One Health Modelling for Emerging Infectious Diseases
Part I

Lectures: 38 hours

Instructor: OMNI-REUNI researchers with appropriate background

The Course.

This course introduces students to the mathematical modelling of infectious diseases in One Health. 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 between humans, animals and the environment. Public health mitigation, as well as animal and environmental pathogen control are discussed, and the models are extended to include vaccination, drug therapies and population contact control strategies in public health and healthcare. Students will learn to formulate, analyze, parameterize, and validate quantitative models for infectious disease processes and data. Applications include SARS-CoV-2, MERS-CoV, avian influenza, bacterial diseases and antibiotic resistance, and fungal pathogens and antifungal resistance. 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 (3 hours)
Review of the models of animal, plant and human population growth (3 hours)
Introduction to coronaviruses (1 hour)
Introduction to zoonoses (1 hour)

Theme 1: Coronaviruses
Introduction to SARS-CoV-2 and MERS-CoV (1 hour)

Introduction to the mathematical modelling of SARS-CoV-2 and MERS-CoV in the human and animal interface (3 hours)
Extension of SARS-CoV-2 and MERS-CoV models to include public health mitigation, population control, and pharmaceutical interventions (3 hours)
Group work and presentations (3 hours)

Theme 2: Influenza
Introduction to avian and swine influenza (1 hour)
Introduction to mathematical modelling of swine and avian influenza (3 hours)
Extension of swine and avian influenza models to include public health mitigation, population control, and pharmaceutical interventions (3 hours)
Group work and presentations (3 hours)

Theme 3: Environmental transmission of bacterial and fungal pathogens
Introduction to environmental transmission of bacteria and fungal pathogens and antimicrobial/antifungal resistance (1 hour)
Introduction to the mathematical modelling of environmental transmission including animals and humans (3 hours)
Extension of environmental transmission models to include public health mitigation, agricultural control, and pharmaceutical interventions (3 hours)
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.