EMORY
ROLLINS SCHOOL OF PUBLIC HEALTH

Design a Transmission Model

Session 3

Novel Respiratory Pathogen

- All individuals are susceptible (at first) and become infected by contact with an infected individual
- People are infectious for a while and then become immune
- Immunity eventually decays

Model

We can partition our population into:

- Susceptible (S)
- Infected (I)
- Immune (R)

Total Population Size N = S + I + R

S I R

$N = S + I + R$

Flow between Compartments

λ is the force of infection per susceptible person:

- contact rate α
- probability of infection on contact with an infectious person β
- probability that a randomly encountered person is infectious $I(t)/N$
- $\lambda_t = \alpha * \beta * I_t/N$

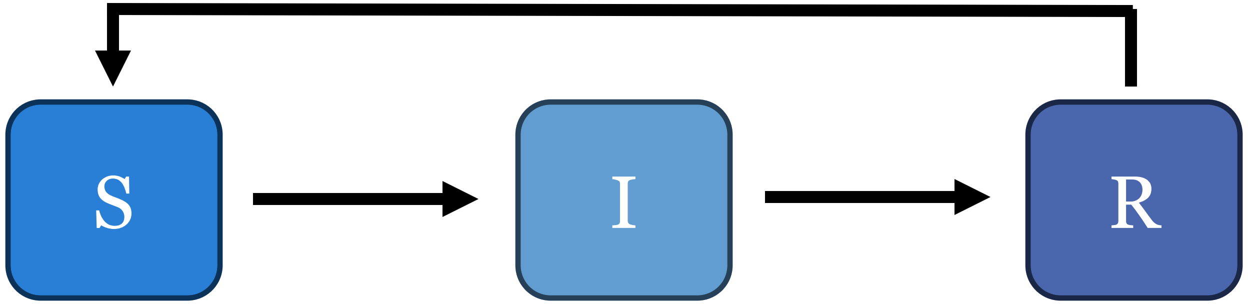
Flow between Compartments

σ is the recovery rate

$N = S + I + R$
$\lambda_t = \alpha * \beta * I_t / N$

Flow between Compartments

ω is the rate at which immunity is lost



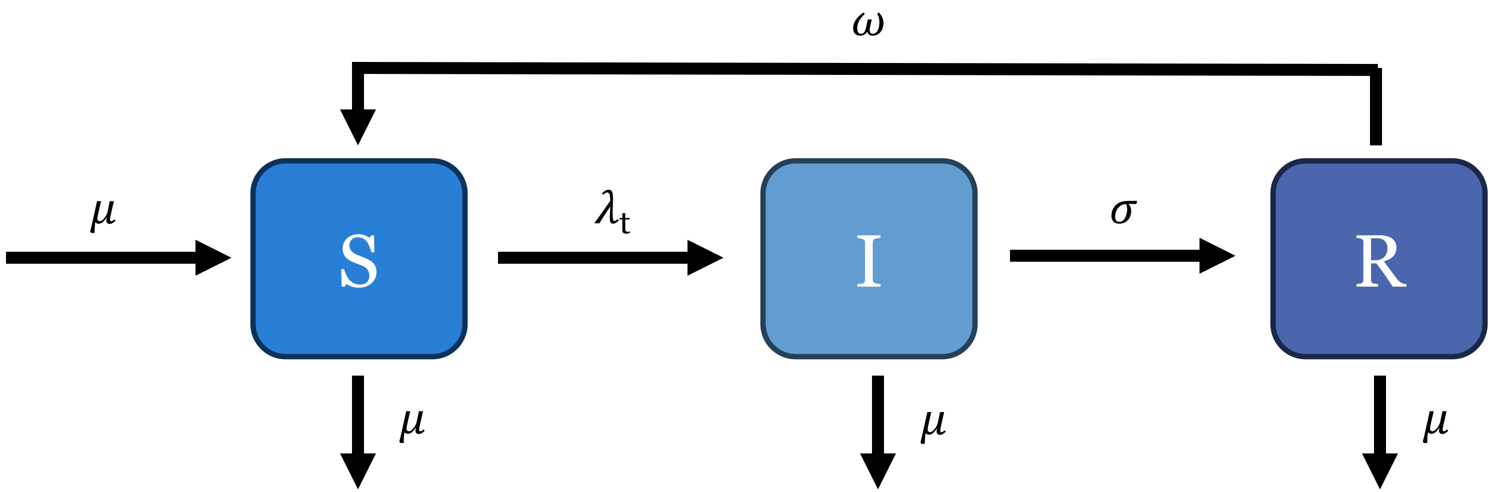
$N = S + I + R$
$\lambda_t = \alpha * \beta * I_t / N$

Exercise: Update Diagram & Write Equations

- All individuals are susceptible (at first) and become infected by contact with an infected individual
- People are infectious for a while and then become immune
- Immunity eventually decays
- People are born susceptible
- People die at equal rates regardless of infection status
- People are vaccinated at random

Example Answer: Updated Diagram

μ is both the birth and death rates



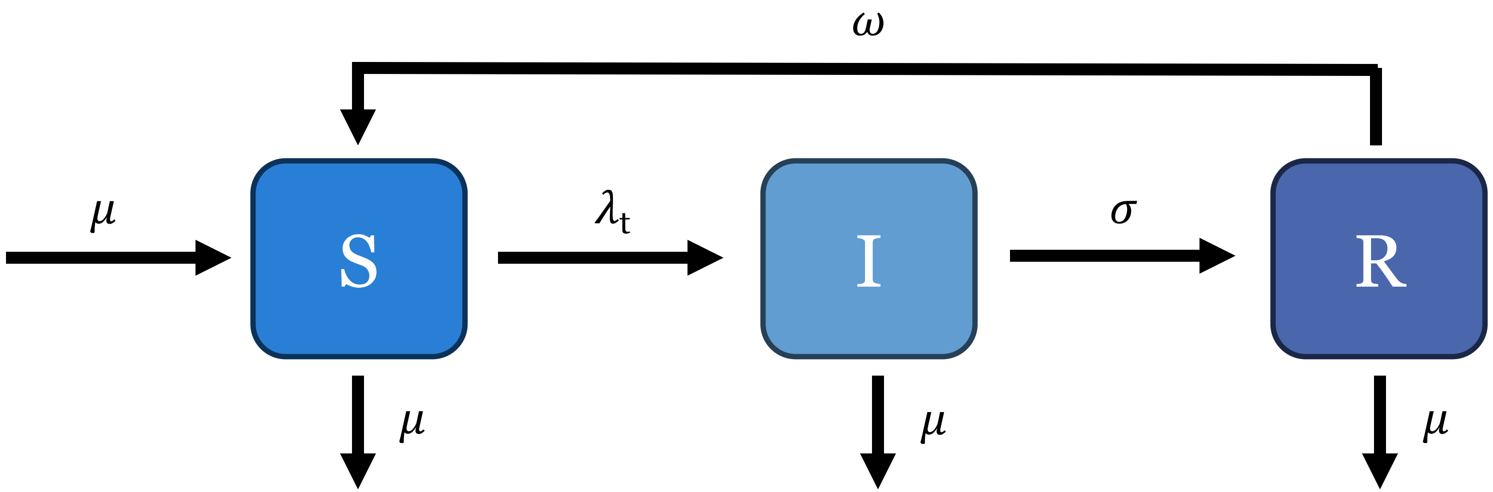
N = S + I + R
$\lambda_t = \alpha * \beta * I_t / N$

Example Answer: Write Equations

$$S_{t+1} = -\lambda_t * S_t + \omega * R_t + \mu * N_t - \mu * S_t$$

$$I_{t+1} = \lambda_t * S_t - \sigma * I_t - \mu * I_t$$

$$R_{t+1} = \sigma * R_t - \omega * R_t - \mu * R_t$$



$N = S + I + R$

$\lambda_t = \alpha * \beta * I_t / N$