One Health Modelling for Emerging Infectious Diseases
Part II

Lectures: 38 hours

Instructor: OMNI-REUNI researchers with appropriate background

The Course.

This course is an extension of One health Modelling for Emerging Infectious Diseases Part I. This course introduces students to mathematical modelling of infectious diseases in One Health, including vectorborne diseases, livestock diseases, and waterborne diseases.

Infectious diseases models are developed to track infection and transmission in animal, plant, and human populations. Particular attention is paid to infections that can be transmitted to humans in animals from their environment, including insects, livestock, and affected water sources. Public health mitigation, as well as animal and environmental pathogen control are discussed, and the models are extended to include vector control, treatment and immunization of livestock, other vector and livestock control disease control mechanisms (i.e., culling), and environmental treatment. Students will learn to formulate, analyze, parameterize, and validate quantitative models for infectious disease processes and data. Applications include malaria, zika virus, west nile virus, lyme disease, foot and mouth disease, avian influenza, cholera, Hepatitis A virus, and typhoid fever. Approaches involve computer simulation, differential equations, individual-based models, least squares, likelihood, matrix equations, Markov processes, and stochastic processes. Computing labs cover simulation and programming methods in specific software programs that are popular in the field of Infectious Disease Modelling. Course discussions in model evaluation and appraisal of current literature include opportunities for reflection and communication. Students will have opportunity to collaborate with their course colleagues on group projects.

Prerequisite.

Familiarity with epidemiology and public health. Some training in disease modelling. Or, permission of the instructor.

Class Structure.

Classes will include lectures, group discussion and computer labs. Group project presentations will occur in the last week of each section of the course.

Syllabus:

Introduction:
Review of the basic models of diseases transmission and immunity (2 hours)
Review of the models of animal, plant and human population growth (2 hours)
Introduction to mathematical models of vector life stages – mosquitoes and ticks (2 hours)
Introduction to livestock modelling (2 hours)

Introduction to environmental contamination modelling (2 hours)

Theme 1: Vectorborne diseases
Introduction to malaria, west nile virus, lyme disease (2 hours)
Introduction to the mathematical modelling of vectorborne diseases without vector lifecycle model structure (2 hours)
Extension of vectorborne diseases models to include simple models of the vector lifecycle (2 hours)
Discussion of vector control (1 hour)
Group work and presentations (3 hours)

Theme 2: Livestock diseases
Introduction to foot and mouth disease, avian influenza (1 hour)
Introduction to mathematical modelling of foot and mouth disease and avian influenza in livestock (2 hours)
Extension of the livestock models to include livestock movement (markets, trading between farms, selling for meat processing (3 hours)
Discussion of disease control within the livestock movement environment (1 hour)
Group work and presentations (3 hours)

Theme 3: Waterborne diseases
Introduction to cholera, hepatitis A, and typhoid fever (2 hours)
Introduction to the mathematical modelling of waterborne diseases (2 hours)
Extension of the models to include public health mitigation (1 hour)
Group work and presentations (3 hours)

Project.

Each course theme includes a group project. The projects will be done in groups of three to five. The goal is to apply methods and techniques learned in class to a specific research problem. A project presentation is required. Each member of the group needs to contribute equally to the project and presentation.

Textbook.

There is no textbook for this course. Suggested supplemental readings to support learning are in the following:

1. Trinh, P., Zaneveld, J.R., Safranek, S. and Rabinowitz, P.M., 2018. One health relationships between human, animal, and environmental microbiomes: a mini-review. *Frontiers in public health*, *6*, p.235.
2. Keeling, M.J. and Rohani, P., 2011. Modeling infectious diseases in humans and animals. Princeton university press.
3. Atlas, R.M. and Maloy, S. eds., 2014. *One Health: people, animals, and the environment*. ASM Press.