

# Society of General Internal Medicine Evolution and Medicine Symposium and Interest Group San Diego, 2014

We aim to build a network of SGIM members who share fascination with the view of health and illness through an evolutionary lens. Through this lens, the very nature of questions one can ask shifts from proximate “what” questions about mechanism and development in individuals to evolutionary “why” questions about selection forces and phylogenetic development. Medicine is based on biology and biology is based on evolution but medical education and research rarely taps into the elegance and power of evolutionary principles.

## Practicing medicine with only half of biology?

Why do we age? Why is congestive heart failure so common? Why do so many of us wear glasses? Why is there a menopause? Why must we sleep? Why do we get febrile when infected?

If you are like 99% of current medical students, trainees, or physicians, your first responses to these intriguing questions is to think about pathophysiologic answers. We are drawn to underlying questions of how the mechanism might work. These proximal, mechanistic explanations form the conceptual and cognitive framework for our learning, practice, and research in medicine.

However, such bodily mechanisms tell only half of the story. To fully understand the complexities of these problems we must take the longer view and ask evolutionary questions as well. In 1963, Tinbergen described the four questions that must be answered to provide a full explanation of any biological trait. The figure is published in Nesse, Randolph M. "Tinbergen's four questions, organized" *Trends in ecology & evolution* 28(12):681-682, 2013.

Four Areas of Biology: Four Questions R. Nesse, <i>TREE</i> , 2013		Two objects of explanation	
		<u>Developmental/Historical</u> A sequence that results in the trait	<u>Single Form</u> The trait at one slice in time
Two kinds of explanations	<b><u>Proximate</u></b> Explains how organisms work by describing their mechanisms and their ontogeny	<b><u>Ontogeny</u></b> <b>Q: How does the trait develop in individuals?</b> A: Description of the trait's forms at sequential life stages, and the mechanisms that control development.	<b><u>Mechanism</u></b> <b>Q: What is the structure of the trait; how does it work?</b> A: Description of the trait's anatomy, physiology, regulation, and how the trait works to accomplish a function.
	<b><u>Evolutionary</u></b> Explains how a species came to its current form by describing a sequence of forms, and how they were influenced by selection and other evolutionary factors.	<b><u>Phylogeny</u></b> <b>Q: What is the phylogenetic history of the trait?</b> A: Description of the history of the trait as reconstructed from its phenotype and genotype precursors	<b><u>Adaptive significance</u></b> <b>Q: How have variations in the trait interacted with environments to influence fitness in ways that help to explain the trait's form?</b> A: Description of how variations in the trait have influenced fitness

*"Nothing in biology makes sense except in the light of evolution"*

- Dobzhansky T. *American Zoologist* 1964

*"Teaching evolution as a basic science does not add extra facts, it adds a framework on which those facts can be organized and it can make medical education more coherent. It can give students a real feel for the organism."*

- Nesse R. *Lancet* 2008;372:S21-27

### **Websites of Presenters**

- Mark D Schwartz <http://www.med.nyu.edu/biosketch/mds13>
- Joe Alcock [http://hsc.unm.edu/emered/content/FacultyBio\\_Alcock.shtml](http://hsc.unm.edu/emered/content/FacultyBio_Alcock.shtml)
- Randolph Nesse <http://RandolphNesse.com>

### **What is the potential role of evolutionary science in...?**

- Clinical Practice
  - Contextualize health & disease in evolutionary terms
  - Lessons from antibiotic resistance
  - Distinguish symptoms of disease from adaptive host defense mechanisms
    - Fever, cough, diarrhea, dysphoria
  - Counsel/educate patients
- Research
  - Integrate basic and clinical sciences to solve problems
  - Distinguish proximate from evolutionary causal questions
  - Principles of testing evolutionary hypotheses
  - Questions about why natural selection has left us vulnerable to disease

### **What can we do to expand education in evolution for physicians?**

- MCAT 2015 will now include questions on evolutionary biology
  - >30 undergrad courses in "Darwinian Medicine"
- Incorporate evolution questions and concepts on rounds
  - Use of evolutionary "puzzlers"
- Faculty Development courses for medical school faculty
- New series of "Clinical Briefs" in the *Evolution, Medicine, and Public Health Journal*
  - 1-page summaries of foundational evolutionary concepts and of diseases with perspectives and implications of integrating with evolutionary principles

## EVOLUTION AND MEDICINE RESOURCES

### Key Papers:

**Evolutionary medicine: its scope, interest and potential.** Stearns S. Proc Roy Soc Bio Sci 2012; 279:4305-4321.

Describes the range of topics covered by evolutionary medicine, which include human genetic variation, mismatches to modernity, reproductive medicine, degenerative disease, host-pathogen interactions and insights from comparisons with other species. It then discusses priorities for translational research, basic research and health management. Its conclusions are that evolutionary thinking should not displace other approaches to medical science, such as molecular medicine and cell and developmental biology, but that evolutionary insights can combine with and complement established approaches to reduce suffering and save lives.

**Six kinds of evolutionary explanations for vulnerability.** Nesse, RM, & Dawkins, R (2010). Evolution: Medicine's most basic science. In Warrell, Cox, Firth & Benz (Eds.), Oxford Textbook of Medicine, 5th edition (pp. 12-15).

1. Mismatch between aspects of our bodies and novel environments
2. Pathogens that evolve faster than we do, and resulting costly defenses that cause harm
3. Constraints on what natural selection can do
4. Trade-offs that keep any trait from being truly perfect
5. Traits that increase reproduction at the cost of health
6. Protective defenses such as pain and fever

**Evolutionary Biology in the Medical School Curriculum.** Nesse and Schifman. BioScience 2003;53:585-587

- 48% of Medical School Deans (N=55) said evolution is important for physicians
  - No medical school teaches evolutionary biology as basic science
  - No medical school requires evolution as a prerequisite
  - 16% had PhD faculty in evolutionary biology
  - 32% addressed core topics in evolution (Median of 4 hours curricular time)

**Making evolutionary biology a basic science for medicine.** Nesse, Bergstrom, Ellison, Flier, Gluckman, Govindaraju, Niethammer, Omenn, Perlman, Schwartz, Thomas, Stearns, Valle. PNAS;107(Suppl 1):1800-8007, 2010.

- This article suggests specific ways to implement AAMC HHMI recommendations for incorporating evolution in medical curricula.

### Web Sites:

**The Evolution & Medicine Review** (a virtual home for the evolution and medicine community) The Evolution & Medicine Review (EMR) is a web journal created by and for the community of scientists, scholars, clinicians and teachers working at the interface of evolution and medicine/public health The EMR provides open access to carefully selected information from diverse sources, along with engaging commentary and opportunities for discussion.

<http://evmedreview.com/>

**Evolution, Medicine, & Public Health.** An open access Oxford University Press journal edited by Stephen Stearns. <http://emph.oxfordjournals.org/>

**Evolutionary Medicine,** An open access Ashdin Publishing journal edited by Paul Ewald. <http://www.ashdin.com/journals/jem/jem.aspx>

**The Foundation for Evolution, Medicine, and Public Health.** The Foundation supports research, education, and communication in the field of evolutionary medicine. <http://evolutionarymedicine.org>

**EvolutionMedicine Blog.** Joe Alcock's blog from his course on Evolution and Medicine at the University of New Mexico School of Medicine. <http://evolutionmedicine.com>

**Center for Evolution, Medicine, & Public Health at Arizona State University.** Directed by Dr. Nesse, this new, University-wide Center at ASU aims to establish evolutionary biology as an essential basic science for medicine, worldwide. <http://EvMedCenter.org>

## **Videos:**

### **The Genius of Charles Darwin**

[Uncut interview on Evolution and Medicine](#) with Randolph Nesse, from the 'The Genius of Charles Darwin' presented by Richard Dawkins. The edited interview became an episode in the Channel 4 UK television series *The Genius of Charles Darwin* which won "Best TV Documentary Series of 2008" at the British Broadcast Awards. Segments from the interview are also available on YouTube.

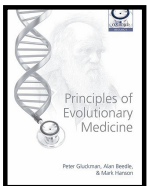
**NIH Video and Podcasts on Evolution and Medicine** are now available online. They can be accessed from <http://videocast.nih.gov/PastEvents.asp?c=64>

### **Evolution and Medicine: How New Applications Advance Research and Practice**

38 online lectures by the world's leading experts. This is a complete course that covers the breadth of this new field in depth. You can view part of the lectures but need to buy the CD or have your university purchase access to see them all. Free trial for universities. This series is for all those wishing to be briefed on the latest developments in the study and understanding of evolutionary medicine including students of undergraduate and graduate courses in biology, medical and nursing courses and health care clinicians.

[http://www.hstalks.com/main/browse\\_talks.php?father\\_id=20](http://www.hstalks.com/main/browse_talks.php?father_id=20)

## **Books:**



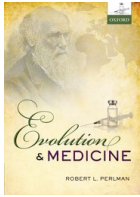
**Principles of Evolutionary Medicine (2009)** by Peter Gluckman, Alan Beedle, and Mark Hanson. Oxford University Press.

First textbook on topic aimed at medical students and trainees.

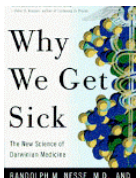


**Evolution in Health and Disease (2008, 2nd Edition)** edited by Stephen C. Stearns and Jacob C. Koella, Oxford University Press.

Provides a state-of-the art account of current developments in the field etc.



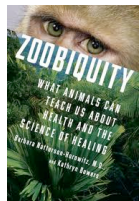
**Evolution and Medicine** (2013) by Robert Perlman, MD, Oxford Press. Evolution and Medicine interweaves the presentation of evolutionary principles with examples that illustrate how an evolutionary perspective enhances our understanding of disease.



**Why we get sick: The new science of Darwinian Medicine** (1994)

Randolph M. Nesse, MD and George Williams, Vintage.

The answers are in this groundbreaking book by two founders of the emerging science of Darwinian medicine, who synthesize the research on disorders ranging from allergies to Alzheimer's and from cancer to Huntington's chorea. Why We Get Sick compels readers to reexamine the age-old attitudes toward sickness.



**Zoobiquity: What Animals Can Teach Us About Health and the Science of Healing**

(2012). Barbara Natterson-Horowitz, MD and Kathryn Bowers, Knopf.

In this pan-species approach to medicine, the authors present a revelatory understanding of what animals can teach us about the human body and mind, exploring how animal and human commonality can be used to diagnose, treat, and heal patients of all species.



**Evolutionary Medicine and Health: New Perspectives** (2007, 2nd edition) edited by Wenda R. Trevathan, E. O. Smith and James McKenna. Oxford University Press. Provides a view of the field from the social sciences (Anthropology, Psychology, etc)