BEAM's Going Viral!

Neil Kamdar, Jacob Yim, David Paner, Marianne Kanaris, Jodie Shi, Marisa Wong | Spring 2021

Field(s) of Interest: Epidemiology

Brief Overview (1-3 sentences):
In this lesson mentees will learn what viruses are, and also gain insight on how diseases form and spread within a population. They will also get a chance to practice diagnosing patients with common diseases.

Agenda:

- Introduction (5 min)
- Module 1: Viruses (8-10 min)
- Module 2: Epidemic/Disease Spread (10 min)
- Module 3: How to Save a Life (15 min)
- Conclusion (5 min)

Main Teaching Goals/Key Terms:

- ➔ **Pathogens:** Any kind of microbe that causes disease.
- ➔ **Transmission**: The process of an infectious disease being passed from an individual to others. There are 2 types:
  - ◆ **Direct**: when disease particles are transmitted through contact or droplet spread between individuals
  - ◆ **Indirect**: when disease particles are transmitted through suspended air droplets, inanimate objects, or animal vectors
- ➔ **Symptoms:** sign or evidence of a disease
- ➔ **Diagnosis:** identifying the disease based on the symptoms of a patient

Background for Mentors: Module 1

Teaching Goals

- Pathogens
- Viruses

A **pathogen** is any kind of microbe that causes disease. Our bodies naturally carry all kinds of microbes--bacteria, viruses, and other microorganisms--but many are harmless under normal circumstances. Pathogens, however, are dangerous, often foreign microbes that may cause diseases when they enter the body. Pathogens, like the microorganisms in our bodies, can come in all kinds of forms.

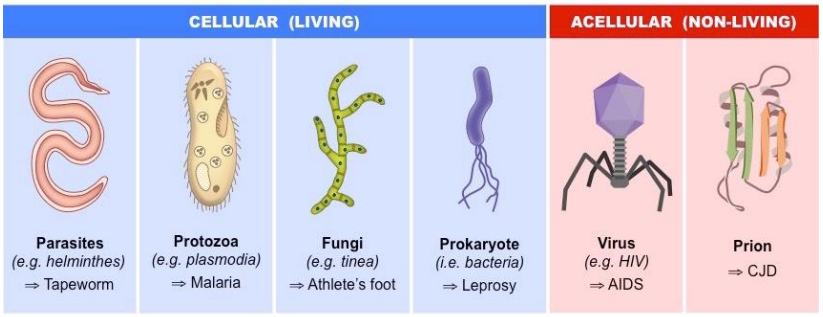

Figure 1: Types of pathogens

A **virus** is one kind of pathogen. Viruses carry DNA inside of bodies made of protein. They infect cells by injecting them with this DNA. The cell then replicates the virus, allowing it to reproduce. Viruses, unlike microorganisms like bacteria, are generally not considered living--they do not have cells and need to infect other organisms to reproduce. Viruses have a spike that allows them to infect other organisms and transfer genetic material. A capsid is a protein cage to hold the genetic material. A membrane and envelope protect the inner capsid. The genome is the genetic material that is shared with cells that the virus infects.

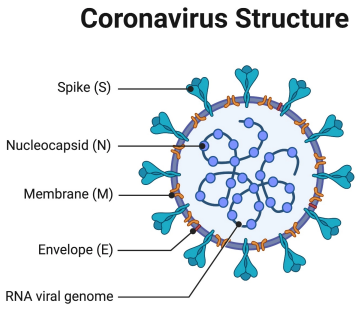

Figure 2: Parts of Coronavirus

Background for Mentors: Module 2

Teaching Goals

- Transmission
- Immunity
- Vaccine

Infectious diseases are passed between from an infected host individual to others through **transmission**. *Direct transmission* results from direct contact or droplet spread between individuals. *Indirect transmission* occurs when disease particles are transmitted through suspended air droplets, inanimate objects, or animal vectors.


Fig. xa & xb: Sneezing is an example of direct transmission and can spread virus-laden droplets to other individuals. Mosquitoes are an example of a disease vector that spread diseases such as malaria and west nile virus.

Organisms can achieve **immunity** to a disease through acquiring antibodies specific to the pathogen causing it. There are two major types of immunity: active immunity and passive immunity. Active immunity is provided when a person is exposed to the disease organism, which triggers the immune system to respond and produce antibodies specific to that disease to both help fight off the current infection, and any reoccurrence of the infection in the future. Passive immunity is provided when a person is given the antibodies to the disease, as in the case of a vaccine.

Fig. x: Herd immunity is achieved when enough of the population is immunized against a disease. Those who are unable to be immunized are still protected as the disease is much less likely to reach them.

Vaccines are preparations containing an agent that resembles the disease-causing pathogen, which serves to stimulate the body's immune system to recognize and destroy the infection. This can provide long-lasting immunological memory; and widespread immunity due to vaccination has helped eradicate a number of notable diseases.

Background for Mentors: Module 3

Module 3

- Symptoms
- Medical Note
- Diagnosis

When experiencing discomfort, it's always important to describe the **symptoms** or signs of a disease experienced as detailed as possible. Oftentimes, many different diseases share the same set of common symptoms so it's important that doctors write **medical notes** which can include notes on the patient's diet, habits, severity of symptoms, and if there's been any interactions with infected individuals. Sometimes, the deciding factor for identifying a disease is within the patient's behavior rather than their experienced symptoms.

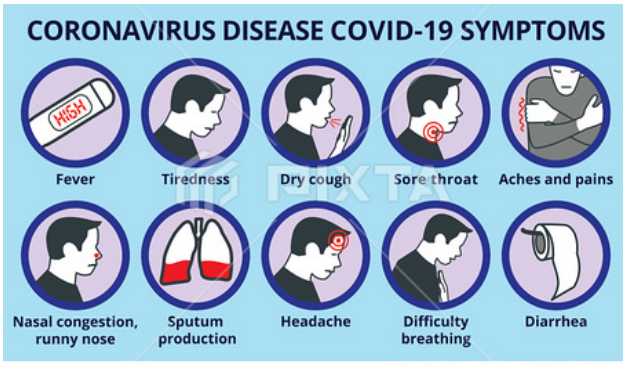

Figure 1: Symptoms of Covid-19

Only with an accurate description of all the symptoms and recent behaviors will a doctor be able to make an accurate **diagnosis** in which they identify the disease that is responsible for all the experienced symptoms.

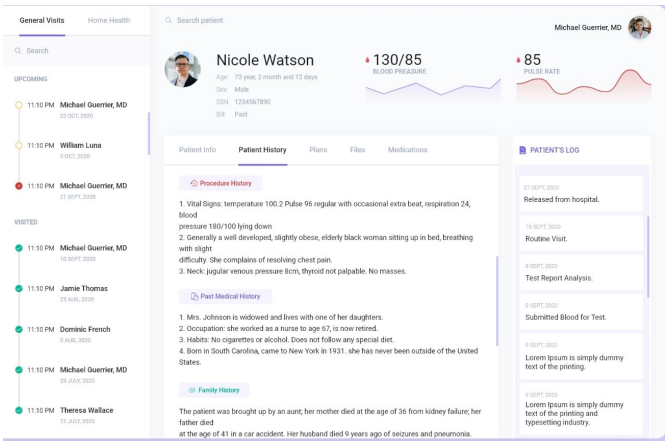

Figure 2: Example Patient Profile with Medical Notes

Introduction

This lesson is important because it teaches about what viruses are along with safety procedures to protect ourselves from viruses. It is especially relevant with the COVID-19 pandemic that has affected our lives and made it important to understand how viruses are transmitted.

Concepts to Introduce	**Questions to Pique Interest**
● Spreading ○ Analogy: zombie apocalypse that starts slow then goes rapidly ● Pandemic ○ When a disease/virus spreads across international borders	● Are viruses living things? ● How do you tell what illness an individual is experiencing? ● What are ways that diseases can spread?
Scientists, Current and Past Events	**Careers and Applications**
● Dr. Fauci: In charge of discussing the COVID-19 outbreak ● Spanish Flu: In 1918, the H1N1 influenza virus spread around the world, killing between 17 million to 100 million globally ● 2009 Swine Flu: Spread across the world, killing around 500,000 - was not any worse than the normal flu ● COVID-19 pandemic: Current pandemic	● Doctors - Diagnosing illnesses based on symptoms and offering a treatment ● Epidemiology - study of the distribution of disease causing determinants in the community worldwide

Module 1: Viruses

The mentees will be learning about the structure of a virus along with understanding that viruses are not actually living things.

Teaching Goals	Materials
1. **Pathogens:** a bacterium, virus, or other microorganism that can cause disease 2. **Viruses:** infectious agent that replicates only inside the living cells of an organism	• https://media.hhmi.org/biointeractive/click/virus-explorer/index.html

Procedure

1. https://media.hhmi.org/biointeractive/click/virus-explorer/index.html
2. Share screen and check out the different viruses for around 3-5 mins. Point out the parts of a virus that were covered in the lecture section.
    a. Capsid, Envelope, Genome, Spikes
3. Discussion Question: Ask the mentees if they think a virus is a living thing. Suggest that viruses spread like cells, and they can change forms (mutate).
    a. But they aren't! Why? Because viruses are not made out of cells, they can't keep themselves in a stable state, they don't grow, and they can't make their own energy

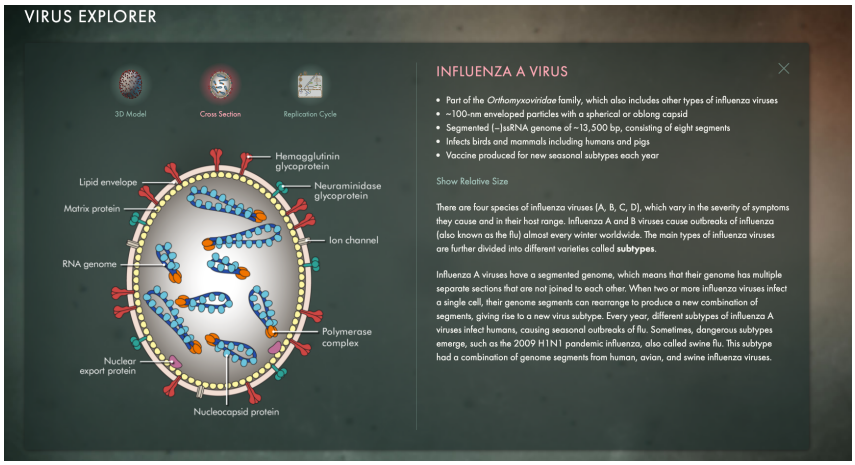

Fig. 1: example of a virus and its cross-section that we will be analyzing

Module 2: Epidemic/Disease Spread

Summarize the module here. What will kids be doing? How does this module teach/show that?

Teaching Goals	**Materials**
1. **Vaccine:** a type of medicine that helps your immune system prepare to fight off a specific disease 2. **Immunity:** the ability of an organism to be resistant to getting a certain infection or disease 3. **Transmission:** the direct transfer of disease between individuals through different methods	• Infection Simulation

Procedure

1. Access the simulation
2. Share screen and run the simulation for around 5 minutes.
    a. Start off with settings: *Kold, Medium, None*
    b. Then ask for mentee input to try different combinations
3. Discussion question: How does population density affect the spread of the disease? What about how the presence of population mixing affects spread?
    a. Point out that with low population density, the disease can die out. But with high population density, the disease can spread out to everybody.
    b. Point out that with no population mixing, the disease can die out. But if there is population mixing, the disease could affect the whole population.
4. Run the simulation again, but set the Lesson setting at the top of the page to “Vaccination”
    a. Start off with settings: 5% vaccinated
    b. Then ask mentees to try different combinations
5. Discussion question: How does increasing the starting population of vaccinated people affect the spread of disease?

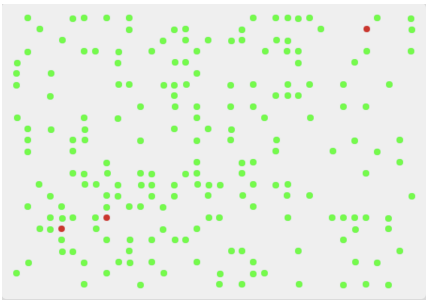

Fig. 2: lessening the population density causes the disease to die out quicker

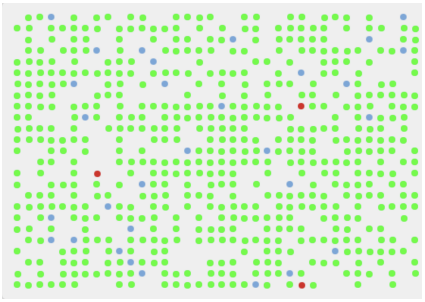

Fig. 3: Increasing the vaccinated population lessens the spread of disease.

Module 3: How to Save a Life

In this module, mentees will be introduced to a simple procedure of how doctors diagnose illnesses. Mentees will have a symptoms sheet and practice asking the mentors questions in an attempt to identify the illness the mentor has.

Teaching Goals	**Materials**
1. **Symptoms -** sign or evidence of a disease 2. **Medical Note** - an entry into the medical system that includes notes on recent behaviors or activities of the patient's that can be a clue when diagnosing 3. **Diagnosis -** identifying the disease based on the symptoms of a patient	• Illness sheet • Patient Charts

Procedure

1. Mentees will be divided into breakout rooms of 4-5 mentees and 3 mentors.
2. Mentees should be given access to the illness sheet whether through link sharing or screen sharing.
3. Each mentor will choose an identity from the patient charts and the mentees must figure out what illness each patient has by asking questions about the mentor's **symptoms**.
4. Lead the mentees into asking questions that can be written down as a **medical note** as well.
5. They will end with a **diagnosis** and if there is time, groups can switch to the other group of mentors.

Conclusion

Our COVID-19 pandemic has been caused by a virus, and we see how much a small pathogen can cause so much havoc! We saw how easily viruses spread, and how getting a vaccine, like Pfizer, Moderna, or Johnson and Johnson can help us lower the effects of them. We have also think about how to save someone's life when they're sick and notice the side effects or indicators that someone isn't feeling so well