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Front cover artwork: Whole *Drosophila* ovary triple stained with DAPI (blue) to reveal all nuclei, anti-Vasa (pink) antibodies to reveal early germ cells, and phalloïdin to reveal actin filaments (green). Image courtesy of Florence Besse, Institute of Developmental Biology and Cancer, Nice, France.

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Preface

The famous quotation by Charles Darwin, "It is not the strongest of the species that survives, nor the most intelligent, but the one most responsive to change," beautifully illustrates the unique role of germ cells in the maintenance and evolution of the species. To be inherited, the changes to which Darwin refers need to occur in germ cells. For this, and many other reasons nicely developed in this book, germ cells have long fascinated a large number of researchers over many decades. Restricted for many years within the boundaries of descriptive science, the field of germ cell research has dramatically benefited from the development of molecular biology techniques, of genome-wide array approaches, and of cell- and tissue-specific gene ablation by homologous recombination, as well as from the increasing number of species in which experiments can be done. The past two decades have witnessed the accumulation of a spectacular amount of knowledge, including several discoveries that have fundamentally altered the manner in which we look at how germ cells develop and function.

The idea for this book originated from a desire to incorporate in a single volume not only the remarkable advances that have been made in the field but also the emerging concepts and hypotheses that currently drive thinking and experimentation in this field. In most cases, the authors have aimed to describe both facts and concepts arising from studies across multiple species. This approach reveals common themes, as well as intriguing examples of diversity. We, the editors, have worked with the authors to ensure that overarching ideas are linked among the chapters.

Germ cell development is unique in the way it generates the haploid cells responsible for perpetuating the species. The resulting germ cells are virtually totipotent; they will generate all possible cell types and tissues after fertilization. How is such a complex and elaborate differentiation program achieved? In what way is it unique with respect to the numerous programs of somatic cell differentiation? These questions have recently acquired even broader interest because of the excitement generated by stem cell biology and the therapies it promises. The intrinsic potential of germ cells to generate a whole new organism relies on very specific and fascinating molecular and cellular pathways operating during their development. Of course, the process of meiosis is one outstanding feature of germ cells that involves a series of highly specialized biochemical and metabolic processes. In addition, germ cell development requires choices between alternative pathways of gene expression, each generating a drastically different outcome. As an example, during mammalian spermatogenesis, spermatogonial stem cells face the choice of self-renewal or differentiation. Whichever pathway they choose, the task is formidable. On one hand, self-renewal is one of the most impressive examples of highly controlled and efficient cell proliferation, one that continues until old age in human males. On the other hand, cells unique in their structure are generated through the differentiation pathway requiring drastic biochemical reorganization and meiotic division. When things go wrong, the outcome can be dramatic, possibly leading to infertility on one hand or cancer on the other.

Two fundamental characteristics underlie the fascination of current germ cell research. First, germ cells must carry out all the basic functions of cells, ranging from transcription to division, but under the control of the germline developmental program, they do so in unusual and exceptionally interesting ways. Second, although the appearance of the exquisitely specialized cells that are gametes differs profoundly among species, in part to allow exploitation of different niches, strikingly

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unifying themes arise from the comparison of germ cell development across species. We strove to highlight both of these fundamental features in the organization of this book.

We hope this book will not only serve the aficionados in the field but also be accessible to students and researchers from other fields who wish to discover the fascinating world of germ cells. Indeed, part of our ambition is to motivate new generations of investigators to enter the field. The authors have contributed magnificently toward these goals, and we thank them for their participation.

Finally, we wish to thank the outstanding staff at the Cold Spring Harbor Laboratory Press and their compositors, particularly Hannah Turner at Techset, for their efforts in making this book a reality. Our deep appreciation goes to Project Manager, Barbara Acosta, for her sense of organization, limitless patience, and constant kindness. We also thank Acquisitions Editor, Alex Gann, whose vision and intelligence initiated the process that lead to this work.

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