Preface

One of the striking findings of modern developmental biology has been the high degree of conservation of signaling and developmental mechanisms among different animal species. Such conservation allows information learned from a given organism to be applicable to other species, including humans, and has validated the use of a few model systems to deduce general biological principles. In spite of this underlying conservation, however, each species has unique characteristics arising from its evolutionary history. The picture emerging from the ongoing research on a limited number of model organisms is thus a patchwork of knowledge that reflects those unique systems. The important contribution of other less-studied, emerging model systems will be invaluable to fill these gaps. The modern developmental biologist strives to fill this currently fragmented picture in search of a more refined, fuller view, which better reflects both the underlying biological principles and the genetic continuum between species.

While studying the same process in various types of organisms may highlight common developmental mechanisms, individual features of species differ, each providing advantages for analyzing various aspects of a given process. With regard to laboratory research, some approaches may be more feasible in some species than in others; for example, the ease of embryological manipulations in amphibians and chicken set them apart as premier embryological models in the last century. Differences in underlying developmental genetic circuitries may also give differential access to analyzing a given process, such as when different types of mutant phenotypes affecting the same organ are found in different organisms. In addition, some laboratory systems may be more closely related to the species in which specific knowledge is needed, for example, mammalian species for medical applications or fish species for aquaculture. Studies in other systems may also be desired to better understand the process in an evolutionary context. Thus, for a number of reasons an optimal overarching research strategy may require the analysis of multiple species.

It is in this dual context, to better define the landscape in which development operates in nature and to maximize the output of biological research, that modern biological research is increasingly crossing model system boundaries. In addition, studies involving multiple species are the focus of new research areas, such as the use of hybrids to understand mechanisms of speciation or the use of interspecies nuclear/oocyte transfer in bioregenerative medicine and conservation genetics. This volume attempts to address the increasingly important need of straddling species boundaries in the context of a single research program by compiling research protocols used in a wide range of vertebrate species. These protocols include not only embryological methods but also cellular and genetic approaches that have complemented and expanded our understanding of embryonic development. Undoubtedly, assembling in full detail the entire set of methods available for a laboratory model system in a single or a couple of chapters is beyond feasibility. This volume does not pretend to turn a blind eye to this reality, but rather strives to provide a platform to facilitate the exchange of ideas and protocols between scientists studying different vertebrate species. In fact, this volume has been designed so that readers can readily find information on species *other* than the one with which they may be most familiar.

Keeping in mind this purpose, contributors have attempted to emphasize the advantages and challenges of research in each particular organism, as well as unique features of the system. It is our hope that this will allow comparisons between protocols and facilitate transposing experimental strategies from one research organism to another, as well as help readers make informed decisions on the feasibility of using an alternative model system to analyze a specific biological question. In addition, we hope that this volume will also be useful as a compilation of methods for educators leading advanced laboratory courses.

While a number of chapters are dedicated to the most popular model systems, this volume also incorporates other emerging systems spanning the vertebrate subphylum. Underlining that not even a group as diverse as vertebrates can be considered in isolation and that comparative studies in more ancestral forms may be key to the understanding of the basis of vertebrate development, we also include protocols in closely related invertebrate chordates such as ascidians and amphioxus. In addition, a number of chapters highlight a specific method that is in principle applicable to multiple species, such as TILLING and ZFN-mediated mutagenesis, the generation of embryonic stem (ES) cell lines, and nuclear/oocyte transfer. Opening this volume, an account of the use of various species in the field of developmental biology places the rest of the chapters in a historical context. Another chapter highlights important insights from an investigator with a multi-species research program. Reflecting that animal research is a privilege that needs to minimize discomfort to the organism experimented upon, the volume closes with a chapter on animal care guidelines applicable to vertebrates.

We hope this compilation of protocols will be of use to the molecular, cell, and developmental biology community to accelerate the pace of its research. While reading and editing these chapters, I have already found a number of ways in which approaches in other model systems could help resolve hurdles present in my own laboratory. We hope the reader will similarly benefit from this compilation. May this volume contribute to the ongoing collective effort toward a better understanding of the beauty and logic of vertebrate development.

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