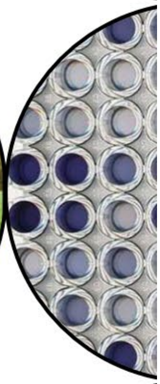
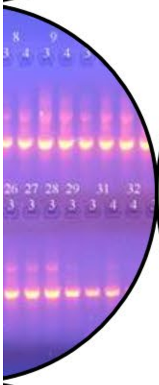
Course Guide
REG-33306

DISEASE ECOLOGY





Contact Person

KEVIN MATSON
kevin.matson@wur.nl

WILDLIFE
ECOLOGY &
CONSERVATION
GROUP

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For quality of life

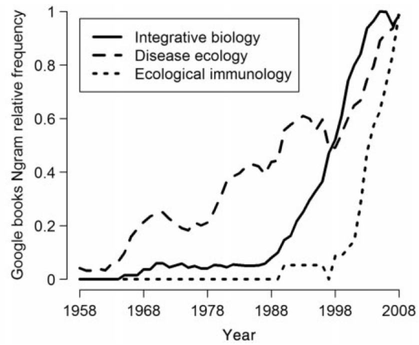
DISEASE ECOLOGY (REG 33306)

Language	English
Components	Classroom lectures Computer tutorials with instructions, computer modelling Practical lab and field training Self-study
Credits	6
Course types	2 Le; 1 T16; 1 T32; 2 F24
Period	6 (6WD-1ST-HALF), 2021-2022 Calendar Weeks 19-22 Academic Weeks 37-40
Time & Venue	See course schedule.
Exam & Re-exam	See course schedule.
Contact persons	Dr. KD Matson (WEC) de.wec@wur.nl 0317 481782
Lecturers	Dr. KD Matson (WEC) Dr. WF de Boer (WEC) Dr. HJ Esser (WEC)
Examiners	Dr. KD Matson (WEC)
Secretariat	Patricia Meijer Lumen B.109 patricia.meijer@wur.nl 0317 485828

Profile of the course

Diseases can have on manifold impacts on individuals, populations, communities, and ecosystems (and vice-versa). In some instances, diseases associated with wild animals can have detrimental health effects for humans, domestic animals, or both (e.g., Lyme, Ebola, swine fever, avian influenza), but in other instances, diseases can be harnessed for beneficial purposes. Ecological, immunological, physiological, epidemiological, and evolutionary concepts underlie the complex interplay between free-living organisms and infectious diseases. Consequently, disease ecology is applicable to a variety of current issues, including wildlife management, livestock production, land use, and policy, all of which can influence disease outbreak patterns. For example, since disease-causing organisms typically travel with their hosts through the landscape and the diversity and density of hosts influence parasite and pathogen assemblages and transmission, landscape alterations and host population management strategies can shape disease processes.

This course will survey these concepts and applications and examine the rich area at the intersection of two rapidly growing and highly integrative biological domains: disease ecology and wild immunology. The main goal of the course is to prepare students for careers 1) that require a scientific understanding of the factors underlying disease outbreaks and 2) that involve control, management, and policy related decision-making linked to infectious diseases and healthy ecosystems.



"*Disease ecology* seeks to explain and predict the transmission and emergence of diseases at the population-level and above … *Ecoimmunology* [or *wild immunology*] has … focused on investigating how the traits of hosts impact variation in immunity"

Quote and figure from Brock, P. M., Murdock, C. C., & Martin, L. B. (2014). The history of ecoimmunology and its integration with disease ecology. *Integrative and Comparative Biology*, 54(3)353-362.

Fundamental concepts and classic examples will be combined with contemporary, emerging issues. The course will be concept-driven rather than taxon-based. Via case studies, lecture examples, computer modelling, and field and lab work, the course will cover the etiology, transmission dynamics, mitigation/control, and pathology and other impacts of diseases caused by various infectious agents. Overall, host-parasite/pathogen relationships will be presented within a broad framework of ecological factors and species interactions.

The main targets are students from MBI (specializations: Human and Animal Health Biology; Ecology and Biodiversity) and MFN (specializations: Management; Ecology), complemented with students from other programs (e.g., MAS specializations: Animal Ecology; Adaptation, Health and Welfare) and with PhD students taking the course as a refresher. This course will help prepare students 1) for jobs in government agencies, non-governmental organizations, and the private sector (e.g., Rijksinstituut voor Volksgezondheid en Milieu, Central Veterinary Institute, Erasmus MC, Food and Agriculture Organization, and private consulting firms) or 2) for carrying out PhD research at universities in the Netherlands and abroad.

Assumed prerequisite knowledge

Ecological interactions, basic physiology, basic microbiology, e.g.,
MBI: CBI-20306 Cell Biology and Health, HAP-21806 Behavioural Endocrinology, NEM-20806 Basics of Infectious Diseases
MFN: REG-20803 Applied Animal Ecology, REG-30306 Animal Ecology
MAS: QVE-20306 Veterinary Epidemiology and Economics, QVE-30306 Quantitative Veterinary Epidemiology, QVE-30806 Management of Infections and Diseases in Animal Populations.

Learning outcomes
The overarching aim of the course is to offer a current and comprehensive view of the causes and consequences of infectious disease at the levels of individuals, populations, communities, and ecosystems. Primary objectives are that students understand 1) the host-parasite relationship as a key ecological interaction (i.e., analogous to the predator-prey relationship) and 2) the general approaches and specific techniques essential to the study disease ecology.

These broader objectives can be broken down into specific learning outcomes. By the end of this course students will be able to do the following:
1. Summarize the key features and describe the impact/relevance of different infectious diseases affecting free-living organisms.
2. Evaluate behavioral and ecological factors that affect spatio-temporal variation in disease outbreaks.
3. Make and justify predictions relating to ecological variation and host immune defenses.
4. Assess methods for studying diseases and host defenses of wild populations.
5. Design and implement an ecological study to answer a question related to diseases and host defenses.
6. Develop and analyze compartmental models and other SIR models, including through the use of programming software (e.g., R).
7. Appraise the strengths and limitations of modelling diseases and outbreaks in wild populations.
8. Compare and contrast scenarios that would and would not result in a disease outbreak.
9. Evaluate potential interventions for their capacity to control an outbreak.

Course materials & resources
Resources, including the following, will be made digitally available: handouts from the lectures; the required readings (usually two articles per double lecture); additional related (and sometimes non-required) literature and audio-visual files; and background, explanations and protocols for the modelling and field practical components.

Note: No course materials generated/provided by the teaching team (e.g., handouts from the lectures, the required readings, lecture recordings, assignments, etc.) should be shared in any way or with anyone outside of our course.

Educational (i.e., teaching & learning) activities
The following items are core components of this course:
- Attending lectures and practicals.
- Reading assigned literature.
- Participating case studies and other collaborative classroom activities.
- Searching for and reading relevant supplemental literature.
- Modelling disease in wild or captive model populations.
- Carrying out experiments.
- Analyzing data collected during the experiments.
- Presenting results from models and experiments.

Assessment strategy ("Toetsplan")
Three main components will contribute equally to the final grade:
- Final examination (individual assessment; based on entire lecture/theory component).
- Project I (group assessment; computer/modelling practical; here a subset of the exercise is submitted for evaluation and feedback).
- Project II (group assessment; field/laboratory practical; here short research summaries supported by PowerPoint slides (or equivalent) are presented in class for evaluation and feedback).

The following aspects of both projects will be used for assessment: 1) clarity of and integration into disease ecology framework; 2) depth and quality of analyses; 3) quality, relevance, and appropriate use of peer-reviewed scientific literature and other sources; and 4) overall presentation technique and layout.
To pass the course, a minimum grade of 5.50 is required for each component (examination, project I, and project II). Grades for each component are kept on record until the end of the following academic year.

Learning Outcome	***Where assessed***		
	Exam	*Project I*	*Project II*
1	*X*		
2	*X*	*X*	*X*
3	*X*		*X*
4	*X*	*X*	*X*
5			*X*
6		*X*	
7	*X*	*X*	*X*
8	*X*	*X*	*X*
9	*X*	*X*	*X*
Contribution to final grade	33.3%	33.3%	33.3%
Types of questions/ examination			
Questions with restricted options	*X*		
Open questions (re-exam)	*X*		
Other criteria (explained during lectures)		*X*	*X*
Assessed by			
KD Matson	*X*	*X*	*X*
WF de Boer	*X*	*X*	*X*
Time schedule (week number)	4	2	5

- Exam grades will be available within 2 weeks after the exam date.
- Assignment grades will be available within 2 week after submission/presentation dates.
- Grades (of the three main components of the assessment strategy) are kept on record until the end of the following academic year.
- Minimum passing mark of each component is 5.50.

Principal themes of the content

1. Introduction: What is disease? What causes disease? Why are diseases relevant?
2. SIR and modeling
3. Abiotic factors affecting disease patterns
4. Biotic factors affecting disease patterns
5. Wild immunology
6. Emerging infectious disease
7. Evolution of infectious disease
8. One Health, applications, and management

Course schedule

The course consists of lectures, a modelling practical, and a field/laboratory practical. Course materials should be studied when there are no lectures or practical sessions. Below is a general outline of the course organization. For a detailed schedule, please see the course's Brightspace page.

	Monday	*Tuesday*	*Wednesday*	*Thursday*	*Friday*
Week 1	Topic 1 + Comp	Topic 2 + Comp	Topic 3 + Comp	Topic 4 + Comp	Topic 5 + Comp
Week 2	Topic 6 + Comp	Topic 7 + Comp	Topic 8 + Comp	Self-Study	Exam
Week 3	Field/Lab 1	Field/Lab 2	Field/Lab 3	Holiday	Field/Lab 4
Week 4	Field/Lab 5	Field/Lab 6	Field/Lab 7	Field/Lab 8	Final Presentations

Lectures
Lecture topics will be based on the principal themes listed above. In most cases, one or two 45-minute lectures (or video equivalents) will be dedicated to each theme.

Computer modelling practical
Compartment models can be used to simulate temporal changes in disease prevalence. One type of compartment model is the SIR model, where "S" equals the number of susceptible individuals, "I" equals the number of infected individuals, and "R" equals the number of recovered individuals.

Students will learn how to create SIR models using the programming language R. Using the models, they create, students will investigate the influence of several parameters on changes in disease prevalence over time. Example parameters include transmission rate, recovery rate, basic reproductive rate (R_0), host density, and host interaction frequency. Students will be able test the impact of certain control measures, such as vaccination (herd immunity) or culling, on the disease prevalence. They will also be able to extend the models to include additional compartments (e.g., the exposed in an SEIR model). Moreover, an emphasis will be placed on modeling the impact of ecological factors. Such factors include the birth of young, secondary/tertiary host species, host age and condition, dispersal, habitat characteristics, temperature and seasonality, and stochastic events. Not all factors will be modeled by all students; instead, students will be given leeway to model phenomena that are interesting to them.

Compartment models have advantages and drawbacks. On the one hand, the models are relatively simple and can simulate the spread of certain diseases relatively well, especially the diseases like avian influenza that can be described by diffusion processes. On the other hand, diseases that spread through contact are often dependent on the social or contact networks of the hosts. This phenomenon will be illustrated with models in Net logo.

The computer modelling practical will take place during ~8 afternoon sessions. Lecturers and teaching assistants will provide feedback as needed.

Field/laboratory practical
During the field/laboratory practical, students will set up an experiment and collect data on disease ecology or ecological immunology. Students will go through most of the stages of conducting a research project: literature analysis to frame and design questions and predictions, data analysis, and presentation of results.

Topics for projects during the field/laboratory practical include the following:

- Relationships between the biology of an arthropod disease vector (e.g., ticks) and abiotic and biotic factors.
- Experimental infections of invertebrate hosts (e.g., flour beetles (*Tribolium confusum*)

The field/laboratory practical will take place during ~8 full days. Lecturers and teaching assistants will provide feedback on project progress and presentations by the student groups.

Continuation courses
Thesis MFN, MAS, MBI