

EEB325 – Evolutionary Medicine
Department of Ecology & Evolutionary Biology, University of Toronto
Winter 2019

Course description

How evolutionary principles can help us better understand health and disease. Concepts from evolutionary biology (e.g., life history theory, coevolution, 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

What I hope you learn is a way of looking at the world: through case studies, we will explore contemporary issues in health and disease – ones that we confront on a regular basis – and ask how evolutionary concepts help us to understand, mitigate, or combat those issues. We will answer questions like how does understanding human evolutionary history inform us of the causes of common diseases? What role does evolution play in chronic diseases and reproductive health? In what way is cancer an evolutionary process? What are the consequences of pathogen evolution for disease outcomes, treatment, and control? What are some strategies for overcoming or circumventing pathogen evolution in response to medical intervention? Can we predict the next disease that will emerge in humans?

Prerequisites

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

Course instructor

Professor Nicole Mideo, Ecology & Evolutionary Biology
nicole.mideo@utoronto.ca
Office hours, Tuesdays 3:30-5:00pm, ESC2063.

Teaching Assistants

Amber Hoi, Tsukushi Kamiya, Madeline Peters, Kiran Wadhawan

Time

<u>Lecture</u>	<u>Tutorials</u>
Mon 11-12, WI1016	Wed 3-4 T0101, SS2120 Amber Hoi [REDACTED]
Wed 11-1, WI1016	T0102, WE75 Kiran Wadhawan [REDACTED]
	Thurs 11-12 T0201, SS1078 Madeline Peters [REDACTED]
	T0401, BL113 Tsukushi Kamiya [REDACTED]
	Thurs 1-2 T0301, UC256 Madeline Peters
	T0302, ES1016M Tsukushi Kamiya

Accessing course info

Lecture slides, announcements, and required readings will be available via Quercus (<https://q.utoronto.ca>). Only students who are officially enrolled in EEB325 have access to this site (within 24-48 hours of enrolling).

Course policy on email usage

Email messages must include in the Subject line the course identifier and a concise and clear statement of purpose (e.g., “EEB 325: more background reading?”) otherwise it is likely to be deleted. If you have a question about course content, please post it on the Quercus discussion board. I will endeavor to answer all posted questions promptly.

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 Quercus. Some of the readings must be accessed through the library website. There will be quizzes associated with the weekly readings and you may also be tested on the content of these readings during exams.

Additional readings (clearly labeled as “Further reading”) will be posted on Quercus for those who are particularly interested in 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 one of these textbooks (**NOT required**). (1) Stearns, S.C. and Koella, J.C. *Evolution in Health and Disease*, 2nd Edition. Oxford University Press. (2) Stearns, S.C. and Medzhitov, R. *Evolutionary Medicine*. Sinauer Associates, Inc.

Course organization

Lectures - This course consists of 23 lectures related to the readings of original scientific and popular press articles. Wednesday lectures will sometimes, but not always, take up the full 1hr50min time slot. Please view any extra time on Wednesdays as an opportunity for Q&A about lectures or readings, or broad discussions about course content.

Tutorials - TA-led tutorial sessions will be focused on small group discussions and organized activities. These tutorials present course material in a different (more practical) way, and are intended to stimulate critical thinking while providing an opportunity for a ‘deeper dive’ into particular topics. See below for details on how tutorials are evaluated.

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. 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 focuses on health problems that are largely a consequence of evolutionary processes acting on humans. We will focus on cancer, degenerative diseases, chronic diseases, and reproductive health, and we will discuss how an evolutionary perspective can inform treatment and prevention strategies.

Section 3 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 evaluating the potential for different intervention strategies to withstand pathogen evolution.

Sensitive material

In this course, we are focused on human health and disease. Many of the issues we cover are common and so we are likely to talk about ones with which you or those you know have been confronted. Since our purpose is inquiry, our approach to these topics can seem dispassionate. I recognize that this can be challenging for students. I record and post all lectures on Quercus, so you are welcome to listen to them on your own time in an environment of your choice.

Evaluation

This course has 7 graded components:

1. Midterm exam 25% (**Wednesday February 13**)
2. Final exam 25%
3. Quizzes 8% *best 8 out of 10*
4. Tutorials 14% *based on attendance, participation, and completion of three mini-assignments*
5. Blog post #1 8% (**due Friday February 1, 5pm**)
6. Blog topic 2% (**due Monday March 11, 5pm**)
7. Blog post #2 18% (**due Friday March 29, 5pm**)

Plus some opportunities for extra credit.

- (1) Individual blog posts (2nd blog assignment) that are particularly lucid, stimulating, or lateral (max 3%).
- (2) Suggested exam questions. These should be multiple choice (I will post an example on Quercus) and e-mailed to me by February 4th for the midterm or March 22nd for the final. If they are different from questions I’ve already used, and I use them, you get extra credit at 1% per question. Sending many (good) questions increases your chances of hitting on one I’ll use. Plus, you’ll know the answer!

Exams - All exams will consist of multiple choice and short-answer questions, emphasizing the understanding of concepts. No study aids of any type are permitted. The midterm will be during regular class time and the final during the exam period.

Quizzes - Quizzes are intended to help you stay on top of the readings. Thus, they will consist of multiple-choice or (very) short answer comprehension questions, rather than applications. Quizzes should take you no more than 10 minutes. They will be posted on Quercus and available from Monday after lecture until Wednesday before lecture.

Tutorials - TAs will evaluate your tutorial grade on the basis of attendance, preparation, participation, and completion of mini-assignments. Attendance. TAs will take attendance every tutorial. You may miss one tutorial without penalty for any reason, no explanation needed. After that, there will be a penalty for any unexcused absence. Arriving substantially late or leaving early may count for 0.5 or 1 absences. Preparation. Attending lecture and doing the required readings will generally be sufficient preparation for tutorials. Participation. Many things, including active listening, participating in small group exercises, asking questions, as well as other evidence of developing insight and aptitude in evolutionary medicine, can partially count for participation, though 'excellent' participation (80%+) typically includes frequent contributions to whole tutorial discussions. The very best contributions are those that respond to, or build upon, the contributions of your classmates. Mini-assignments. In general, completing worksheets and tutorial activities is considered participation. Three tutorials (marked in red in the schedule below) will require you to complete a short, explicit assignment in response to the tutorial activity. The content of these mini-assignments will be assessed.

Blogs – From Paleo diets to the looming “antibiotic apocalypse”, the general public has a keen interest in the role of evolution in health and disease (even if they don't realize that these are evolutionary issues). But misinformation abounds and bridges between scientific research and public understanding are often lacking. Over the course of your studies, you have been exposed to primary scientific literature and have learned how to read, understand, interpret, and put into context research results. Not everyone has these skills. It is important for those who can to distill complicated scientific findings into digestible, accurate, and actionable information. That is why these assignments are blogs: I am asking you to convey and interpret scientific results in an accessible, entertaining, and informative way. My aim is to help you further develop your science communication and critical thinking skills. Telling 'adaptationist' stories is easy; evaluating the scientific evidence for those stories is harder, but crucial, especially when it could shape lifestyle choices, individual health, or clinical care. You are becoming an expert in Evolutionary Medicine, and I hope you will be a good ambassador for the field.

For the first blog, you will choose from a set of topics that I provide. More detailed instructions and a grading rubric will be posted on Quercus by Jan 14. For the second blog, you will choose your own topic. The topic will be approved by your TA (see evaluation item #6, above). This can be something covered in class, *but on which you put some unique spin*, or it can be something else that interests you, related to health and disease that we don't cover. If you need inspiration, read the science or health section of your favourite news source, check out scienceblogs.com, take a look at *National Geographic* or *Scientific American* online, or check out the latest research in the journal *Evolution, Medicine and Public Health*. The two blog assignments are structured so that the first one is worth little (8%), but will receive lots of feedback from your TA. This feedback should help you improve your second blog post (worth 18%).

Turnitin.com

Normally, students will be required to submit their written course work to Turnitin.com (via Quercus) for a review of textual similarity and detection of possible plagiarism. In doing so, students will allow their work to be included as source documents in the Turnitin.com reference database, where they will be used solely for the purpose of detecting plagiarism. The terms that apply to the University's use of the Turnitin.com service are described on the Turnitin.com web site. Students are permitted to opt-out of using Turnitin. If you wish to opt out, please contact me **before Monday, January 21** to indicate that you would like to make alternate arrangements and get more info.

Late penalties

For blog assignments, the late penalty is ~3% per day of lateness (1 mark deducted out of a possible 30, per day). The course policy on assignment extensions is that NO extensions will be given on due dates.

Missing a test

Students who have a legitimate reason for missing an exam (see University guidelines for details) should inform me **within 24 hours of the test**. In the event of illness, you must provide 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 will be short answer questions only.**

There are NO make up quizzes for this course. I'll be dropping the two lowest quiz marks for each student.

Remarking a test

If you are concerned about the mark you receive on any assignment, quiz, or exam, please provide me with a written argument explaining why you think a different mark is deserved. I will **remark the whole assignment or exam**, not individual questions. Marks may thus go up or down. If there is an issue with arithmetic, i.e., the scores were added up wrong, please let me know. That does not require remarking.

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 or www.accessibility.utoronto.ca.

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 or quiz 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 (e.g., 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.

Audio recording of lectures

Since I record and post lectures myself, I prefer that others do not also do so. Students should note that their voice may therefore be recorded by me during the class. Please speak to me if this is a concern for you. Please keep in mind that all lecture materials – including audio recordings – are for personal use only by the students enrolled in EEB325. **The distribution, transmission, reproduction, or re-posting of any EEB325 lecture material, in part or whole, is strictly prohibited without my written permission, and constitutes a violation of intellectual property rights and the Canadian Copyright Act.**

Week	Date	Monday lecture	Wednesday Lecture	Tutorial	Quiz
1	Jan 7-11	Syllabus & organization Why are we vulnerable to disease? • <i>Nesse & Stearns 2008</i>	Human evolution & mismatch to modern environments • <i>Johnson & Andrews 2015</i>		
2	Jan 14-18	Microbiomes • <i>Radiolab podcast: Gut Feelings</i>	Genetics of disease susceptibility & personalized medicine • <i>Resnick 2018</i>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
3	Jan 21-25	Human evolution & defense • <i>McCullough 2015</i> • <i>Best & Schwartz 2014</i>	Aging • <i>Hughes 2013</i>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
4	Jan 28-Feb 1	Reproduction • <i>Croft et al. 2015</i>	Between-individual conflict & disease • <i>Radiolab podcast: Fetal Consequences</i> Blog 1 due Friday February 1, 5pm	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
5	Feb 4-8	Within-individual conflict & cancer • <i>Zimmer 2007</i>	Cancer, cont'd • <i>Jansen et al. 2015</i>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
6	Feb 11-15	Circadian rhythms • <i>Sample 2016</i>	In-class MIDTERM (2 hours)		<input checked="" type="checkbox"/> *
	Feb 18-22	READING WEEK – NO CLASSES			
7	Feb 25-Mar 1	Virulence evolution • <i>Yong 2014</i>	HIV & virulence evolution • <i>Fraser et al. 2014</i>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
8	Mar 4-8	Case Study: Influenza • <i>Science Weekly podcast: Why is the flu so bad this year?</i>	Emerging diseases • <i>Zimmer 2016</i>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
9	Mar 11-15	Emerging diseases, cont'd • <i>Weaver 2017</i> Blog topic due Mon. March 11, 5pm	Drug resistance • <i>Woods & Read 2015</i> (Be sure to read before tutorial!)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
10	Mar 18-22	A conversation with Dr. Woods and Prof. Read • <i>Meanwhile in the future podcast: Revenge of the germs</i>	'Non-classical' drug resistance • <i>Birget et al. 2014</i>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
11	Mar 25-29	Vaccines • <i>Shah 2013</i>	Vaccines cont'd • <i>Yong 2015</i> Blog 2 due Friday March 29, 5pm	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
12	Apr 1-5	Evolution-proof control • <i>Vale et al. 2016</i>	Student choice lecture		
			Review Session		

All readings are subject to change. **Please watch Quercus for updates!**

* This 'quiz' will be an opportunity for mid-course feedback (i.e., you'll get credit for completing it; no wrong answers).

READING LIST

- Best & Scwhartz (2014) Fever. *Evolution, Medicine, and Public Health* 2014:92.
- Birget et al. (2018) Altered life history strategies protect malaria parasites against drugs. *Evolutionary Applications* 11:442-455.
- Croft et al. (2015) The evolution of prolonged life after reproduction. *Trends in Ecology and Evolution* 30:407-416.
- Fraser et al. (2014) Virulence and pathogenesis of HIV-1 infections: An evolutionary perspective. *Science* 343:1243727
- Hughes (2013) Why do we age? A 46-species comparison. *National Geographic* (8 Dec 2013)
<http://phenomena.nationalgeographic.com/2013/12/08/why-do-we-age-a-46-species-comparison/>
- Jansen et al. (2015) Control vs. eradication: applying infectious disease treatment strategies to cancer. *Proceedings of the National Academy of Sciences* 112:937-938.
- Johnson & Andrews (2015) The fat gene. *Scientific American* (October 2015).
- McCullough (2015) Iron restriction. *Evolution, Medicine, and Public Health* 1:149.
- Meanwhile in the Future: Revenge of the Germs. <https://soundcloud.com/flashforwardpod/revenge-of-the-germs>
see description here: <http://gizmodo.com/meanwhile-in-the-future-when-antibiotics-stop-working-1710031889>
- Nesse & Stearns (2008) The great opportunity: Evolutionary applications to medicine and public health. *Evolutionary Applications* 1:28-48.
- Radiolab podcast: Fetal Consequences <http://www.radiolab.org/story/205334-fetal-consequences/>
- Radiolab podcast: Gut Feelings <http://www.radiolab.org/story/197242-gut-feelings/>
- Resnick (2018) How scientists are learning to predict your future with your genes. *Vox* (25 August 2018)
<https://www.vox.com/science-and-health/2018/8/23/17527708/genetics-genome-sequencing-gwas-polygenic-risk-score>
- Sample (2016) Morning flu jabs could save thousands of lives, study suggests. *The Guardian* (26 April 2016)
<https://www.theguardian.com/science/2016/apr/26/morning-flu-jabs-could-save-thousands-of-lives-study-suggests>
- Science Weekly podcast: Why is the flu so bad this year? *The Guardian*
<https://www.theguardian.com/science/audio/2018/feb/01/why-is-the-flu-so-bad-this-year-science-weekly-podcast>
- Shah (2013) New threat from poxviruses. *Scientific American* (March 2013).
- Vale et al. (2016) Beyond killing: Can we find new ways to manage infection? *Evolution, Medicine, and Public Health* 2016:148-157.
- Weaver (2017) Emergence of epidemic Zika virus transmission and congenital Zika syndrome: Are recently evolved traits to blame? *mBio* 8:e02063-16.
- Woods & Read (2015) Clinical management of resistance evolution in a bacterial infection. *Evolution, Medicine, and Public Health*
doi:10.1093/emph/eov025
- Yong (2014) Coincidental killers. *Aeon* <https://aeon.co/essays/when-bacteria-kill-us-it-s-more-accident-than-assassination>
- Yong (2015) Leaky vaccines enhance spread of deadlier chicken viruses. *National Geographic* (27 July 2015)
<http://phenomena.nationalgeographic.com/2015/07/27/leaky-vaccines-enhance-spread-of-deadlier-chicken-viruses/>
- Zimmer (2007) Evolved for cancer? *Scientific American* (January 2007)
https://www.jstor-org.myaccess.library.utoronto.ca/stable/26069116?seq=1#metadata_info_tab_contents
- Zimmer (2016) Ebola evolved into deadlier enemy during the African epidemic. *The New York Times* (November 2016) [https://www-nytimes-com.myaccess.library.utoronto.ca/2016/11/04/science/ebola-evolution-african-epidemic.html?partner=bloomberg](https://www.nytimes-com.myaccess.library.utoronto.ca/2016/11/04/science/ebola-evolution-african-epidemic.html?partner=bloomberg)