Quantitative Biology > Populations and Evolution

The Emergence of Modularity in Biological Systems

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In this review, we discuss modularity and hierarchy in biological systems. We review examples from protein structure, genetics, and biological networks of modular partitioning of the geometry of biological space. We review theories to explain modular organization of biology, with a focus on explaining how biology may spontaneously organize to a structured form. That is, we seek to explain how biology nucleated from among the many possibilities in chemistry. The emergence of modular organization of biological structure will be described as a symmetry-breaking phase transition, with modularity as the order parameter. Experimental support for this description will be reviewed. Examples will be presented from pathogen structure, metabolic networks, gene networks, and protein-protein interaction networks. Additional examples will be presented from ecological food networks, developmental pathways, physiology, and social networks.

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