Evolutionary Medicine – Syllabus

Biol. 402-038 Biol. 502-038
UNM Department of Biology Fall 2013
Castetter Room 258

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Course description:
This course will describe how evolutionary biology provides insights into human health and disease. For most of the 20th century, the health sciences and evolutionary biology progressed along different paths, with neither discipline having much impact on the other. The last 15 years have seen increased exchange of information between the two fields of study. For instance, medical science has embraced evolutionary concepts that relate to pathogen antibiotic resistance. This course is a broader overview of evolutionary medicine. We will explore how natural selection and phylogeny influence pathogen-host interactions, human genetics, immunology, development, cancer, and diseases of senescence.

Evolutionary biology has important implications for the medical concepts of health, “normal” physiology and illness. One is the recognition of tradeoffs that sometimes promote health and other times result in illness. Many of these ideas challenge the conventional wisdom of the health sciences. During this course we will consider controversies and questions regarding health and evolution. A lecture will be given each Tuesday on a topic, and alternative hypotheses will be presented. After lectures, the class will hold discussions, a "journal club" presentation, and critique of ideas in evolutionary medicine.

Goals:
By the end of this course students will:
- be able to search the literature to find publications in evolution and medicine.
- be able to describe how an evolutionary perspective can help a clinician or researcher.
- learn to critique and evaluate evolutionary medicine hypotheses.
- recognize evolutionary problems in medicine.
- understand the categories (subtypes) of evolutionary medicine hypotheses.
- learn to develop a novel hypothesis in evolutionary medicine.

Required Readings:
Updated on the blog:

http://evolutionmedicine.com

Course Requirements & Grading:
Students will be expected to participate weekly with mini-lectures, discussion, and writing projects. Students should complete assigned readings prior to that week’s meeting and be prepared for discussion. Each week, students will complete a
written summary of that week's topic. For the journal club assignment, student’s will also be assigned a journal article to present to the group, critique, and provide commentary. Finally, each student will write an essay on a topic that interests them related to evolution in health and disease.

1) Attendance and participation - 25%

2) Writing projects - 25%

4) Journal club - 20%

5) Final project- 25%

Course Outline:

**Week 1** August 20

The Evolution of Antibiotic Resistance

Key evolutionary concept: microbial evolution causes antibiotic resistance, affecting all of us.

5:30pm – 6:30pm: Evolution and Antibiotic Resistance, how evolutionary principles can be harnessed to find new therapies. Special Guest: Jon Femling MD.

Levels of Analysis – differentiating between proximate “how” questions and ultimate “why” questions of human diseases.

Readings (Read 1-3 prior to the first meeting).

1. **Introducing evolutionary thinking to medicine** Stephen Stearns, Randy Nesse, and David Haig

Writing project – answer the following:

For discussion:

Are humans still evolving?

What does access to modern medicine do to human evolution?

*Writing assignment due in hardcopy in class Aug 27:*
Why should doctors understand evolution in order to treat their patients?

(1 page maximum.)

**Week 2** August 27

Recent Human Evolution - Adaptation to Altitude and Lactase Persistence

We will discuss the evolutionary biology of high altitude peoples of the Andes, Himalayas, and Ethiopian Plateau. How might gene-environment mismatch account for acute mountain sickness in Europeans? How many generations does it take to evolve solutions to the problem of living in a high altitude environment?

Why do some populations have trouble digesting milk?

1. Beall
7. Read about the concept of lactase persistence and the concept of race in medicine: [Unkindest cup](http://news.nationalgeographic.com/news/pf/92910801.html)

**Week 3** September 3

Life history theory and the evolution of aging

- key evolutionary concept: antagonistic pleiotropy, declining power of selection.
- key evolutionary concept: inclusive fitness
- key evolutionary concept: life history theory

5:30pm. Senescence - why we get old (JA)
Declining power of selection – does natural selection keep post-reproductive people alive?
Antagonistic pleiotropy – do genes that promote youthful health also cause disease in the elderly?
Disposable soma hypothesis.
The role of infection in diseases of senescence.
Reproductive senescence and menopause.

Topics for discussion:
What explains the frequency of lipoprotein ApoE in humans; could balancing selection explain the persistence of an allele that is associated with cardiovascular disease and Alzheimer disease.

Readings:

Writing project: Why do women cease to reproduce in middle age? How did menopause evolve in humans?

Some suggest that menopause evolved because grandmothers are more successful at passing on their genes by investing in grandchildren than in more babies of their own. Others argue that menopause is a consequence of modern medicine prolonging the lifespan of women past 60 when most pre-historic women would be dead. So in the past reproductive aging would have been in sync with aging of the rest of the body. In this view menopause reflects the early mortality in pre-history and is a gene-environment mismatch. Argue for either the "grandmother hypothesis" or the "artificial lifespan prolongation" hypothesis.

Week 4  September 10

The hygiene hypothesis

How does exposure to microorganisms affect chronic inflammation and allergic diseases? Is exposure to a diverse microbial environment a good or bad thing for human? Could it be possible that bacteria modulate the behavior, metabolism, and the fatness of humans? How and when can physicians treat diseases by manipulating gut bacteria.

Reading:

Week 5  September 17

Host defenses

“50% of what doctors learn will be proven false, we just don’t know which 50%” is a common saying in medical education. Is it true. Are there evolutionary lessons hidden in medical mistakes?

What is the function of fever?

Why do so many treatments for sepsis not work?


Week 6  September 24

Paleo diet or Paleo fantasy

From a genetic point of view, are we cavemen (and cavewomen)? How do our caveman genes interact with the radically changed modern environment to cause illness?

Readings:
1. Excerpt from Paleofatasy by Marlene Zuk 2013.

Writing project: (due next session).

Many websites argue for the paleo diet, in which meat is emphasized, grains and processed foods are avoided? What would you tell your relative who is trying to get the whole family to eat Paleo? Is it a good idea or bad. defend your answer.

Week 7  October 1
Journal Club – Student presentations on assigned journal articles. Critique and discussion.

**Week 8** October 8

Evolution and Birth: genomic imprinting and reproductive conflicts

Do genes derived from maternal or parental sources have different effects on offspring?  
Gestational diabetes – a paternal gene effect?  
Pre-eclampsia – what effect does blood pressure have on the placenta and vice-versa?  

Readings:

Writing project:
Some have suggested that the age of weaning of infants from the breast is subject to parent-offspring conflict. Eg. infants might want to breastfeed longer than the mother would like. Breastfeeding tends to suppress ovulation and delay pregnancy. Give an evolutionary hypothesis for why infants might exhibit behavior that promotes longer breastfeeding. What behaviors might these be? The infant has 1/2 maternal derived genes and 1/2 paternal derived genes; which of these would these be expected to prolong breastfeeding?

**Week 9** October 15

Evolution and Cancer

Application of selection and ecological dispersal theory to neoplasia is a hot and productive area in evolutionary medicine.


**Week 10** October 22

Evolution and Diabetes

The Thrifty Genotype and the Thrifty Phenotype

Writing project:
There appears to be switch activated in underweight babies that leads to diabetes later in life. Early on, these individuals might be insulin resistant - so less glucose gets metabolized by muscle tissue. As a result, less energy is devoted to growth and building muscles and bones. On the flip side, more glucose is available for other tissues - like the brain and also infection fighting cells. Come up with a hypothesis for how insulin resistance might be helpful for underweight neonates?

**Week 11 October 29**

Evolution, the Microbiome and Obesity

Gut microbes have been linked with obesity. We will explore new evolutionary insights from the microbiome

**Week 12 November 5**

Microbial manipulation of human eating behavior

What is the evidence?


**Week 13 November 12**

Evolution and Mental Health

Can depression have an adaptive benefit?


Depression is thought to be partly heritable. Are there “genes” that increase the risk of depression? If so why?

**Week 14 November 19**

Evolution of Virulence

Hospital Acquired Infections – are medical workers vectors of disease? Do pathogens evolve toward commensalism?
Readings:

Writing project (due next week)
Choose one:

a) Dengue fever immobilizes its adult victims. Does immobilization help or hurt the transmission of the virus? How is dengue different from the common cold?
b) Why do "hospital-acquired" infections get different antibiotics than "community acquired" infections. Which are generally worse and why?

**Week 15 – November 26**

Summary and final observations
Presentations (15 minutes each)

**Week 16 December 3**

Final Presentations

**Finals Week** December 10

Final Presentations.