SIR Model of Epidemic

- Infective: Has the disease and can infect others
- Susceptible: Can contract the disease
- Removed: Former infectives who are no longer infectious (includes recovered, died, isolated)
- S = number of susceptibles, I = number of infectives, R = number removed
- Assumptions:

  $S + I + R = N$ constant

  Incubation time negligible

Model Equations

- $dS/dt = -\beta SI$
- $dI/dt = \beta SI - \gamma I$
- $dR/dt = \gamma I$
- *infection rate* = β
- *removal rate* $= \gamma$ (inversely proportional to infectious period)
- These equations say …

Consequences

- $S = S_0 \exp(-(1/\rho)(R - R_0))$, where $\rho = \gamma/\beta =$ *relative removal rate*
- Threshold Theorem:If $S_0 < \rho$, then the infection dies out (no epidemic). If $S_0 > \rho$, then the disease spreads (there is an epidemic). (S_0/ρ = *basic reproduction rate*, confusingly denoted R_0)
- The maximum value of I is $S_0 + I_0 + \rho \ln(\rho/(eS_0))$

Modified SIR Models

- Recurrent diseases: Infectives or removes can become susceptible
- Recruitment: e.g., new births in modeling measles
- Vaccination: (susceptibles become immune)
- Latent class: Infected but not yet infectious (SEIR)
- Maternal antibody class
- Interacting classes (e.g., STD’s, malaria)
- Variable incubation period (e.g., AIDS)