Shape as a result of the viable control of proliferation, differentiation, migration and apoptosis

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Morphogenesis is the process by which a single cell develops into a multicellular organism. It is a complex and dynamic process that is controlled by cell proliferation, differentiation, migration and apoptosis (PDMA). Precise control of PDMA in time and space is essential for normal morphogenesis. Perturbations in this control can lead to malformations or disease.

Over a thousand growth factors, cytokines, and chemokines influence cell fate. These diffusible molecules act on receptors on the stem cell surface to control their PDMA. The binding of growth factors to fractones is required to activate on stem cell borne receptors. Fractones consist of glycoproteins that are involved in a variety of cellular processes, including signal transduction and cell adhesion.

Morphogenesis can be mathematically modeled as a multivalued dynamical system. A dynamical system is a set of objects that evolve over time according to predefined rules. Constraints are restrictions that limit the system's evolution. The viability kernel is the set of initial states from which the system can evolve in a way that always respects constraints. In other words, the viability kernel is the set of initial states leading to a viable evolution of the system. We hypothesize that regulations laws are the means by which the organism maintain a viable form. Cellular regulations are the mechanisms that control PDMA. They ensure that cells divide, differentiate, migrate, and die at the right time and place to construct and maintain the organism's form.

We study the dynamical systems of organisms that integrate environmental signals to control their morphogenesis. We believe that fractones and the

associated fibroblast/macrophage network play an important role in these systems. We anticipate that the latter create non-linear regulatory laws enabling the organism to remain within its viability domain. Fractone-borne glycoproteins are likely produced by macrophages, which are associated with a network of fibroblasts, are thought to play a key role in this process. That fractones associated with the fibroblast/macrophage network regulate PDMA, ensures that the organism develops in a healthy and coordinated manner.