Guest commentary: The human microbiome and the promise of clinical ecology

Phil Hugenholtz

Australian Centre for Ecogenomics, School of Chemistry and Molecular Biosciences & Institute for Molecular Bioscience
The University of Queensland
Qld, Australia

Metagenomics, the application of high-throughput sequencing to nucleic acids extracted directly from environmental samples, made its debut in 2004 through two high-profile papers in *Science* (Sargasso Sea) and *Nature* (acid mine drainage). A key strength of the approach is the ability to circumvent the well-known cultivation bottleneck and lay bare the genetic blueprints of ecologically important members of the microbial community, many of which cannot be easily obtained in culture.

More recently, metagenomics has been applied to clinical systems most visibly through the Human Microbiome Project (http://commonfund.nih.gov/hmp/). This type of "clinical ecology" research is making it increasingly apparent that microorganisms constitute a kind of second genome to our own that complements our arguably limited metabolic capabilities. Also of great interest is the recognition that we are diverse ecosystems in our own right with, for example, tropical and arid regions populated by strikingly different communities adapted to their local conditions. Culture-independent surveys of hundreds of individuals indicate that the human gut microbiome can be divided into broad groupings dubbed "enterotypes" that reflect host genotype (for example, ethnicity) and environmental factors (for example, diet). The same appears also to be true for other body sites such as the mouth and the vagina. This holistic treatment of the microbiome is also influencing the classical view of disease as the result of a single pathogen to a more complex interplay of microbial agents set in the context of the normal microbiota.

However, study of the human microbiome by microbial ecologists alone is not making full use of the potential that new molecular tools bring to the table. The really fun stuff starts to happen when substantive collaborations are forged between clinicians, microbial ecologists (both bacteriologists and virologists), immunologists and host (human, mouse, and so on) geneticists. This typically takes researchers out of their comfort zone but the pay-offs seem well worth the investment of time and energy. Such collaborations bring into sharp relief the importance of the native microbiome in shaping both the innate and adaptive immune system and its role in a whole spectrum of human afflictions including autoimmune and allergic disorders, cancer and even behaviour. Aside from the flurry of new insights into human health and disease, the applied prospects for clinical ecology hold great promise. The holy grail of health care – personalised medicine – is currently being led by human genome research; however, it will be exciting and satisfying to see human microbiome research take its rightful place in tailored medical treatment.

Recommended reading

Clemente, J.C. *et al.* (2012) The impact of the gut microbiota on human health: an integrative view. *Cell* 148, 1258–1270.

Virgin, H.W. and Todd, J.A. (2011) Metagenomics and personalized medicine. *Cell* 147, 44–56.