Diversity and Complexity of Biological Networks

The quantity and quality of biological data has accompanied the realization that biological function cannot be understood by isolating a small subset of components. This is reflected in the rise of fields such as Systems Biology, Complex Adaptive Systems, and to some extent Bioinformatics. Our ability to tackle the structure and functions of large biological systems has reached a critical stage enabled in part by a unique combination of technological advances and computational power. Understanding how large biological systems are structured and how this structure relates to function, dynamics and development, is today one of the central scientific challenges of the 21st century. Interacting networks are the common conceptual element of these large systems across all of Biology, and of the interface of biology with the social sciences as well.

Genes and their products influence each other’s expression and phenotype, cells signal each other and influence physiological function, species interact with one another in tangled webs that underlie ecosystems’ balance and function. Networks are fundamental to the regulation of transcription in the development of pattern in embryos, to the evolution of interacting genes that control metabolic pathways, to the assembly and robustness of ecological communities in patterns of biodiversity, and to the transmission of infectious of disease. Networks as different as those describing interacting cells and Internet connections have strikingly and intriguingly similar basic properties, and advances in network analysis in one field can often inspire novel research if not be immediately applied to another field, across sociology, ecology, epidemiology, or cell biology, making this subject an obvious choice for an interdisciplinary endeavor. The initiative on ‘Diversity and Complexity of Biological Networks’ includes the Department of Epidemiology in the School of Public Health, the Center for Computational Biology and Medicine (CCMB) in the Medical School, the Center for the Study of Complex Systems (CSCS), and the Departments of Ecology and Evolutionary Biology (EEB), Cellular, and Developmental Biology (MCDB), and Biophysics in the College of Literature, Science and the Arts (LSA). It will bring together a cluster of scientists to (1) address the structure and function of biological networks at different levels of organization, (2) better understand how the diversity and complexity of networks affect their robustness to environmental change and variability, and (3) develop new computational and statistical approaches for analyzing networks.