

The Hierarchical Genome

The Hierarchical Genome and Differentiation Waves: Novel Unification of Development, Genetics and Evolution (Vol. I, II) (1999) Richard Gordon. World Scientific and Imperial College Press, London, 1836pp. Hardback; ISBN: 981-02-2268-8.

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An unexpected experimental finding triggers a plethora of novel ideas that attempt to explain this new phenomenon. In the Physical Sciences, the situation is usually settled when a new unique theory is formulated, since an experiment admits, as a rule, only one interpretation. In contrast, Biology, and Developmental Biology in particular, is so complex that an observation is generally susceptible to several interpretations. Positional information, organizing centres, and embryonic induction are some central ideas used in understanding more or less the same developmental facts. Although they have common elements, they diverge in many respects and yet they can all explain much of the existing data. In this book, Richard Gordon proposes a self-contained new theory of Development with the ambition of extending it to Genetics and Evolution.

In the seminal paper of 1924, Spemann and Mangold reported that a blastopore dorsal lip grafted to the ventral side of a newt ectoderm led to the induction of a second neural plate, which later developed into a second embryo. This remarkable result initiated a search for the discovery of the chemical substance responsible for this new phenomenon of neural induction. During nearly 80 years, although it has been claimed that many molecules act as inducers, the goal of this search has remained elusive. In contrast to the above chemical approach, Gordon proposes a physical cause of induction. His original papers are reprinted in a series of Appendices at the end of Volume II. A theoretical model predicting the contraction waves is followed by an experimental verification of their existence and their spreading on that part of the amphibian ectoderm surface that will subsequently become the neural plate. Although the author admits there are still many crucial problems to be solved, he believes that such waves underlie cellular differentiation during all developmental stages. How is the contraction wave triggered? Is it really the cause of differentiation and, if so, is it unique? Such questions have to be convincingly answered before it is possible to speculate about the evolutionary modifications of differentiation trees.

In a masterly exposition, the author describes the continuing but fruitless attempts to identify the inducer molecule. Since the chemical cause has almost monopolised all efforts for decades, Gordon's physical hypothesis is a heretical approach which, I imagine, would be dismissed at first sight by some embryologists and molecular biologists. However, as there is no reasonably satisfying theory as yet, any hypothesis should be taken seriously as long as it conforms to accepted first principles and it accommodates existing data. Compared to the theory of an inducer molecule, the contraction (and expansion) waves model is more difficult to test since transplantation manipulations themselves constitute a mechanical disturbance and may be an independent secondary source of contraction waves. Some other ingenious interventions must be thought of in order to test cellular differentiations due to genuine initiations of contraction waves. It is most probable that an integrated synthesis of chemical and physical inducers may be responsible for embryonic differentiations.

The author is certainly a polymath with a sound judgment on widely different areas of knowledge. He moves with ease from the Aristotelian entelechy as restricted to vitalism of living organisms to stereomicroscopic video taping and from perturbation analysis of last century that inspired Turing to Spemann's prejudice against female students. For the reader who appreciates referring to forgotten ancient texts, the book is both valuable and enjoyable. There are characteristic excerpts from modern and classical writers in both volumes giving a sense of authentic referral to the sources. Although this flavour of history may be preferred by many readers, it is at the same time distracting because it disrupts the flow of the main text. The same applies to the referenced sources, which are very detailed at the cost of space—the list of references at the end of volume II extends to more than 300 pages.

The author has obviously enjoyed writing this book where he has deposited both his personal work (experimental and theoretical) on amphibian embryos and his unifying credo extending up to Macroevolution. Evidently his index of 272 propositions will remain open to verification for many years. Readers who have the luxury of leisurely going through hard facts intertwined with historical and philosophical diversions will find the book delightful. However, it is not an easy read for young researchers who feel the everyday pressure of running experiments. These readers would appreciate more a concise treatment in one volume of the origin and basic role of contraction waves in development. A future edition in this spirit would serve well the purpose of triggering their interest to the author's ideas—after all, it is their originality and imagination that are needed for the establishment or refutation of this new theory.