What evolutionary biology offers public health

Randolph M Nesse [a]

Evolution is the foundation of biology, and biology is the foundation of medicine and public health, so you would think that evolutionary biology has already been applied to every possible aspect of health. Remarkably, this is not the case.[1] With the exceptions of population genetics and methods for tracing phylogenies, other applications are very recent developments. There are few evolutionary biologists in schools of medicine or public health, so news about advances in this field is often slow to arrive.

The publication of a new edition of *Evolution in health and disease*[2] offers a good opportunity to take stock. For instance, work on diseases of pregnancy continues to accumulate evidence that diabetes and hypertension of pregnancy may be related to evolutionary conflicts between interests of the maternal and paternal genomes and the fetus. Imprinted genes that influence these conflicts have profound implications for in vitro fertilization policies. Life history theory explains how selection has shaped rates of ageing and its relationship with reproduction. The evolutionary reasons why we remain vulnerable to cancer are better separated into aspects of modern environments, and tradeoffs that explain why selection cannot make better protective mechanisms.

The epidemic of obesity can be interpreted in terms of the evolutionary forces that shaped dietary preferences and appetite regulation mechanisms, along with the possibility that selection has shaped adult physiology to cope with the nutritional environment as indicated by intrauterine conditions. Antibiotic resistance, that stalwart example of natural selection, turns out not to be so simple; mathematical models are needed to create optimal strategies to avoid resistance, and the speed with which resistance fades after antibiotics are withdrawn remains uncertain.

These advances are not well known in medicine and public health but word is spreading. Eight major international conferences in the past year have brought together evolutionary biologists and medical researchers. In 2008, the American College of Epidemiology will devote its annual meeting to "The Dawn of Evolutionary Epidemiology". The United States National Academy of Sciences will hold a Sackler Symposium on evolution and medicine in 2009.

There are many questions to be asked about why selection has left the body vulnerable to disease.[3] Why are our coronary arteries so narrow and prone to plaque? Why hasn't natural selection found a different, safer route for childbirth, or at least enlarged the pelvic opening? Why do we have third molars, given the trouble they cause? Why can't our bodies create better defences against bacteria? Why is the endothelium so vulnerable to inflammation? Such evolutionary questions are fundamentally different from questions about how the body works.[4]

We also have an urgent need to understand the evolutionary significance of genetic variations. If a rare allele slows ageing, can we assume it is superior? Not necessarily, as evolutionary patterns have shown that such benefits usually have other costs. If an allele accounts for much of the vulnerability to myopia, obesity or alcoholism, does that mean it is a genetic defect? No, it is more likely to be a quirk, a variation harmless in ancestral environments that results in disease only when it interacts with aspects of the modern environment.[4] If a genotype is associated with allergic sensitivity to dust mites and asthma, does that mean it is abnormal? No, it may well protect against schistosomiasis, and that protection may influence both the prevalence of that infection and asthma in certain groups.[5,6] It is clear that identifying genetic variations is only the first step. Explaining the variation is the next. New techniques for identifying signals of selection give an increasingly detailed view of the evolutionary history of deoxyribonucleic acid (DNA) sequences. The next step is harder – figuring out what selection forces, if any, account for the presence and distribution of an allele.

Establishing evolutionary biology as a basic science for medicine and public health will take major education initiatives, from undergraduate courses to scientific conferences. The Evolution and Medicine Network (available at: http://evolutionandmedicine.org) provides information about people, publications, courses, conferences, and new opportunities in evolution and medicine. ■

References

1. Nesse RM, Stearns SC, Omenn GS. Medicine needs evolution. *Science* 2006;311:1071. PMID:16497889 doi:10.1126/science.1125956
2. Stearns SC, Koella JK, eds. *Evolution in health and disease*. 2nd edn. Oxford: Oxford University Press; 2007.
3. Nesse RM, Williams GC. *Why we get sick: the new science of Darwinian medicine*. New York: Vintage Books;1994.
4. Trevathan WR, McKenna JJ, Smith EO, eds. *Evolutionary medicine*. 2nd edn. New York: Oxford University Press; 2008.
5. Nesse RM. Maladaptation and natural selection. *Q Rev Biol* 2005;80:62-70. PMID:15884737 doi:10.1086/431026
6. Barnes KC. Genetic epidemiology of health disparities in allergy and clinical immunology. *J Allergy Clin Immunol* 2006;117:243-54. PMID:16461122 doi:10.1016/j.jaci.2005.11.030

[a] University of Michigan, Ann Arbor, MI 48109, United States of America.
Correspondence to Randolph M Nesse (e-mail: nesse@umich.edu).
doi:10.2471/BLT.07.049601