

scenarios that may account for the deposition of carbon-rich facies in the Cretaceous. Continued advances in studies of Recent anoxic environments, in development of sedimentological, geochemical, and paleontological information available from the stratigraphic record, and in conceptualization of geochemical and physical oceanographic models are necessary before the true nature of many of the "anoxic" strata of Cretaceous and other ages can be understood. This well-conceived volume not only summarizes the present nature of such research but will serve as a stimulus to outline the direction of future research.

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Embryonic Development

The Neural Crest. NICOLE LE DOUARIN. Cambridge University Press, New York, 1983. xii, 260 pp., illus. \$65. Developmental and Cell Biology Series, 12.

The neural crest of the vertebrate embryo appears early in development as the embryo's central nervous tissue is formed. Crest cells separate from the epithelial folds that produce the embryonic neural tube, disperse extensively, and eventually produce diverse cellular phenotypes in precise embryonic locations. These derivatives include the neurons and supportive cells of the peripheral (autonomic, sensory, and enteric) nervous systems, pigment cells, endocrine derivatives, and skeletal and connective tissues of the head and face. Because the vertebrate neural crest is a precisely identified embryonic cell population whose developmental history, morphogenetic behavior, and differentiative fates are known, it may be useful in answering two central questions posed by cell and developmental biologists—namely, how developmental restrictions are established within cell lineages and how cellular morphogenetic movements are controlled. At least ten review articles on aspects of neural crest development have appeared in the last three years, indicating the high level of interest in and research on this attractive system and suggesting that its usefulness is being recognized and exploited.

Le Douarin's monograph is the latest and most complete of the recent reviews of research on the neural crest. It is a beguiling and highly personalized work, focusing primarily on the very substan-

tial contributions Le Douarin and her colleagues have made exploiting a marking technique that she introduced about a decade ago. This technique, in which cells of quail embryos can be permanently distinguished from those of chicken embryos by the characteristic staining of heterochromatin, involves reciprocal grafting between embryos of the two genera. Using such quail-chick chimeras, Le Douarin and her colleagues have been able to establish in exquisite detail the normal developmental fates of avian neural crest cells and the origin in the early avian embryo of the crest cells that produce particular tissue derivatives. The existence of such detailed information has been essential in enabling her and others to test the developmental potential of the neural crest in vivo and in vitro and to examine the role of environmental cues in regulating morphogenetic and differentiative processes in normal development.

The monograph begins with a useful summary of methods of analysis of crest development and a consideration of the migratory ability of crest cells and its control. The remaining chapters on the crest derivatives each begin by characterizing the crest-derived structures and presenting a concise, well-balanced, and useful historical perspective of early work on the system. They continue with evenhanded and critical presentation of recent experimental results.

The author presents a perceptive description of the stages of crest dispersal, emphasizing the multiplicity of steps in the process. Her treatment of the role of the environment in controlling directional migration and localization includes a brief summary of the extracellular matrix components encountered by migrating crest cells and their interactions to form fibrillar elements in the interstitial spaces. Although not definitive, Le Douarin's summary has at least identified many of the important questions that remain about the structure of the environment and its role in affecting crest cell morphogenetic behavior.

The author's presentation of pigment cell differentiation and pigment pattern formation will introduce the reader to the extensive and complex literature on the genetics of pigment patterns. Her summary is necessarily too brief, however, to permit her to identify useful generalizations.

The most extensive and thorough treatments are reserved for the contributions of crest to the peripheral nervous system and to skeletal and connective tissue of the head and face. Since these are the subjects on which Le Douarin's

laboratory has made the most detailed contributions, the presentations are both authoritative and heuristic. Le Douarin's discussion of the limited crest contributions to the so-called APUD (amine precursor uptake and decarboxylation) series is definitive and should set straight prevailing misconceptions. The extremely thorough discussion of the development of ectomesenchymal derivatives will be an important resource for workers concerned with this subject. Likewise, Le Douarin's treatment of the development of autonomic neuronal derivatives in vivo and in vitro, including careful and insightful interpretations of her own data, will undoubtedly provide a valuable point of departure for further work on the subject. I was disappointed, however, that she largely ignores the crest-derived supportive cells of the peripheral nervous system and fails to mention the extensive literature on the responsiveness of peripheral nervous system neurons to nerve growth factor and other trophic factors. I would also have welcomed color plates with "textbook examples" of enzyme- or immuno-cytochemical stained crest derivatives instead of diagrams that have been adequately presented as line drawings in previous publications.

In summary, Le Douarin has described significant portions of the extensive crest literature, including the many important contributions of her laboratory, thoroughly and critically. In many, but not all, instances, she was probably wise to resist the temptation to examine other subjects of research on specific neural crest derivatives. Her monograph is, on balance, a worthy culmination of the many reviews that have recently been published on neural crest development. It will become the standard reference for cell and developmental biologists working on neural crest and related subjects. The book appears not when the facts about early neural crest development are settling comfortably into place, but rather when new experiments are providing exciting approaches to questions about possible heterogeneity in the migrating crest cell population, about alternative modes of crest cell dispersal, about the role of crest cells in pattern formation of the head and face, and about the possible role of neural crest derivatives in vertebrate evolution. It should therefore fulfill the author's declared goal of enticing new recruits into the field.

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