

## EEB325 – Evolutionary Medicine

Department of Ecology & Evolutionary Biology, University of Toronto

Winter 2015

### Time

Lecture	Mon	11-12, SS1069
	Wed	11-12, SS1069
Tutorial	Wed	12-1, SS1069

### Course description

How evolutionary principles can help us better understand health and disease. Concepts from evolutionary biology (e.g., life history theory, coevolution, genomic conflict, constraints and trade-offs) will be applied to key problems in medicine and public health, including antibiotic resistance, aging, cancer, autoimmune disease, and pathogen virulence.

### Course objectives

By the end of the course, we will answer (i) how does understanding human evolutionary history inform us of the causes of common diseases? (ii) What are the consequences of pathogen evolution for disease outcomes, treatment, and control? (iii) What are some strategies for overcoming or circumventing pathogen evolution in response to medical intervention? (iv) Can we predict the next disease that will emerge in humans? (v) Why do we age? (vi) What role does evolution play in chronic diseases and reproductive health?

### Prerequisites

[BIO130H1](#), [BIO220H1](#)

### Course instructor

Professor Nicole Mideo, Ecology & Evolutionary Biology (Office: ESC2063)

[nicole.mideo@utoronto.ca](mailto:nicole.mideo@utoronto.ca)

Office hours available by appointment.

### Teaching Assistants

Arvid Ågren and David Smith

Office hours will be posted on Blackboard.

### Course policy on email usage

Your email message must include in the Subject line the course identifier and a concise and clear statement of purpose [e.g., EEB 325: I would like more background reading] otherwise it is likely to be deleted.

### Accessing course info

Lecture slides, additional information, and required readings will be available via the UofT Portal on Blackboard. You will need to use your UTOR ID to login online at <http://portal.utoronto.ca>. Only students who are enrolled in EEB325 on ROSI have access to this site (within 24-48 hours of enrolling).

### Readings

Each week you will be **required** to read one or a few papers from the primary scientific literature and/or popular press, or listen to a podcast. These are listed in the syllabus, and links or pdfs will be posted on Blackboard. Some of the readings must be accessed through the library website. You may be tested on the content of these readings.

Additional readings (clearly labeled as “Further reading”) will be posted on Blackboard for those who are

interested in diving deeper into a topic. These readings are **not required** and you will not be tested on their specific content, but reading them would certainly bolster your general understanding. For those who are really keen on this subject, you may be interested in this textbook (**NOT required**): Stearns, S.C. and Koella, J.C. *Evolution in Health and Disease*, 2<sup>nd</sup> Edition. Oxford University Press.

### Course organization

This course consists of 23 lectures related to the readings of original scientific and popular press articles. A weekly tutorial session will be used for (1) discussion sessions which will reinforce and expand on the concepts covered in class, or (2) question / review sessions. This tutorial slot will also allow for an in-class midterm and in-class flash assignments.

### Changes to the syllabus

Evolutionary Medicine is a growing field, and new findings and ideas arise constantly. Thus, I reserve the right to modify the syllabus in order to incorporate any new and interesting research or to delve into particular topics in more detail, depending on needs and interests of the class. With that said, the topics in the schedule below will (probably) be covered and the course will largely be structured as follows.

*Section 1* focuses on the basic principles of evolutionary medicine, emphasizing differences between proximate and ultimate explanations. This section provides an introduction to human defenses to infectious organisms, and describes major cultural transitions in human history that altered exposure to infectious disease.

*Section 2* uses the evolutionary medicine approach to examine infectious diseases. Here, we will focus on the unique challenges of fighting disease-causing organisms that are themselves subject to evolutionary change as well as approaches for predicting the next major disease threat.

*Section 3* focuses again on humans and applies the evolutionary medicine approach to degenerative diseases, chronic diseases, and reproductive health.

### Evaluation

This course has 4 graded components:

1. Midterm exam 32%
2. Final exam 32%
3. Participation 12% (based on attendance in discussions, 6% each for coming to 2 sessions (out of 3))
4. Flash assignments 24% (3 x 8% each, with the option of dropping the lowest mark, see #5 below)

Plus some optional assessment items:

5. Class blog 8% (write a post in lieu of a missed flash assignment, or to try to raise a low mark)
6. Extra credit 10% (This can come from 2 sources, to a maximum of 10%)
  - (1) Individual blog posts that are particularly lucid, stimulating, or lateral (max 5%)
  - (2) Suggested exam questions. These should be multiple choice (I will post an example on Blackboard) and e-mailed to Dr. Mideo by the end of March. If they are different from questions I've already used, and they (or something close) get used, you get extra credit at 2.5% per question. Sending lots of (good) questions increases your chances of hitting on one I'll use. Plus, you'll know the answers!

All flash assignments and exams will consist of multiple choice and short-answer questions, emphasizing the understanding of concepts (rather than factoids). No study aids of any type are permitted. All exams will last approximately 2 hours. Flash assignments will be short, ~10-15 minutes; that's why they are called "flash".

The class blog is available on Blackboard. If you write a post on the blog, we will be marking 4 components, (1) is it relevant to the course material? (2) is it original (i.e., are you doing more than rehashing someone else's ideas from the internet somewhere)? (3) is it thoughtful? (4) is it well-referenced / connected?

### **Missing a test**

Students who have a legitimate reason for missing an exam (consult University guidelines for details) should inform the instructor within 24 hours. In the event of illness, you must provide me with a written statement from the university health service or an outside medical professional (i.e., MD, RN) in order to be allowed to write a make-up exam. If your absence is caused by a personal or family crisis, you must provide a written statement to that effect from your college registrar or his/her representative. Make-up exams may be of a different format than the in-class exam.

There are NO make up flash assignments for this course. You are given the opportunity to make up for a missed flash assignment (or a low mark) through the blog. It's your responsibility to take advantage of this! Similarly, there are no 'make up' discussion sessions. You are only required to be at 2 of the 3 sessions, which are spaced predictably throughout the semester, so you have to be rather unlucky to miss more than 1. Do not miss class – and thus discussion session – lightly.

### **Academic Integrity**

Academic integrity is fundamental to learning and scholarship at the University of Toronto. Participating honestly, respectfully, responsibly, and fairly in this academic community ensures that the U of T degree that you earn will be valued as a true indication of your individual academic achievement, and will continue to receive the respect and recognition it deserves.

All students are expected to know and respect the University of Toronto's *Code of Behaviour on Academic Matters* (<http://www.artsci.utoronto.ca/osai/students>). Cases of academic misconduct are treated very seriously. All suspected cases will be investigated following the procedures outlined in the code. Consequences can be severe, including a failure in the course and a notation on your transcript. Potential offenses include, but are not limited to,

- Looking at someone else's exam / assignment answers.
- Providing unauthorized assistance to another student (e.g., letting someone else look at your answers).
- Submitting an altered test for re-grading.
- Falsifying or altering any documentation required by the University. This includes, but is not limited to, doctor's notes.
- Using or possessing an unauthorized aid in any test or exam.
- Misrepresenting your identity.

There are other offences covered under the *Code*. Please respect all rules and the values that they protect.

### **Accessibility needs**

The University of Toronto is committed to accessibility. If you require accommodations for a disability, or have any accessibility concerns about the course, the classroom or course materials, please contact Accessibility Services as soon as possible, [disability.services@utoronto.ca](mailto:disability.services@utoronto.ca) or [www.accessibility.utoronto.ca/](http://www.accessibility.utoronto.ca/)

### **Audio recording of lectures**

If you wish, taping lectures with a personal recorder is permitted. If you bring a recording device to the front of the room, you do so at your own risk and you assume responsibility if it is lost or stolen. Lecture materials including audio recordings are for personal use only by the students enrolled in EEB325. The distribution, transmission, reproduction, or re-posting of the EEB325 lecture materials including audio recordings, in part or whole, is strictly prohibited without the written permission of the instructor. **Students are advised not to treat recordings as a substitute for attending lectures (or discussions) and taking notes.**

Week	Date	Topic	Readings‡
1	M, Jan 5	Syllabus & organization Why are humans vulnerable to disease?	Nesse & Stearns 2008
	W, Jan 7	Human evolution and mismatch to modernity	Diamond 2003 Nuwer 2013
2	M, Jan 12	Human evolution and host defense	Cuadrado et al. 2013
	W, Jan 14 <i>Tutorial</i>	Genetics of disease susceptibility <b>Flash Assignment 1 &amp; question session</b>	
3	M, Jan 19	Virulence evolution I: why some bugs go bad	Galvani 2003
	W, Jan 21 <i>Tutorial</i>	Virulence evolution II: opportunistic pathogens <b>Discussion 1A.</b>	Brown et al. 2012
4	M, Jan 26	Emerging diseases	Zimmer 2013a Radiolab Patient Zero Extra:Ebola
	W, Jan 28 <i>Tutorial</i>	Influenza, a case study on emergence <b>Discussion 1B.</b>	
5	M, Feb 2	Drug resistance I	Kouyos et al. 2014
	W, Feb 4 <i>Tutorial</i>	Drug resistance II: malaria case study <b>Flash assignment 2 &amp; question session</b>	Huijben et al. 2013
6	M, Feb 9	Evolution-proofing control measures	
	W, Feb 11	<b>In-class MIDTERM (2 hours)</b>	
7	M, Feb 23	Vaccines: applied evolution	
	W, Feb 25 <i>Tutorial</i>	Vaccines: evolutionary consequences <b>Discussion 2A.</b>	
8	M, Mar 2	Student choice lecture	
	W, Mar 4 <i>Tutorial</i>	Aging <b>Discussion 2B.</b>	
9	M, Mar 9	Evolution and reproduction	
	W, Mar 11 <i>Tutorial</i>	Reproduction, conflict, and disease <b>Flash assignment 3 &amp; question session</b>	
10	M, Mar 16	Within-individual conflict and disease	
	W, Mar 18 <i>Tutorial</i>	Evolution and cancer <b>Discussion 3A.</b>	Zimmer 2007
11	M, Mar 23	Cancer and chemotherapy	Zimmer 2013b
	W, Mar 25 <i>Tutorial</i>	Autoimmunity and molecular mimicry <b>Discussion 3B.</b>	
12	M, Mar 30	Microbiomes & disease	
	W, Apr 1	<b>Review session (2 hours)</b>	

‡Please watch Blackboard for further required readings. The syllabus will continually be updated there as well.

## **READING LIST (so far)**

- Brown et al. 2012 Evolution of virulence in opportunistic pathogens: generalism, plasticity, and control. Trends in Microbiology 20(7): 336-342.
- Cuadrado et al. 2013. Fever: Friend or foe? <http://www.clinicalcorrelations.org/?p=7041>
- Diamond 2003. The double puzzle of diabetes. Nature 423: 599-602
- Galvani 2003. Epidemiology meets evolutionary ecology. Trends in Ecology and Evolution 18(3): 132-139.
- Huijben et al. 2013. Aggressive chemotherapy and the selection of drug resistant pathogens. PLoS Pathogens 9(9): e1003578.
- Kouyos et al. 2014. The path of least resistance: aggressive or moderate treatment. Proceedings of the Royal Society B 281: 20140566.
- Nesse & Stearns 2008. The great opportunity: Evolutionary applications to medicine and public health. Evolutionary Applications 1(1): 28-48.
- Nuwer 2013. Worm therapy: Why parasites may be good for you. <http://www.bbc.com/future/story/20130422-feeling-ill-swallow-a-parasite>
- Radiolab Patient Zero Extra: Ebola <http://www.radiolab.org/story/patient-zero-extra-ebola/>
- Zimmer 2007. Evolved for cancer? Scientific American [http://carlzimmer.com/articles/2007.php?subaction=showfull&id=1173216962&archive=&start\\_from=&uc\\_at=10](http://carlzimmer.com/articles/2007.php?subaction=showfull&id=1173216962&archive=&start_from=&uc_at=10)
- Zimmer 2013a. MERS at one: The deadly virus drizzle. <http://phenomena.nationalgeographic.com/2013/09/24/mers-at-one-the-deadly-virus-drizzle/>
- Zimmer 2013b. Studying tumors differently, in hopes of outsmarting them. The New York Times. [http://www.nytimes.com/2013/06/27/science/studying-tumors-differently-in-hopes-of-outsmarting-them.html?\\_r=0](http://www.nytimes.com/2013/06/27/science/studying-tumors-differently-in-hopes-of-outsmarting-them.html?_r=0)