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Functional Aspects of Biological Networks

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We discuss biological networks with respect to 1) relative positioning and importance of high degree nodes, 2) function and signaling, 3) logic and dynamics of regulation. Visually the soft modularity of many real world networks can be characterized in terms of number of high and low degrees nodes positioned relative to each other in a landscape analogue with mountains (high-degree nodes) and valleys (low-degree nodes). In these terms biological networks looks like rugged landscapes with separated peaks, hub proteins, which each are roughly as essential as any of the individual proteins on the periphery of the hub. Within each sup-domain of a molecular network one can often identify dynamical feedback mechanisms that falls into combinations of positive and negative feedback circuits. We will illustrate this with examples taken from phage regulation and bacterial uptake and regulation of small molecules. In particular we find that a double negative regulation often are replaced by a single positive link in unrelated organisms with same functional requirements. Overall we argue that network topology primarily reflects functional constraints. References: S. Maslov and K. Sneppen. "Computational architecture of the yeast regulatory network." Phys. Biol. 2:94 (2005) A. Trusina et al. "Functional alignment of regulatory networks: A study of temerate phages". Plos Computational Biology 1:7 (2005). J.B. Axelsen et al. "Degree Landscapes in Scale-Free Networks" physics/0512075 (2005). A. Trusina et al. "Hierarchy and Anti-Hierarchy in Real and Scale Free networks." PRL 92:178702 (2004) S. Semsey et al. "Genetic Regulation of Fluxes: Iron Homeostasis of Escherichia coli". (2006) q-bio.MN/0609042