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Preface

Our understanding of skeletal biology has taken tremendous strides during the past few years. On the one hand, the spectacular recent breakthroughs in developmental biology have led to an understanding of the global rules shaping and positioning the cartilage and bone primordia in the vertebrate embryo. On the other hand, the discovery of key master regulators of the chondrocyte and bone lineage, such as Sox9 and Runx2, as well as the signaling pathways involved in the regulation of the differentiation of these lineages, has provided a much better understanding of these processes. This knowledge led to the elucidation of the molecular etiology of a majority of bone and cartilage genetic diseases.

The goal of this book is to provide a comprehensive and up-to-date summary of the field of skeletal biology. This is a large field and due to space limitations, some areas might be covered more extensively than others. However, an attempt was made to cover all stages of skeletal development and patterning, as well as differentiation of cartilage and bone cells. The complex area of bone physiology is discussed in some of the chapters, but is not addressed extensively. This book covers essentially three major themes.

The first theme relates to the development and patterning of bone in vertebrates. Several chapters deal with classical model systems that have been used to study bone and cartilage patterning in the vertebrate embryo. Specifically, the limb bud and the rules governing the formation of bone primordia are addressed, as well as the development of long bones, which provides a classical model to study the endochondral mode of bone formation. A chapter is devoted to cranial skeleton development, which is derived largely from the neural crest and is formed mostly by membrane bones. In addition, the process of segmental patterning and differentiation of the spine is discussed, which involves very different regulatory mechanisms. Also, the evolutionary origin of bone, which appeared early in the vertebrate lineage, constitutes the topic of an independent chapter.

The second theme explores the molecular mechanisms underlying the specification and differentiation of the cartilage and bone lineages. Four chapters address the major aspects of the control of differentiation of these lineages by transcription factors and signaling molecules. This area has recently exploded with the discovery of master regulators that are required for the differentiation of all cartilage and bone cells. The spatio-temporal deployment of these transcriptional regulators is exquisitely controlled by a handful of signaling pathways whose role is discussed extensively in two chapters. This theme also covers the genetic diseases resulting from mutations affecting bone and cartilage differentiation. A number of classical bone diseases, which have recently been associated with defects in the regulatory systems, are discussed as well.

The third and last theme covers major aspects of bone and cartilage terminal differentiation and remodeling. Bone and cartilage are supporting tissues that provide the rigid frame on which our body is built. The characteristic physical properties of these tissues result from the production of highly specialized extracellular matrix, which can become mineralized. Several chapters survey our current understanding of these different processes.

While this book is expected to meet the expectations of specialists, it is intended also to provide a survey of the field to newcomers. We hope that this book will take its place as a useful tool for those working in the ever-growing field of skeletal biology.

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