

## **INTEGBI 114 – Infectious disease dynamics (4 units)**

**Class Time:** Tuesdays and Thursdays 2-3:30pm

**INSTRUCTORS:** Profs Mike Boots and Britt Koskella

**Webpage:** <https://bootslab.org> and <https://naturesmicrocosm.com>

**GSI:** TBD

**GSI emails:** TBD

**GSI office hours (VLSB 5015):** TBD

### **INSTRUCTOR INFORMATION**

Prof Boots is a quantitative disease ecologist with broad training in ecological, epidemiological and evolutionary theory, and laboratory and field disease biology. He develops ecological evolutionary theory on host defense and parasite virulence, test this theory in model systems and apply ecological and epidemiological models to specific infectious diseases of humans and wildlife. Currently he is working on honeybee viruses, an insect virus model laboratory system, the spatial spread of plant disease in the field and models of TB in Badgers and Wildboar in addition to Dengue in human populations. Prof Boots believes that a quantitative understanding of the ecology and evolution infectious disease is critical in their management and that infectious disease provides a uniquely well-understood context to teach these quantitative approaches.

Prof Koskella has broad training in Ecology and Evolution, with a particular focus on hostpathogen interactions. Her research began as an undergraduate student examining the genetics of a fungal 'smut' pathogen that sterilizes flowers, then continued during her PhD where she used a snail-trematode interaction to test for the importance of host-parasite coevolution in driving diversity, and most recently has been focused on how bacteriophage viruses influence their bacterial hosts, and what effects this might have on the eukaryotic hosts in which these bacteria live.

Profs Boots and Koskella believe in the need for increased diversity in science, and work to foster a classroom and research environment in which all opinions and ideas are valued, and where each student feels empowered to offer new insight to a rapidly developing field.

### **COURSE FORMAT**

Two lectures/discussions per week and one hour of study section focused on understanding readings, current epidemics and a major project of research on a particular disease.

### **PREREQUISITES**

Bio 1A and Bio 1B or equivalent required, Ecology or Evolution course suggested.

## **FULL COURSE DESCRIPTION AND AIMS**

As the current SARS-CoV-2 pandemic highlights, infectious disease continues to be a major public health problem. Infectious disease is also critical to agricultural production and plays a major role in wildlife population dynamics and conservation.

Many of the challenges of managing infectious disease are essentially ecological and evolutionary problems. Disease follows the rules of species interactions as it spreads through host populations while resistance to antibiotics and vaccine escape occurs through the rules of evolutionary biology.

The key aim of the module is to teach ecological and evolutionary principles in the light of infectious diseases affecting human populations and societies as well as agriculture and wildlife.

This is applied ecology and applied evolution writ large.

There is a larger body of successful theoretical models and more data in disease interactions than in any other ecological interaction. We aim to show how this combination of modeling and data has been used to understand (1) the processes that determine population dynamics, (2) how we can successfully intervene in medical and conservation contexts (for example how many individuals should we vaccinate?), (3) how we can understand parasite virulence in the light of evolution and (4) how we can manage the impact of evolution on medical interventions. We include an introduction to the diversity of infectious disease but focus on key concepts using case studies and primary research literature to illustrate the fundamental concepts of disease ecology and evolution.

## **INTENDED LEARNING OUTCOME**

- Understanding the role of infectious disease in natural populations and communities
- Understand the role of disease in shaping human health, agriculture and societies
- Describe how infectious disease may be important in conservation
- Discuss when parasite virulence makes sense in the light of evolution
- Explain how to apply ecological and evolutionary principles to the treatment and control of infectious
- Present a scientific poster on the dynamics of a specific infectious disease.

## **TEXTBOOK**

No required textbook

## **ASSESSMENT: (% of Final Grade, Due date)**

Midterm 1 (15%): Multiple choice

Midterm 2 (15%): Multiple choice

Poster (on assigned disease system; 20%)

Participation in weekly discussion (15%, throughout term)

Quizzes on readings, case studies and disease of the week (10%, throughout term)

Final exam (25%, Finals week): Multiple choice/short answer

## **ABSENCES**

Each student can miss up to 3 class sessions without penalty, no need to contact us. If these absences are not used, students can drop the lowest 1 to 3 (depending on absences taken) scores they have on quizzes/participation.

## **COURSE SCHEDULE**

Classes will consist of two approximately 90 minute lectures per week generally focusing on a major conceptual topic in the dynamics of infectious disease. If (when!) there is a current important epidemic in the world we will discuss this: the dynamics of SARS-CoV-2 will be discussed in detail. We will teach a familiarity with disease modeling and forecasting techniques using hands on web-based modeling tools.

Discussion sections will (1) go over questions about the lectures, esp. as there is no text, (2) discuss the readings that will be presented in the last lecture of the week, and (3) later in the course it will help you with the major project (research on a particular disease to produce a poster). Instructions on all these things will be given during discussion. The general format of a discussion section will be: (a) Quiz or materials to be handed in (b) Any questions from lecture (c) Discussion of readings, (d) Assignments for the following week. Later in the semester, the discussion sections will introduce you to how to conduct library and data base searches on a specific disease, and how to present the results as posters.

Your discussion leader is PRIMARILY YOUR MENTOR!! Contact them with questions about lecture, etc. If you e-mail questions, we may share answers by e-mail with the rest of the class – rarely is something you are uncertain about unique to you. Nor is uncertainty or curiosity any kind of indictment of your abilities – quite the reverse – it means you are thinking and participating!!

## **LECTURE SCHEDULE (subject to change)**

August 25th, 2022 (Boots): Introduction to the course - historic and current importance of infectious disease

August 30th, 2022 (Koskella): Diversity of disease: Prions and Viruses

September 1st, 2022 (Koskella): Diversity of disease: Bacteria and Fungi

September 6th, 2022 (Koskella): Diversity of disease: Protozoa

September 8th, 2022 (Boots): Disease transmission

September 13th, 2022 (Boots): Disease Dynamics

September 15th, 2022 (Boots): Modeling disease

September 20th, 2022 (Boots): Modeling disease

September 22nd, 2022 (Boots): Heterogeneities and contact networks

September 27th, 2022: (MIDTERM 1)

September 29th, 2022 (Koskella): Why scale matters for the study of disease

October 4th, 2022 (Koskella): Complex life cycles of parasites

## IB 114 syllabus

October 6th, 2022 (Boots): Modeling foot and mouth disease - case study  
October 11th, 2022 (Koskella): Plants versus Animals  
October 13th, 2022 (Koskella): Disease in Agriculture  
October 18th, 2022 (Koskella): Friends versus Foes - how immune systems know (or don't)  
October 20th, 2022 (Boots): Infectious disease Regulation of Populations  
October 25th, 2022 (Koskella): Coevolution between hosts and parasites  
October 27th, 2022 (MIDTERM 2)  
November 1st, 2022 (Koskella): The Role of Parasites in Shaping Diversity  
November 3rd, 2022 (Boots): Infectious disease and conservation -  
November 8th, 2022 (Koskella): The microbiome in health and disease  
November 10th, 2022 (Koskella): Phage therapy as an alternative to antibiotics  
November 15th, 2022 (Boots): Evolution of infectious disease  
November 17th, 2022 (Boots): Evolution of infectious disease  
November 22nd, 2022: (POSTER PREPARATION)  
November 24th, 2022: HOLIDAY, NO CLASS  
November 29th, 2022: (POSTER PRESENTATIONS)  
December 1st, 2022 (Boots): Management of infectious disease in the light of ecology and evolution