Biological Systems: Open Access

Greek, Biol Syst Open Access 2013, 2:4
DOI: 10.4172/2329-6577.1000e107

Editorial Open Access

Evolved Complex Systems

Ray Greek*

Americans for Medical Advancement, USA

Biological Systems is a journal about systems. Complex systems can be defined as collection of interacting elements. Williams discusses the fact that the behavior of the system is distinct from the behavior of its parts or elements. Output is not proportional to input and output to a perturbation may vary over time [1].

Biological systems are examples of complex systems and as such are very difficult to study for a number of reasons. Complex systems exhibit the properties of nonlinearity, dependence on initial conditions, robustness, redundancy, emergence, and the whole is greater than the sum of the parts, among other properties. Some properties of biological systems cannot be determined by reductionism. They can only be discovered when the organism is studied as whole, intact system. As reductionism has been relied on, successfully, for over a century, this new way of thinking is difficult for some to accept.

Northrup explains the prerequisites for understanding his introductory book on biological complex systems: "Readers should have had college courses in algebra, calculus, ordinary differential equations, and linear algebra, and, hopefully, engineering systems analysis. They should also have had basic college courses in chemistry, biochemistry, cell biology, and ideally even in human physiology and anatomy. This is the broad background that is required in the interdisciplinary fields of biomedical engineering, biophysics, systems physiology, and economics" [2]. Complex systems also force us to change our idea of a single cause to the notion of a causal chain.

Numerous scientists have addressed the problem of using reductionism to study complex systems. Van Regenmortel acknowledges that the reductionist method has been effective, but cautions that the method has limits that are now becoming manifest. In part this is because complex systems have emergent properties that cannot be ascertained even with total knowledge of the parts of the systems. Van Regenmortel states that the current reductionist approach "underestimates this complexity and therefore has an increasingly detrimental influence on many areas of biomedical research, including drug discovery and vaccine development" [3].

Yet, reductionism continues to be overly relied on. Northrop addresses this. He reminds us that humans evolved to be hunter-gatherers, not to solve complicated problems. Our evolutionary background lends itself to single causes and a linear approach to problem solving. We have limitations as a species. Northrop states: "We need specific training in the area of dealing with complex systems" [2]. Wolkenhauer et al. agree with Northrop when they state: "Conventional modes of medical and biological explanation rely primarily on verbal reasoning and are only suited for dealing with mechanisms that involve small numbers of components and short chains of causality. The diseases most relevant for humankind, however, involve a large number and variety of components interacting through complex networks. New approaches are therefore required to fuel further advances in modern medicines" [4].

Biological systems are also examples of evolved systems. Evolution results in slight changes in the genome which, propagated through time, result in important changes in the initial conditions of the organism-the genome. As complex systems are highly dependent on initial conditions, the fact that biological systems have evolved is significant when considering how they will respond to perturbations.

John Maynard Keynes stated: "The difficulty lies, not in the new ideas, but in escaping the old ones; which ramify, for those brought up as most of us have been, into every corner of our minds." Studying systems as whole instead of relying on reductionism alone requires change and in order to understand why change is required one must have critical thinking skills. Critical thinking is learning how to think [5], not what to think and most students, including science students, are not learning how to think in college [6,7]. Critical thinking can be counter-intuitive and thus humans, scientists included, usually need formal training in order to reason properly.

As an editor, contributor, and reader of Biological Systems, I look forward to learning more about evolved, complex systems in the articles published by Biological Systems.

References

1. Williams G (1997) Chaos theory tamed, Joseph Henry Press. D.C.
2. Northrop RB (2011) Introduction to complexity and complex systems, CRC Press. Boca Raton.
3. Van Regenmortel M (2004) Reductionism and complexity in molecular biology. Scientists now have the tools to unravel biological complexity and overcome the limitations of reductionism. EMBO Rep 5: 1016-1020.
4. Wolkenhauer O, Fell D, De Meyts P, Bluthgen N, Herzel H, et al. (2009) Sysbiomed report: Advancing systems biology for medical applications. IET Syst Biol 3: 131-136.
5. The Critical Thinking Community (2013) Critical thinking: Where to begin.
6. Johnson SK (2012) Rethinking the way colleges teach critical thinking.
7. Willingham DT (2007) Critical thinking: Why is it so hard to teach?

***Corresponding author:** Ray Greek, Americans for Medical Advancement, USA, Tel: 805-685-6812; E-mail: drraygreek@gmail.com

Received December 16, 2013; **Accepted** December 17, 2013; **Published** December 19, 2013

Citation: Greek R (2013) Evolved Complex Systems. Biol Syst 2: e107. doi:10.4172/2329-6577.1000e107

Copyright: © 2013 Greek R. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.