Evolutionary Medicine – A Great Way to Teach Biology

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Evolutionary Medicine – A Great Way to Teach Biology

Great teaching is often all about the questions posed to students. When learners get their teeth into an interesting question, they grow as they chew on it. As physicians, we have discovered that disease makes more sense if you ask evolutionary questions, and these questions make a great starting point for science education.

One of Darwin's two main questions was how species are related to each other. His answer was that all organisms have common ancestors. This is the foundation for studies of phylogeny. To teach phylogenetic trees, you can use canids or birds, but students are particularly interested if they are tracing the origins of HIV or tuberculosis, or the history of human traits, such as the appendix.

Darwin's other question was about why bodies work so well. His answer was natural selection. The characteristics of individuals who have more offspring than others become more common over the generations. This explains why kidneys, hearts, eyes, and brains are so astoundingly well suited to their purposes.

As physicians, we constantly confront a very different question. If natural selection is so powerful in fine tuning anatomy and physiology, why do so many people have nearsightedness, diabetes, atherosclerosis, cancer, and a tragically too narrow birth canal?

We were taught in medical school to ask why some people get sick and others don't. Variations in genes and environments provide what are called "proximate" explanations. The field of evolutionary medicine asks a different question – why did natural selection leave us all with bodies that have so many traits that leave us vulnerable to diseases? Some, like Huntington's chorea, result from the mutations that natural selection cannot completely prevent. Others, like atherosclerosis, result from the mismatch between our bodies and modern environments. Some, like the blind spot in vertebrate eyes, result because natural selection cannot start a design again from scratch, but can only make sequential changes based on previous designs. Other traits, like aging, result from trade-offs that give advantages that outweigh their costs. A few, such as pain and fever, seem like problems because they are so unpleasant, but they are actually useful responses. Asking such questions inspires students to think deeply.

When students discuss why aging exists at all, they quickly realize that natural selection shapes bodies not for health or longevity, but for reproductive success. Once they realize that cephalopods do not have a blind spot, they recognize the limits imposed by natural selection's inability to redesign a trait from scratch. Once students start considering possible evolutionary explanations for fever, pain, cancer, or menopause, they quickly find themselves on the cutting edge of tough but fascinating scientific questions.

Realizing that cancer, heart failure, and autoimmune diseases also occur in other animals further transforms how students understand the nature of health and illness. Such thinking encourages them to reconsider their assumptions about human uniqueness, pushing them past human exceptionalism to recognize *Homo sapiens* as one of millions of species in Earth's ecosystem.

Recognition that nonhuman animals are also vulnerable to behavioral disorders such as compulsions, obesity, anxiety, and self-injury highlights our shared neurobiological ancestry. Understanding the functions of risk-taking in adolescent fish, reptiles, and birds offers students an evolutionary insight that is profoundly important for why so many young humans die in traffic accidents. Understanding why changes in social status influence the moods of chimps and crayfish offers insights into the origins of students' own moods.

Evolutionary medicine is not a special kind of practice – it is just the application of the basic principles of evolutionary biology to medicine and public health. We have nonetheless found evolutionary thinking invaluable in our clinical work. In cardiology it encourages looking beyond causes of heart disease, such as smoking, high cholesterol, and hypertension, to also consider more fundamental explanations for why we humans are vulnerable to atherosclerosis in the first place. In psychiatry, an evolutionary perspective makes it clear that emotions like anxiety and sadness are symptoms just like fever and cough – useful in certain situations, but very often excessive because of "the smoke detector principle"; a false alarm costs much less than the harm that could result if no response is expressed.

Some teaching resources for evolutionary medicine are available, such as the NIH-sponsored supplement to BSCS biology, but many teachers may find it hard to figure out where to start. The International Society for Evolution Medicine and Public Health has made a major investment to provide teaching resources. In addition to its website, its annual meetings, and its journal, *Evolution, Medicine, and Public Health*, the organization sponsors EvMedEd.org, an open access online database that provides links to thousands of videos, webpages, articles, and books. EvMedEd also provides lesson plans, test questions, and suggestions for how to deal with prevalent misconceptions. For instance, students who learn that evolved traits have evolutionary explanations are likely to make the mistake of assuming that diseases like diabetes and cancer have benefits. Considering all alternative hypotheses for traits that make a species vulnerable to a disease provides a wonderful exercise in critical thinking.

EvMedEd is not just for teachers – it also showcases materials created by teachers. Please share lesson plans, articles, slides, and classroom exercises; they will be welcomed and appreciated by many other teachers who will share a new perspective on disease with future health professionals, some of whom will be become medical educators who finally bring evolutionary biology to medicine.

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