KS6 - Frederick Cummings (University of California, Riverside - USA)

On a Heuristic Model of Pattern Coupled to Form

Abstract:

A model of patterning in living systems is examined, one involving the interaction of a pair of (different, in general) signaling pathways. The model of pattern is coupled to the changing shape of a (closed, thick) epithelial surface. Aspects of the model are discussed in turn: the pattern, the epithelial sheet geometry, and the coupling of the latter two. The model is intended to provide a simplest example of morphogenesis. It is most `reductionist' in the sense that it reduces morphogenesis to its most elemental `modules': pattern, shape and their interaction. This is a reversal from the usual temporal progression (e.g., as in physics), i.e., first from phenomenological modeling, then only later, to its reductionist underpinnings: e.g., thermodynamics and statistical mechanics, or e&m and quantum electronics. Biology has been, at least for the past fifty years, primarily and certainly fruitfully, focused on the genetic and molecular basis of development. On the other hand, mathematical modeling has rarely dealt with animal shape, or with its coupling to pattern. A beginning attempt is made to uncover possible molecular and genetic foundations of the present elemental model of interacting shape and pattern. There have been very important recent genetic findings, and it is suggested that the very most conserved regions of DNA are of relevance to providing a beeper understanding of the successive coupling of signaling pathways. Molecular bases for pattern, shape and their interactions are discussed, and possible connections to the model are tentatively proposed. The model provides positional specification for stem cells as interstitial to the regions undergoing differentiation.