

Mathematical Epidemiology

Course instructors

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Course description This course will cover different formulations and analyses of epidemiological models. Topics include host heterogeneity, multiple pathogens, spatial spread, within-host dynamics, and zoonotic spillover.

Prerequisites. Students should have completed undergraduate courses in dynamical systems and modelling.

Textbook: [Modelling Infectious Diseases in Humans and Animals](#) by Matt Keeling and Pejman Rohani (K&R) (available as a .pdf from the MUN library).

Rationale: This course will cover the different types of epidemiological models so that students understand the scope of options when modelling infectious diseases. Students will learn the assumptions of the different model formulations (the models are autonomous and non-autonomous, delay, and integro- differential equations, partial differential equations, and branching processes) and mathematical approximations that simplify computationally complex specifications (i.e., Gillespie's Direct Algorithm, moment equations, master equations, separation of time scales, commuter approximations). Students will analyze the models to understand their temporal dynamics (i.e., disease-free equilibrium stability as determined by the net reproduction number, dynamic resonance, bifurcation diagrams, numerical solutions), how the temporal dynamics depend on the biological assumptions, and how to interpret models to answer public health questions.

Grading: Assignments (40%), Project (60%)

Course outline

- [1] Simple Epidemiological Models (Ch 2 K&R)
- [2] Host Heterogeneity (Ch 3 K&R)
- [3] Multipathogen/Multihost (Ch 4 K&R)
- [4] Pathogen evolution
- [5] Temporally-forced models (Ch 5 K&R)
- [6] Within-host dynamics
- [7] Stochastic dynamics (Ch 6 K&R)

[8] Spatial models (Ch 7 K&R)

[9] Modelling importations

[10] Zoonotic spillover

[11] Controlling Infectious Disease (Ch 8 K&R)