

Preface

Stem cells appear to be fundamental cellular units associated with the origin of multicellular organisms and have evolved to function in safeguarding the cellular homeostasis in organ tissues. The characteristics of stem cells that distinguish them from other cells have been the fascinating subjects of stem cell research. The important properties of stem cells, such as *maintenance of quiescence*, *self-renewal capacity*, and *differentiation potential*, have propelled this exciting field and presently form a common theme of research in developmental biology and medicine. The derivation of pluripotent embryonic stem cells, the prospective identification of multipotent adult stem cells, and, more recently, the induced pluripotent stem cells (popularly called iPS) are important milestones in the arena of stem cell biology. Complex networks of transcription factors, different signaling molecules, and the interaction of genetic and epigenetic events constantly modulate stem cell behavior to evoke programming and reprogramming processes in normal tissue homeostasis during development. In any given cellular scenario, the regulatory networks can pose considerable complexity and yet exert an orderly control of stem cell differentiation during normal development. An aberration in these finely tuned processes during development usually results in a spectrum of diseases such as cancers and neurological disorders. This underscores the imminent need for a more complete understanding of molecular mechanisms underlying the regulatory circuitries required for stem cell maintenance.

Over the past 3–5 years, a diverse group of bench and physician scientists have prospectively enhanced our knowledge of stem cell biology. These studies are unveiling many unrecognized or previously unknown fundamentals of developmental biology. Furthermore, they are also opening up new horizons in clinical medicine. Some of the basic questions that are being currently pursued include: *How are the cellular context-dependent and cell type-specific gene expression patterns controlled by the cross-talk between intracellular signaling pathways and extracellular signals? What are the genetic and epigenetic controls associated with stem cells, and how do they operate during their developmental transitions and in the maintenance of the resulting phenotype? What are the functional roles of the recently emerging new layers of control in gene expression at the post-transcriptional/translational/post-translational levels in stem cells? Most importantly, can stem cells be engineered with fidelity for a particular application, and would the application have to be patient specific?* Attempts to meaningfully address many of these questions face challenges from biological complexities such as the potential of multiple stem cell types in a given cellular context. Understanding these stem-cell-specific regulatory networks is therefore the key to successfully harvesting the fruits of stem cell research.

Regulatory Networks in Stem Cells is an initial attempt to decipher the key factors involved in stem cell pluripotency, maintenance, and directed differentiation toward specific cell lineages and stem cell types. The presentation of the contents is such that upper-grade undergraduates, graduate students, postgraduates, and basic research as well as clinical research scientists are provided with accessible information about recent advances in the stem cell field. This book also covers the necessary basic concepts of developmental biology in order to facilitate the reader's understanding and also to anticipate potential applications in this fast-growing field.

We and the authors have worked together to ensure that the chapters address current topics for advanced, inquisitive researchers as well. For the convenience of readers, chapters are grouped into the following sections: (A) Molecular Regulation in Stem Cells, (B) Regulation by Stem Cell Niches, (C) Epigenetic Mechanisms in Stem Cells, (D) Signaling and Regulation in Select Stem Cell Types, and (E) Disease Paradigms and Stem Cell Therapeutics. Stem cell regulatory networks are only just beginning to emerge in the field that is regularly inundated with a myriad of novel developments.

We hope that this edition enables readers to gain crucial insights into the field of stem cell research and provides a framework for planning stem cell research with the goal of improving human health.

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