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Born in 1960 in Los Angeles
Studied Population Ecology and Entomology at the University of California, Berkeley, and Population Biology at the University of London

FOCUS

PROJECT

Evolutionary Approaches to Understanding Cancer Progression and Optimizing Therapies

Somatic cellular selection and evolution are the fundamental processes leading to malignancy, metastasis and resistance to therapies, with the contribution of cancer stem cells as the progenitors of these more differentiated cell types. A complication is the tremendous plasticity of cells, and more specifically cancer cells, that allows them to acquire stem cell characteristics through deregulated expression of just a few genes. Tumors can be viewed as collections of individuals (cells) that accumulate genetic and epigenetic changes and, through their interactions with the surrounding environment, adaptively evolve. Examples include stressful microenvironments affecting the evolution of invasive malignancies and the evolution of resistance to toxicity during tumor growth, providing a competitive advantage over healthy cells. My proposal for study at Wiko is the development of theoretical models of (1) how alteration of microenvironments can lead to cancer "breaking out" from controlled growth characteristic of healthy multicellular organisms and (2) how evolutionary and demographic knowledge could be used to optimize anti-cancer therapies. The first of these topics will be addressed by modifying mathematical models of cultural and technological innovations, to represent cell phenotypes and their microenvironments. The second topic will involve employing optimization approaches to managing rather than eradicating precancerous lesions and detected cancers. Both of these themes will be addressed by the Focus Group on the topic of cancer evolution.

Recommended Reading

Hochberg, M. E., F. Thomas, E. Assenat, and U. Hibner (2013). "Preventive Evolutionary Medicine of Cancers." Evolutionary Applications 6: 134-143.
Roche, B., M. E. Hochberg, A. F. Caulin, C. C. Maley, R. A. Gatenby, D. Missé, and F. Thomas (2012). "Natural resistance to cancers: a Darwinian hypothesis to explain Peto's paradox." BMC Cancer 12: 387.
Thomas, F. et al. (2012). "Applying ecological and evolutionary theory to cancer: a long and winding road." Evolutionary Applications 6: 1-10.

TUESDAY COLLOQUIUM, 03.12.2013

A Theoretical Reductionist Approach to Understanding the Social Evolution of Group Formation

In this talk I will briefly introduce some of uses of quantitative models, and then describe in more detail the foundations of evolutionary theory. A common misconception is that evolution is always slow and unobservable. Evolution can be rapid, as is the case for antibiotic resistance in bacteria, which can emerge within hours, or slow, such as occurs for speciation in metazoans or the evolution of complex phenotypic traits, both of which may take thousands of generations and be an ongoing process.

My approach is to use simple models to derive general principles about natural phenomena. Model findings are then confronted with prevailing theory to assess support or refutation, and modification. In some studies (not presented in detail here), I complexify my models as observation or data become available, what I have called the "case model" approach.

As an example of the reductionist approach, I present ongoing research on social group formation. The goal is to assess how social interactions may evolve to produce or not to produce, groups of like individuals. The model is general enough to describe, for example, diverse phenomena, such as population divergence in territorial species, tissue differentiation in multicellular organisms, and the controversial topic of segregation in human society. The emergence of groups may involve sophisticated behavioral repertoires, but the models predict that sophistication is not a requirement for the basic phenomenon to occur. Rather, homophily or heterophily can emerge through a process of positive assortment, requiring only that a given behavior is elicited by a given, simple identifier or "tag". I will briefly conclude by integrating this theory into the larger context of kin selection and social evolution originally proposed by William Hamilton.

PUBLICATIONS FROM THE FELLOWS' LIBRARY

Hochberg, Michael ([S.l.],2014)

Dispersal and spatial heterogeneity allow coexistence between enemies and protective mutualists

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