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Biological computers: Wiring cells within Communicating Networks

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Computation is defining trait of biological systems and a broad framework that captures the complex adaptive nature of molecules, cells and organisms. Computation is also at the core of the genotype-phenotype mapping, since it provides a natural framework to define function in a self-consistent way. The study of existing biological systems (from signalling cascades to ant colonies or brains) as well as the evolution of synthetic in silico networks performing computations reveals a number of nontrivial patterns of organization, sometimes in clear conflict with standard view of engineering or optimization. In spite of our increasing knowledge, there is a lack of a theoretical framework where computation and its possible forms is integrated within a general picture. Synthetic biology provides a new avenue where engineered molecular circuits can be implemented to perform non-standard computations. Here we review recent advances in the domain of multicellular synthetic computing and suggest a potential morphospace of computational systems including both standard andnon-standard approximations.