Lab-wide Learning Outcomes for How Diseases Spread

Knowledge-Based Outcomes

Upon completion of *How Diseases Spread*, students should be able to:

1. Provide examples of infectious diseases, identifying the pathogens responsible and mode of transmission (direct or indirect).
2. Show how simple SIR models can be used to help understand the spread of disease and why R_0 is useful for understanding disease dynamics.
3. Illustrate how key attributes of a pathogen, such as transmission mode, R_0, or long-term immunity, can affect public health decisions about how to respond to an epidemic.

Skills-Based Outcomes

Upon completion of *How Diseases Spread*, students should be able to:

1. Define an SIR model, including underlying assumptions, and discuss how SIR models can be used to estimate how fast a disease will spread and how many people will become infected.
2. Interpret an SIR model output graph.
3. Given a description of a disease system:
    - Predict general disease dynamics, as related to host population characteristics.
    - Identify possible control strategies for the disease.

How Diseases Spread, Part 1: Pathogens and Infectious Disease

Knowledge-Based Outcomes

Upon completion of *Part 1: Pathogens and Infectious Disease*, students should be able to:

1. Distinguish between bacterial and viral diseases, including treatment and pathogen replication.
2. Contrast how human innate and acquired immune responses work.

How Diseases Spread, Part 2: Modeling Epidemics

Knowledge-Based Outcomes

Upon completion of *Part 2: Modeling Epidemics*, students should be able to:

1. Explain how population density (N, when area is constant), transmission rate (β), and infectious period (L) influence the spread of disease.
2. Explain that the population-level transmission rate of a disease is determined by both the frequency of contact between susceptible and infected individuals, as well as the per-contact probability of pathogen transmission.
3. Explain how births might produce disease cycles by replenishing the pool of susceptible individuals in a population that has been previously exposed to a disease such as measles.

Skills-Based Outcomes

Upon completion of *Part 2: Modeling Epidemics*, students should be able to:

1. Calculate the basic reproductive number (R_0) for a disease, given the number of susceptible individuals (S), transmission rate (β), and infectious period (L).
2. Predict whether a disease will spread through a population, based on the value of R_0.

How Diseases Spread, Part 3: Controlling Disease Spread

Knowledge-Based Outcomes

Upon completion of *Part 3: Controlling Disease Spread*, students should be able to:

1. Explain herd immunity, and how it can be achieved by vaccination.
2. Describe how changes in behavior like social distancing and wearing masks can slow the spread of infectious diseases like the flu or COVID-19.
3. Explain what it means to "flatten the curve" and how doing so can improve a community's ability to respond to an epidemic.

Skills-Based Outcomes

Upon completion of *Part 3: Controlling Disease Spread*, students should be able to:

1. Calculate the critical immunization threshold (p_c) required to achieve herd immunity for a particular disease.
2. Demonstrate, using a simulation, that the effectiveness of community mitigation measures depends on the level of compliance.

How Diseases Spread, Part 4: Vector-Borne Diseases

Knowledge-Based Outcomes

Upon completion of *Part 4: Vector-Borne Diseases*, students should be able to:

1. Describe how an SIR model can be used to describe the spread of a vector-borne disease like malaria.
2. Contrast techniques used to control the spread of diseases like the flu, that propagate via direct contact, with those used to control diseases like malaria that are vector-borne.

How Diseases Spread, Part 5: The Evolving Nature of Disease

Knowledge-Based Outcomes

Upon completion of *Part 5: The Evolving Nature of Disease*, students should be able to:

1. Summarize the roles of mutation, genetic drift, and natural selection in pathogen evolution.
2. Explain why frequent mutations in flu viruses necessitate new flu vaccines annually.
3. Explain why evolution by natural selection should, in general, favor intermediate levels of disease virulence.