

Short Communication

Network Biology: an exciting frontier science

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Received 6 February 2011; Accepted 21 March 2011; Published online 16 May 2011

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Abstract

Network biology is an exciting frontier science which uses network theory and methodology to address biological problems as regulatory networks, cancer, brain operation, food webs, ecosystems, etc. In this article the aims, scope, theoretical basis, and methodology of network biology were clearly described.

Keywords network biology; science; frontier; aims and scope; methodology.

1 Definition and Theoretical Basis

Networks are mathematically directed (in practical applications also undirected) graphs, and a graph is a one-dimensional abstract complex, i.e., a topological space. In common sense, a network is a system made of hierarchical elements or vertices interacted with each other.

Everything is meaningless on the scale of atoms. A molecule emerges only from the interaction of a vast number of atoms. An organelle emerges from the interactions of a large number of molecules and a cell emerges from the interactions of large numbers of organelles and molecules. A food web is formed by the interactions of various species. Our universe, our nature, our world, and everything we feel and meet are networks.

Network theory focuses on various topological structures and properties, dynamic properties, and functionality-topology relationship, etc. There are some common mathematical foundations, theories and methodology for network analysis (Zhang, 2012), in which graph theory, topology, statistics, and operational research, etc., are the fundamental sciences of network analysis. Furthermore, other sciences as computational science, differential equation theory, agent-based modeling, etc., can be used also in the network analysis.

Biological network analysis is a fast developing science. Many basic issues, for example, ecological structure, co-evolution, co-extinction and biodiversity conservation in ecology (Dormann, 2011), cell cycle, protein-protein interactions and regulatory networks in cell science (Barabasi and Oltvai, 2004; Jain et al., 2011; Martínez-Antonio, 2011; Rodríguez and Infante, 2011), and tumor development and metabolic regulation in health science (Ibrahim et al., 2011), etc., are expected to be addressed by network approaches and network analysis. Many problems on biological systems could not be solved without network analysis. Network analysis is becoming the basic methodology to treat complex biological systems.

In the view of system dynamics, biological networks are always self-organized systems with emergent, autonomous and adaptive properties. Their dynamics can be represented by agent-based modeling, individual-based modeling and some other methodologies like neural network modeling. Therefore, agent-based modeling, individual-based modeling, self-organization of biological systems, and neural network

modeling, etc., fall into the scope of network biology research.

2 Aims and Scope

Various emerging biological networks and network analysis, at both micro- and macro- levels, may provide numerous sources for the development of network theory and methodology, facilitate the development of theory and methodology of network biology, and solve the problems of complex biological systems (Ferrarini, 2011a, b). The topics covered by network biology include, but are not limited to:

- Theories, algorithms and programs of network analysis;
- Innovations and applications of biological networks;
- Ecological networks, food webs and natural equilibrium;
- Co-evolution, co-extinction, biodiversity conservation;
- Metabolic networks, protein-protein interaction networks, biochemical reaction networks, gene networks, transcriptional regulatory networks, cell cycle networks, phylogenetic networks, network motifs;
- Physiological networks;
- Network regulation of metabolic processes, human diseases and ecological systems;
- Social networks, epidemiological networks;
- System complexity, self-organized systems, emergence of biological systems, agent-based modeling, individual-based modeling, neural network modeling, etc.

3 Network Biology Journal

Explosive numbers of papers on biological networks are publishing around the world. The establishment of the journal, Network Biology, will provide a public and unified platform for the publication of these studies. I expect that with this integrated and unique journal, researchers, university teachers and students in the areas of biology, mathematics, computational science and engineering sciences will have an in-depth and complete insight on theory, methodology and recent advances of biological networks and contribute to this exciting frontier science.

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