

Preface

The poet Vladimir Mayakowsky wrote that revolutions of content require revolutions of structure. And if any science has had a revolution in content, it is developmental biology. The structure of the Sixth Edition of *Developmental Biology* has changed significantly to account for several ongoing revolutions of content. It has also been rewritten to emphasize a core of developmental biology paradigms and principles. In the revision process, *Developmental Biology's* Sixth Edition actually became about 200 pages shorter than its predecessor. This was accomplished by putting much of the more advanced material, as well as nearly all the material now covered in introductory biology textbooks, onto the website that is integrated with the text.

The growth of developmental biology actually made it easier to organize chapters. Studies on phenomena that had been considered separate entities can be brought together into coherent stories. So this edition has rearranged its chapters to best introduce new biology students to the remarkable embryos and the ways we study them.

- There is now an entirely new introductory section of the textbook. The first six chapters, *Principles of Developmental Biology*, provide the basic conceptual background of the anatomical, experimental, genetic, cellular, evolutionary, and ecological approaches to developmental biology. The chapters build on one another, such that material presented in Chapter 1 is revisited throughout the other five chapters, but with different emphases.
- The Sixth Edition integrates the discussion of the early development of several organisms into concise units that detail cleavage, gastrulation, and axis formation simultaneously. This integration has only been made possible in recent years.
- A new chapter on a new topic, *Mechanisms of Plant Development*, was written for the Sixth Edition by Dr. Susan Singer. This chapter concisely and elegantly intro-

duces the basic concepts and exciting new findings of plant developmental biology, and it introduces the student to *Arabidopsis* as a model organism for studying plant developmental genetics.

- Another new chapter, *Metamorphosis, Regeneration, and Aging*, highlights the new importance of these areas of developmental biology.

This reorganization was made possible and necessary by numerous revolutions in the science: Developmental biology is becoming a central organizing discipline in biology, relating cell and molecular biology, anatomy, ecology, evolution, and medicine to each other. It is an exceptionally interesting and busy time to be a developmental biologist, and you should be able to find questions that will excite, challenge, and be worthy of your intellectual talents. These revolutions include:

- *Molecular embryology.* New knowledge about how the inherited genes are expressed differently in different populations of cells is changing our views as to how organs are made. Conclusions that had been stable since the 1920s are now being revised, if not completely overthrown, by studies that use more refined techniques.
- *Biotechnology.* The combining of developmental biology with biotechnology is promising to regenerate spinal neurons and bones for the first time in human history. The altering of our development by embryonic stem cells, cloning, and even the enhancement of our genetic endowment is now theoretically possible.
- *Ecological developmental biology.* As human activity alters the environment, the possible effects of global warming, pesticides, and other chemicals have incited a new interest in the environmental regulation and disruption of development. Developmental biologists may soon find themselves at the forefront of conservation biology and ecological issues.

- **Clinical genetics.** During the past five years, there has been an integration of human embryology and medical genetics to create a new medical developmental biology that seeks to understand and treat the molecular bases of birth defects.
- **Evolutionary developmental biology.** The emergence of new phenotypes is made possible by changes in development. The regulatory genes that have long been thought to control the generation of novel structures are now being discovered.
- **Bioethics.** As a result of our new scientific abilities, there has been the emergence of an entire field of bioethics. The cloning of Dolly has brought both controversy and capital into developmental biology. Developmental biologists are suddenly being asked to discuss ethical and legal issues that they never before had to address.

The Sixth Edition of *Developmental Biology* covers all these issues, many of which are new to developmental biologists (and which certainly were not a part of our own training as professors). At the same time, this volume attempts to provide the fundamental set of techniques, paradigms, and models necessary for a student to understand the core of developmental biology—differentiation and morphogenesis.

In addition to the structural changes mentioned above, there have been many pedagogical changes in the textbook.

- The book has new and elegant **color illustrations**. Gastrulation aficionado Ray Keller (in his review of one of the chapters) told me, “Students should NOT read this material quickly, but too typical a scene is some poor bastard hunkered over this text at 2:30 A.M. with a cup of coffee, frantically scanning the figures to see if he or she can figure out what is happening.” If such a scene really does occur, the wonderful illustrations of the J/B Woolsey studio should make that student’s life much easier.
- This book is also graced with an outstanding collection of **color photographs**. I wish to thank all the scientists who contributed their micrographs and other photographic material to this volume. I especially wish to thank M. Danilchik, G. Müller, S. Paddock, S. Carroll, and G. Schatten for allowing us to use so many of their spectacular images.
- In this edition, each chapter ends with a **Snapshot Summary**. These summaries are to be used to see the forest as well as the trees. While they should be useful in reviewing the chapter, please do not confuse these summaries with the actual science—which consists of evidence and process.
- As mentioned above, the text is linked to a new **website** (www.devbio.com). Our website started as a student-op-

erated site in 1994 and has become so successful that our server could not handle the load. We are on a new server and have greatly expanded our sites. Please see the endpapers for a directory of material on the website that indicates how it is keyed to the book’s chapters.

- This edition also sees the debut of **Vade Mecum**, a CD-ROM created specifically for studying developmental biology. Mary Tyler and Ron Kozlowski have created a unique and remarkable resource for anyone teaching or studying animal development. Time-lapse videomicroscopy has always played a key role in developmental biology education, but these movies and videos depended on television or movie projectors and were therefore confined to classroom or laboratory times. *Vade Mecum* (from the Latin for “come with me”) will enable you to see these videos whenever you want. Developmental biology is about change, and print cannot do the field justice. We are thrilled to include the *Vade Mecum* CD-ROM inside the front cover of this book. The directory on the endpapers shows the references to *Vade Mecum* within the text.

I hope this textbook will provide two gateways—one portal to the actual organisms, and the other to the research that studies them. It is my hope that the textbook will enable each person to appreciate both the development of the organism and the research papers in developmental biology. Developmental biologists find themselves within traditions of inquiry that extend back to the beginnings of human inquisitiveness. We are discovering the mechanisms by which male and female are distinguished, by which left and right are separated, by which caterpillars become butterflies, and by which organs are formed. We are beginning to have answers to questions that have perplexed human thought for as long as we have been human.

But these answers are not “facts,” but conclusions based on the evidence available. Indeed, this book is not about “Facts.” It is about evidence, interpretations, and attitude. In developmental biology, we have become used to many of our most cherished “facts” being overturned by new evidence. But obtaining such evidence is not at all easy. To say that something is true, one must prove that everything else is false, and this is determined by the techniques available at any time. Thus, primary embryonic induction, the mainstay of developmental biology since the 1920s, has recently been shown by molecular techniques to be neither primary nor an induction. The new studies do not invalidate the experiments and observations of our predecessors. Rather, they show how complex the subject is, and they have revitalized these areas of research. If any discipline should embrace change, it is developmental biology. As you read this book, probably the best advice to keep in mind is the instruction of Alfred North Whitehead, who wrote that every scientist should “Seek simplicity and distrust it.”

Acknowledgments

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This book has shown that the management skills of Andy Sinauer, editor Carol Wigg, production coordinator Chris Small, and art director John Woolsey were greater than they ever thought possible. Their efforts have been heroic. With this edition we entered the brave new world of electronic photograph transmission, and David McIntyre and Mariah Peelle coped admirably with hundreds of images transmitted via the Internet. Jeff Johnson did a fine job with the striking cover image. Janice Holabird and Joan Gemme produced stunning chapter layouts and then worked unstintingly to incorporate many last-minute changes to the art and text. It is in part a testament to their flexibility and patience that this textbook could be updated right up until the day it went to press, in March of 2000. Very few publishers allow their authors the freedom to revise at this level, and I hope readers benefit from the work that went into the final polishing.

In particular, this book could not have been started or completed without the enthusiastic support of my wife, Anne Raunio, and the patience of our friends. My deep thanks to you all.

SCOTT GILBERT
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