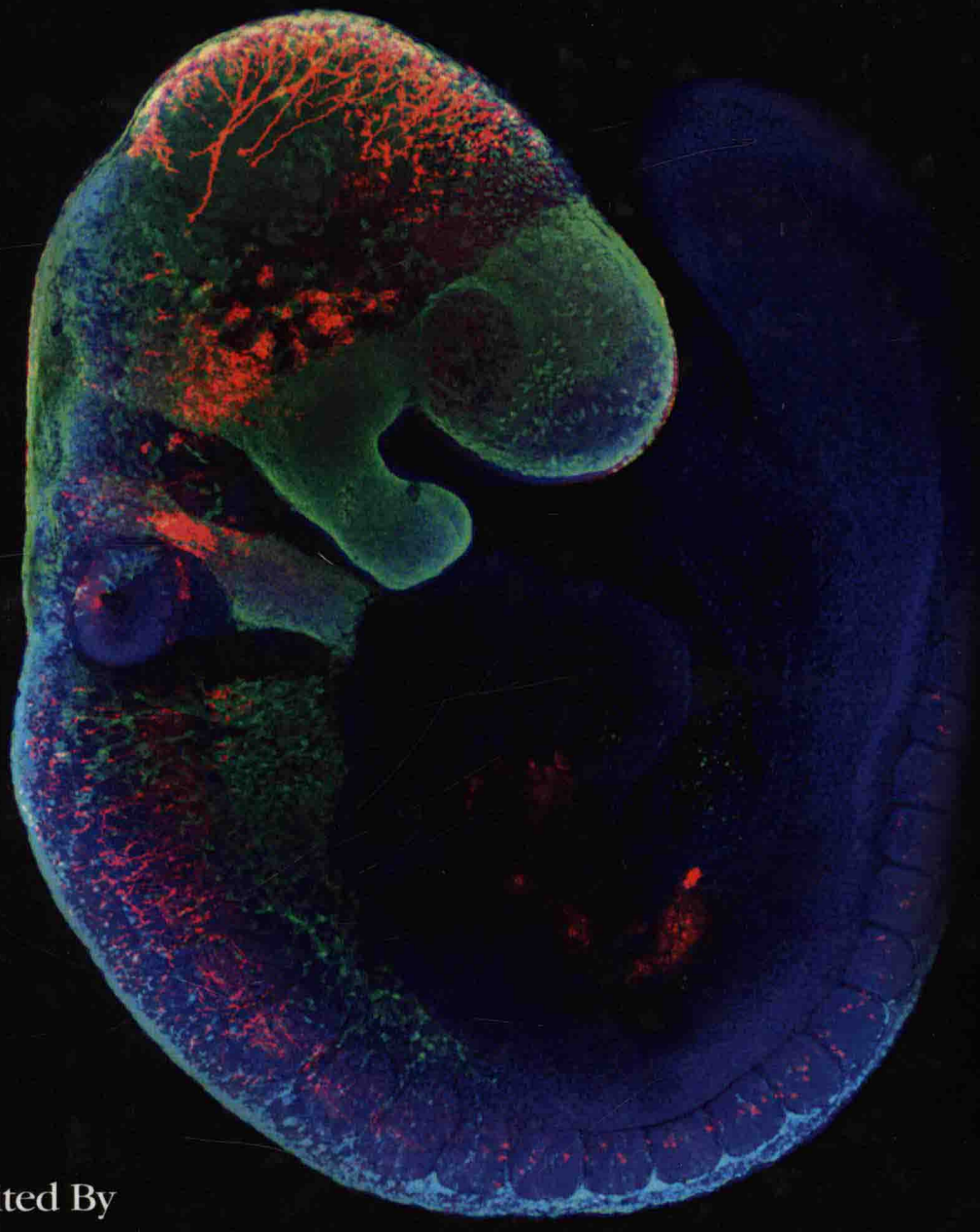
Neural Crest Cells

Evolution, Development and Disease



Edited By

Paul A. Trainor

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Cover Figure
The cover figure was kindly provided by Amanda Barlow and is of a late E9.5 DAPI nuclear stained (blue) mouse embryo illustrating the distribution of neural crest cells (green) and the commencement of their differentiation into neurons (red).

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NEURAL CREST CELLS

Preface

Neural crest cells comprise a migratory, stem and progenitor cell population and are synonymous with vertebrate evolution and development. Although thought to have been first identified by William His in 1868, the term neural crest is attributed to Arthur Milnes Marshall in recognition of the cells anatomical origins. Over the past 145 years, neural crest cells have held the fascination of developmental and evolutionary biologists alike by providing a unique paradigm with which to study various developmental processes such as morphogenetic induction, migratory behaviors, and fate determination.

During the first half of the twentieth century, the majority of neural crest cell research was undertaken in amphibian embryos as reviewed in Horstadius' well-known 1950 monograph. The 1960s saw the introduction of tritiated thymidine cell labeling techniques employed by Weston and Chibon to visualize the migration of neural crest cells throughout the developing amphibian and chick embryos. This was followed shortly thereafter in 1969 through Nicole Le Douarin's seminal introduction of the quail-chick marking system. While similar in principle to the earlier generation of amphibian chimeras by German embryologists such as Andres and Wagner, this now enabled embryologists to distinguish neural crest cells of one species from the surrounding tissue of another species. With this technique, generations of scientists reliably marked and studied the properties of neural crest cells, the principles of which were detailed in Nicole Le Douarin's 1982 book "The Neural Crest." These chimera approaches remain a fundamental staple of neural crest cell research today.

The year 1983 marked another seminal year in the neural crest cell field. Drew Noden illustrated the remarkable properties of cranial neural crest cells and Carl Gans and Glen Northcutt published their "New Head" hypothesis which posited the central importance of neural crest cells in the endless variation of vertebrate craniofacial features throughout evolution. In the late 1980s, new vital dyes cell labeling techniques pioneered by Marianne Bronner and Scott Fraser opened the door to visualizing neural crest cells in any species, but particularly fish and mice. This afforded the opportunity in combination with advances in imaging to follow the dynamics of neural crest cells in real time. Together with advances in molecular techniques, all of these techniques collectively facilitated the study of comparative neural crest cell development, fate, and evolution, highlighting the interplay between patterning and plasticity and spurring the quest to identify the evolutionary origins of neural crest cells. These principles and developments were captured in Brian Hall's 1999 "The Neural Crest in Evolution and Development" and Jean-Pierre Saint Jeannet's 2006 "Neural Crest Induction and Differentiation" books.

In the twenty-first century, much of our focus now revolves around the contributions of neural crest cells to congenital disorders and diseases which are collectively termed neurocristopathies. Understanding the true

genetic and cellular etiology and pathogenesis of individual neurocristopathies offers the potential for developing therapeutic avenues for their clinical prevention. Furthermore, continuing advances have uncovered and characterized the pluripotent stem cell-like characteristics of neural crest cells during embryogenesis and their persistence into adulthood. Thus, there is tremendous excitement in the potential for neural crest cells to be used in tissue engineering and regenerative medicine. This book "Neural Crest Cells: Evolution, Development and Disease" ambitiously tries to capture the classic principles and recent advances in our comprehension of the roles of neural crest cells in vertebrate evolution and development. Much of this has come from the application of new genetic, imaging and systems biology approaches exploring the gene regulatory control of neural crest cell formation, migration, and differentiation. This book also illustrates how this foundational knowledge influences our understanding of the central roles neural crest cells play in the pathogenesis of congenital disorders and diseases and the potential for neural crest cells to be used in tissue engineering and regenerative medicine to treat disorders and disease.

I am extremely grateful to all of the authors for sharing their time, knowledge, and expertise in contributing chapters to this book. I also want to thank all the past and present members of my laboratory as well as colleagues and friends in the neural crest cell field for continually making science and life stimulating and fun.

Acknowledgment

I am indebted to Patrick Tam and Robb Krumlauf for introducing me to neural crest cells and for their scientific training and continual support, mentorship, and friendship.

"Learn from yesterday, live for today, hope for tomorrow. The important thing is to not stop questioning."
Albert Einstein

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Contents

III

TISSUE ENGINEERING AND REPAIR

PART I

NEURAL CREST CELL EVOLUTION AND DEVELOPMENT