Preface

Cardiovascular physiology has always been a central theme in both medicine and biological sciences. While it has long been established that the fundamental mechanisms of cardiovascular function apply to all animals, it is also becoming clear that most animals, i.e., both invertebrates and vertebrates, share the same genetic programming for the development of the heart and major blood vessels. For example, the homeobox gene tinman required in *Drosophila* for the specification of the heart is homologous to a number of *Nkx* genes that are essential for cardiac development in vertebrates. It is also well established that many of the cardiac features of adult fish, amphibians, and reptiles resemble stages in the ontogenetic development of the mammalian heart as well as some common cardiac malformations in humans. As an example, the ventricular septum defects that occur during congenital heart diseases in mammals resemble incomplete ventricular septum in some amphibians and reptiles. Also, the spongious heart of embryonic birds and mammals resembles the adult heart of ectothermic vertebrates.

As the homology of the molecular mechanisms driving cardiac development in different vertebrates and invertebrates has been unraveled, many laboratories, primarily interested in the molecular mechanisms underlying cardiac malformations in humans, are now conducting much of their research on ectothermic vertebrates such as *Xenopus* and zebrafish as well as invertebrates such as *Drosophila*. This is primarily because these animals are much easier to maintain and manipulate than mammals, and hence, does not necessarily reflect an interest per se in the cardiovascular physiology and development of these animals. In parallel to more clinically oriented research on cardiac development, comparative physiologists have studied cardiac function in all vertebrate groups for more than a century and the interest in the ontogenetic development of the cardiovascular function in non-mammalian vertebrates has been a major topic over the past decades. Much of this research has been driven by a desire to understand how the cardiovascular system of these animals functions and how this function can be understood in terms of the evolution of vertebrates and their adaptations to different environments or behaviors.

Hence, as outlined above, two separate research fields—the comparative physiology and the clinically oriented embryology—have studied similar functions in parallel.

Surprisingly, little exchange of information has occurred over the past two decades. The primary objective of this volume is to compile contributions from members of both fields to an in-depth, timely, and comprehensive collection of reviews dealing with the major topics of the ontogeny and phylogeny of cardiac function. The exchange of ideas should be of benefit for both fields, as some techniques originally established in the clinical arena (e.g., the echocardiography or magnetic resonance) recently have become applicable to embryos as well as small adult vertebrates, such as zebrafish. On the other hand, physiological measurements performed in the experimental models have helped to explain some special features to human development such as resistance to ischemia due to its adaptation to physiologically low oxygen tension in the fetal tissues ("Mount Everest in utero") that are not easily measurable in the clinical settings.

Despite the existence of at least two recent excellent textbooks on cardiac development (and regeneration) by Margaret Kirby (Cardiac Development, Oxford University Press, 2007) and Rosenthal and Harvey (Heart Development and Regeneration Vols. 1 and 2, Elsevier, 2010), there is no recent book that integrates the ontogenetic and phylogenetic changes in form and function. Therefore, it is our hope that this collection of reviews will be of considerable interest to biologists and MDs working on any aspect of cardiovascular function. Being state-of-the-art reviews written by competent experts in the field, the content is also of interest for MSc and PhD students in most fields of cardiovascular physiology.

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http://www.springer.com/978-1-4614-3386-6

Ontogeny and Phylogeny of the Vertebrate Heart
Sedmera, D.; Wang, T. (Eds.)
2012, X, 234 p., Hardcover
ISBN: 978-1-4614-3386-6