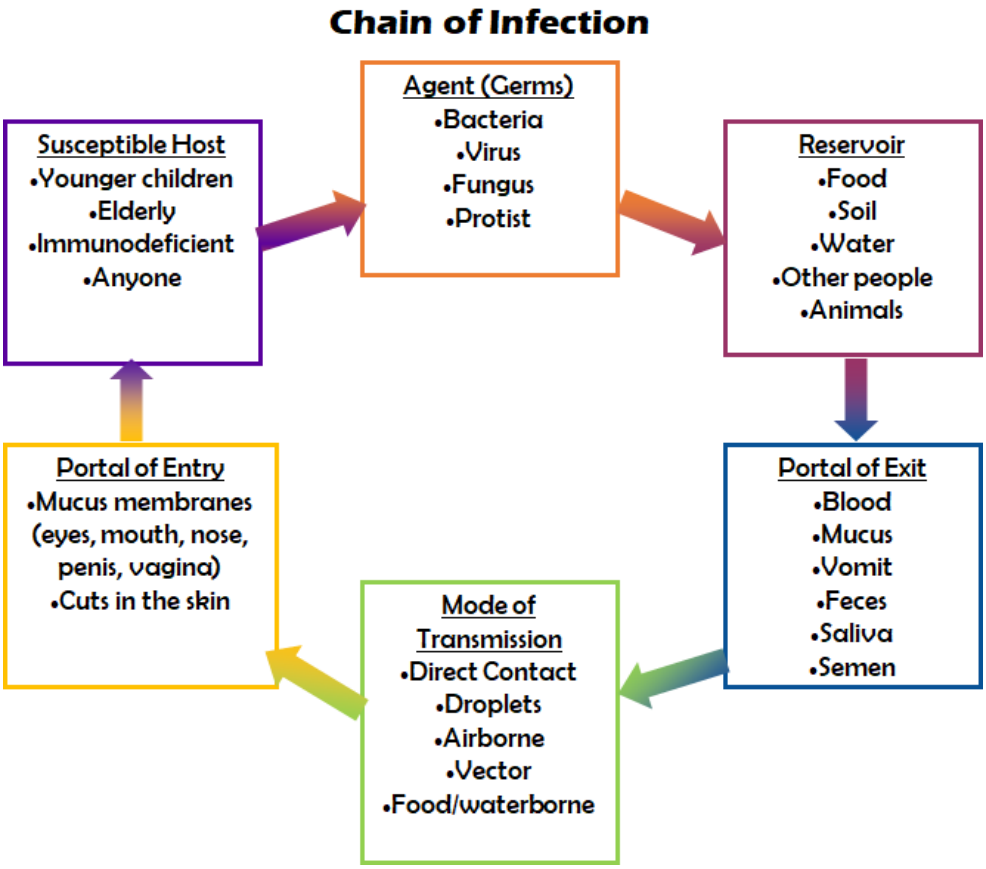
Chain of Infection

A pathogen starts in a reservoir, which is where the microorganism or virus is multiplying. The reservoir can be in another person, in a vector like a flea, or in contaminated water or food. You have probably heard about some diseases that started in animals and were transferred to humans. This is called zoonosis and happens when human come in contact with animals that carry the pathogen. It can exist in the animal reservoir with very little effect on the host, but when transferred to humans can make us sick. Despite what we see in the news, consuming wild animals is not the only way this happens. Pathogens can also be transmitted in the saliva through bites, through the air, or contaminated water. Examples of diseases caused by pathogens spread from animals include leprosy, AIDS, SARS, and bubonic plague.

13. Explain zoonosis. _____
_____

The pathogen is must leave the host through an exit and is usually carried in bodily fluids, such as blood, mucus, or saliva. The mode of transmission can be direct or indirect. Direct contact includes diseases spread through physical contact or diseases spread through droplets. Physical contact would include touching infected areas, kissing, sexual intercourse, or even eating or drinking after an infected person. HIV is spread sexual intercourse because it is found in the white blood cells of semen and vaginal fluids. It can also spread through intravenous drug use. Mononucleosis is the "kissing disease," but can also be shared when you share your drinks. Droplets are spread when a sick person, maybe with the flu, coughs or sneezes in your direction and you inhale those pathogen-filled droplets into your lungs. This also happens when you eat or drink after someone; their saliva droplets are now in your mouth!

Indirect contact is when you don't have to make contact with the infected person to get sick. Airborne diseases such as measles hang out in the air after the sick person is no longer in the area. Diseases spread by a vector include malaria and West Nile. Mosquitos spread the pathogens when they bite a person and it is transferred into the blood through the saliva of the mosquito. Some pathogens can also be spread through food or water contaminated pathogens. This is why proper food handling and cooking temperatures are so important. In the late 1800s, cholera was spread quickly when people in cities were drinking from water pumps that had been contaminated with feces.



14. Explain the difference between direct and indirect transmission. _____
    _____
15. Explain 2 examples of direct contact transmission:
    a. _____
    b. _____
16. Explain 3 examples of indirect transmission:
    a. _____
    b. _____
    c. _____
17. Put the events in the correct order for an infection.
    a. _____ Pathogen may be spread from sick host to new hosts infecting others
    b. _____ Pathogen grows and multiplies in its reservoir
    c. _____ Pathogen grows and multiplies in the new host making the host sick
    d. _____ Pathogen enters the susceptible host through an opening in the body

Pathogens can be spread different ways, but it is important to understand that most diseases are spread one way, not multiple ways. For example, ebola is spread the direct contact with bodily fluids of an infected person. You can't catch it by breathing the same air as them. However it spreads; the pathogen must have a way into the body. Pathogens can enter through any opening into the body. This includes natural openings like the eyes, mouth, nose, penis, or vagina and unnatural opening like breaks in the skin. The mucus produced by the mucus membranes in those natural openings usually do a pretty good job of trapping pathogens, but sometimes they do get through our natural defenses.

Controlling the Spread

It can be pretty scary to start thinking about all the different pathogens and the diseases you could catch. However, we can control the spread of many of these. For example, better waste management help stop cholera outbreaks. For yourself, you can keep yourself healthy by washing your hands after using the restroom and before eating. This helps stop the spread of bacteria from feces and helps keep pathogens out of your mouth when you eat. Covering your mouth, with something other than your hand, when coughing or sneezing helps keep droplets from being inhaled by people close to you. Avoiding the bodily fluids, such as saliva, blood, vomit, sweat, semen, or feces, of other people is also a good idea; especially if you don't know if they are sick. That does include saliva, as in don't share drinks with each other!

18. Explain how basic hygiene can help prevent the spread of pathogens. _____
    _____
19. What are some changes you should make to your daily routine when you are sick or know you have been in contact with someone who is sick? _____
    _____

Can be Helpful

One last important point; bacteria, fungi, protists, and viruses are not all bad! Some of these are actually really helpful to humans. Some are even essential to our survival. For example, some bacteria and some fungi are used in fermentation to give us things like yogurt, cheese, bread, beer, kimchi, kombucha, and other fermented food. Bacteria in your body also aid the digestion and absorption of nutrients; they can also help keep the "bad" bacteria in check. Bacteria, fungi, and some fungus-like protists are essential to our ecosystems because they function as decomposers. Bacteria and plant-like protists carry out photosynthesis, which gives us most of the oxygen on the planet. Even certain viruses live in your body and help destroy certain bacteria. Scientists are also working to genetically engineer viruses to work for us.

20. Give 2 ways that bacteria help us:
    a. _____
    b. _____

21. Give 2 ways fungi help us:
    a. _____
    b. _____
22. Give 2 ways that protists help us:
    a. _____
    b. _____

Follow up Questions

23. What are two other vectors you can think of? _____
    _____
24. Considering the different modes of transmission, which modes would be most likely to infect a large number of individuals in a short period of time? Explain. _____
    _____
    _____
25. Why might diseases spread by vectors be harder to control than other modes of transmission?
    _____
    _____
26. Some infections can be spread before the person starts to show symptoms. Others can be spread by carriers that don't actually get sick. What kind of challenges do health care officials face when trying to control these diseases?
    _____
    _____
    _____
27. Write the vocabulary word next to the correct definition:
    a. _____ animal that spreads an infectious disease
    b. _____ when a disease spreads from animals to humans
    c. _____ heterotrophic organism that can act as a decomposer in the environment or a parasite on organisms
    d. _____ non-living particle that has a genome surrounded by a capsid
    e. _____ prokaryotic organism that can play an essential role in our lives or make us sick; it depends on the type of organism
    f. _____ heterotrophic organism that is usually spread through a vector like a mosquito or through contaminated water
    g. _____ microorganism or virus that causes infectious diseases
    h. _____ DNA or RNA
    i. _____ organism that lives on or in another organism, taking nutrients and causing harm to the other organism

Word Bank: each word is only used once

Nucleic acid	Vector	Bacteria
Fungi	Parasite	Pathogen
Virus	Protist	Zoonosis

Name _____

What are some unanswered questions you still have that you would like answered? List them here and we will try to get them answered!