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The engineering of developmental regulation

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The engineering of developmental regulation

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In recent years, the gathering and mining of massive datasets (genomes, proteomes, interactomes, phenomes, etc.) has prompted attempts to re-envision biological phenomena as emerging from complex networks and systems, rather than just being the consequence of linear genetic and biochemical pathways. This seems like a step forward, but exactly how it advances understanding is not always easy to see. I will argue that one of the great advantages of the "systems approach" is that it enables one to assign importance to components (e.g. genes, proteins, network circuits) by how they contribute to system-level performance objectives (tasks selected for by evolution), and not merely by how striking or severe the phenotypes are when they are deleted. I will illustrate this by discussing several developing systems in which patterning and growth are the targets of complex regulation. Drawing from recent experimental, mathematical and computational results, I will make the case that only by taking into account selection for engineering objectives–things like robustness, adaptability, response time, and noise-suppression–can we make sense of the molecular and genetic networks we observe. In this regard, biology seems finally to be coming around to a viewpoint articulated over 50 years ago by one of the first presidents of the SDB.

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