

# MAP 4484 Modeling in Mathematical Biology: Disease Dynamics

## Disease Dynamics Study Guide

### Key Concepts:

1. **Disease Dynamics:** Disease dynamics is the study of how diseases spread and evolve over time. This includes understanding the factors that influence the transmission of a disease, such as population size, environmental conditions, and human behavior. It also involves modeling the spread of a disease using mathematical equations and computer simulations.
2. **Epidemiology:** Epidemiology is the study of the distribution and determinants of health-related states or events in specified populations, and the application of this study to the control of health problems.
3. **Pathogen:** A pathogen is any organism that can cause disease. Pathogens can be bacteria, viruses, fungi, or parasites.
4. **Transmission:** Transmission is the process by which a pathogen is spread from one person to another.
5. **Infection:** Infection is the process by which a pathogen enters and multiplies inside the body of a host.
6. **Immunity:** Immunity is the ability of the body to resist infection by a pathogen.
7. **Vaccination:** Vaccination is the process of introducing a weakened form of a pathogen into the body in order to stimulate the immune system and provide protection against future infections.

### Equations:

1. **SIR Model:** The SIR model is a mathematical model used to describe the spread of infectious diseases. It is based on the assumption that a population can be divided into three compartments: Susceptible (S), Infected (I), and Recovered (R). The model is described by the following equations:

$$dS/dt = -\beta SI$$

$$dI/dt = \beta SI - \gamma I$$

$$dR/dt = \gamma I$$

where  $\beta$  is the transmission rate, and  $\gamma$  is the recovery rate.

2. **SEIR Model:** The SEIR model is an extension of the SIR model that takes into account the incubation period of a disease. It divides the population into four compartments: Susceptible (S), Exposed (E), Infected (I), and Recovered (R). The model is described by the following equations:

$$dS/dt = -\beta SI$$

$$dE/dt = \beta SI - \alpha E$$

$$dI/dt = \alpha E - \gamma I$$

$$dR/dt = \gamma I$$

where  $\beta$  is the transmission rate,  $\alpha$  is the rate of progression from exposed to infected, and  $\gamma$  is the recovery rate.

3. SIS Model: The SIS model is a mathematical model used to describe the spread of infectious diseases with no immunity. It divides the population into two compartments: Susceptible (S) and Infected (I). The model is described by the following equation:

$$dS/dt = -\beta SI + \gamma I$$

where  $\beta$  is the transmission rate, and  $\gamma$  is the recovery rate.

Definitions:

1. Susceptible: Susceptible individuals are those who have not yet been exposed to the pathogen and are therefore at risk of becoming infected.
2. Exposed: Exposed individuals are those who have been exposed to the pathogen but have not yet become infected.
3. Infected: Infected individuals are those who have been infected with the pathogen and are capable of transmitting it to others.
4. Recovered: Recovered individuals are those who have recovered from the infection and are no longer capable of transmitting it to others.
5. Transmission Rate: The transmission rate is the rate at which a pathogen is spread from one person to another.
6. Recovery Rate: The recovery rate is the rate at which an infected individual recovers from the infection and is no longer capable of transmitting it to others.
7. Incubation Period: The incubation period is the time between exposure to a pathogen and the onset of symptoms.

Rules:

1. Always practice good hygiene to reduce the risk of infection.

2. Get vaccinated to protect yourself and others from disease.
3. Avoid contact with people who are sick.
4. Stay home if you are feeling ill.
5. Seek medical attention if you experience symptoms of a disease.