

Who Owns Your DNA?

Genomics & Personalized Medicine: What Everyone Needs to Know

Author: Michael Snyder
Oxford University Press (2016).
184 pp. \$16.95 (paperback)

Stanford Genetics Professor Michael Snyder's book, *Genomics & Personalized Medicine: What Everyone Needs to Know*, is a work to be enjoyed on multiple levels. Designed for a broad audience, the book delivers a great deal of detail for the scientifically savvy while still providing a generalized overview for the yet-to-be-initiated.

Although brief, the book is timely, having followed closely on the footsteps of President Obama's recently announced multimillion-dollar push into personalized medicine (also known as precision medicine) and his related statements on individual ownership of DNA. This book is a concise overview for many of the stakeholders, particularly physicians, and for the general public as well.

Snyder takes us on a whirlwind tour of many aspects of personalized medicine—from the basic science to the various relevant 'omes, finally touching on the social and ethical issues associated with a personalized medicine future. Within the spectrum between a dry impersonal textbook and a popular science book, Snyder's work falls in the middle. While it includes numerous technical figures and extensive scientific information, it doesn't include references or footnotes. Instead, Snyder writes in an inviting voice. And, even while incorporating substantial technical information, he still sprinkles the complicated areas with his own research experiences to support the conclusions drawn; readers will likely appreciate many of the personal anecdotes, describing how Snyder himself has employed aspects of the science on himself. In relation to these anecdotes, it is worth mentioning that both authors of this Book Review have worked with Snyder in the past on some of these subjects and so were quite excited to see them summarized here.

Even in this relatively compact package, Snyder provides succinct but coherent primers on personalized medicine, genomics, and cancer genetics. He

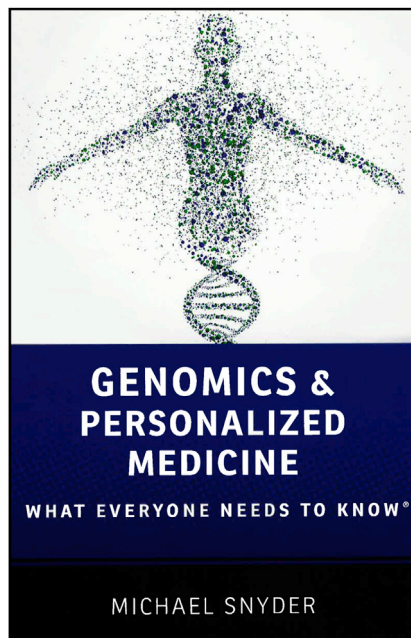
follows with examples of more applications, including mystery disorders, complex diseases, prenatal care, pharmacogenomics, aging, and general health. It's notable that Snyder's book starts off with the classic "NIH genomics playbook" of cancer and rare disease; while these are probably of greatest interest to the general public, much of Snyder's scientific accomplishments lie in other fields, such as functional genomics and proteomics—topics that he only touches on briefly later in the text. Moreover, the relatively minor discussion of proteomics is all the more surprising, as it is often seen as the key link connecting DNA to the more functional aspects of biology, though perhaps this is understandable in terms of the very few current applications of proteomics to the clinic.

After the science introduction, Snyder switches gears to introduce the reader to associated topics, including wearables and big data. Finally, he provides an analysis of some of the thorny social issues

associated with personalized medicine, wading through highly charged areas, including delivery of information, ethics, education, privacy, and insurance, and providing in many instances his own point of view. For example, one of the many interesting chapters relates to the emerging crossover between the quantified-self movement that uses sensors and smartphones to track even the most mundane aspects of our daily lives and personalized medicine's adoption of this technology to incorporate this data into a larger health dataset, an area where Snyder's integrative personal omics profile (iPOP) work has been particularly significant.

Some chapters could arguably benefit from further elucidation, often leaving the intrigued reader looking for more. For example, in the sections relating science to society, Snyder takes a clear and to some degree commendable position: your DNA is your own, and people should be empowered to understand it. This happens to be basically the simple stance that President Obama recently took. However, to strengthen his exposition, Snyder could have addressed the many countervailing and often paternalistic voices arguing in favor of limiting the consumer's access to the genomics—i.e., that it requires specialized knowledge to properly interpret. That said, one gets the sense that Snyder's book is very much directed at the physicians who are the current gatekeepers of patients' DNA. In addition to having a strong opinion on how physicians should facilitate rather than hamper access to their patients' DNA, Snyder is also clearly trying to educate them in the new genomic reality.

Perhaps Snyder should have devoted more time to some of the relevant revolutionary technology of next-generation sequencing. Many of the interesting developments that he alludes to in the book, for instance, the idea of a lipid biopsy from blood or the testing for diseases in cell-free fetal DNA circulating in the maternal blood, rest on the current limitations of this technology. This absence is all the more relevant, as today some of the most exciting aspects of genomics are fundamentally technological in nature, e.g., the ability to sequence from minimal amounts of biological material. Likewise, the excitement in personalized medicine



is also related to devices and the associated software that continuously monitor aspects of our health in real time. We assume that much of the readership would have been very interested in reading Snyder's perspective regarding the current and future developments, as well as medical or non-medical uses of these technologies. In particular, Snyder's point

of view would provide insight into distinguishing reality and potential from the hype. For example, to what degree are liquid biopsies truly possible, or will they be endlessly confounded by noise? Or, to what degree will wearable technology evolve to do real-time metabolomics measurements during exercise synced to your heart rate?

These absences are particularly notable given that Snyder is such a leading expert in biotechnology, having developed many seminal technologies himself. Perhaps biotech will be the focus of his next book. That said, we highly recommend reading this book and hope that it will inform discussion of personal genomics going forward.

Dov Greenbaum^{1,2,*} and Mark Gerstein^{2,*}

¹Interdisciplinary Center Herzliya, Israel, and Yale University, New Haven, CT 06520, USA

²Yale University, New Haven, CT 06520, USA

*Correspondence: dov.greenbaum@yale.edu (D.G.), mark@gersteinlab.org (M.G.)
<http://dx.doi.org/10.1016/j.cell.2016.03.032>