

Preface

Life-long maintenance of multicellular organisms in the face of tissue and cell loss through injury, infection, and normal processes is a biological challenge. Organisms in both the plant and animal kingdoms have largely dealt with this challenge by acquiring cells that are able to persist throughout life, while at the same time acting as the reservoir feeding pathways of cell expansion, differentiation, and maturation necessary for tissue homeostasis and repair. These cells, which we refer to as stem cells, have been the subject of research over more than two centuries, although not always knowingly focused on their special characteristics, and have become the subject of an ever-growing field of investigation and application.

The field of stem cell science is vast, both in terms of the number of people involved in research and the number of disciplines that it encompasses, from molecular and cell biology to tissue engineering, animal husbandry, and politics and ethics. The level of interest in stem cells, especially over the last two decades, and the multidisciplinary nature of the subject have led to the publication of a multitude of books. Most of these books are quite focused and often delve very deeply into detail. Surprisingly, there have been few texts aimed at undergraduate and postgraduate courses that introduce stem cells, and even fewer that have tried to cover the breadth of stem cell science, incorporating plants and animals, invertebrates and vertebrates, fundamental biology and methodology, applications, and social science considerations. This is the task we set ourselves—to create a one-stop shop to enable the student to gain a holistic understanding of stem cells. Our aim is to excite students with the wonders of stem cells and the crucial part that they play in multicellular biology. We have also strived to give a sense of the research that has led to the understanding we have, addressing such questions as: how is stem cell biology explored, what sorts of people have been the thought leaders and what motivated them, what mistakes have been made along the way, and what is controversial?

The book is made up of 20 chapters, which are extensively cross-referenced but can be read in isolation or serve as a backdrop for a lecture. We have divided the chapters into five broad sections, the first two of which form a solid foundation of basic principles of stem cell biology and the methodology used to investigate them. The behavior of stem cells illustrates well how multiple molecular processes come together to dictate very specific cell characteristics, including the ability of the cells to communicate with and respond to their environment and changing circumstances. The biology of stem cells and the way that they have evolved to perform a myriad of roles in different species and different tissues is in itself a fascinating subject, and in the third section, "Stem Cells across the Animal and Plant Kingdoms," we look at the ways in which stem cell characteristics have evolved and become part of multicellular life. This section also challenges the boundaries of what are and are not stem cells. The fourth section, "Stem Cells in Specialized Adult Animal Tissues," represents an extensive survey and comparison of the involvement of stem cells in animals, largely deriving from studies on mammals but incorporating other model organisms, including invertebrates. An even greater driving force toward understanding the biology of stem cells has come about because of their potential applications, including improved therapies for many diseases, but also affecting economically important plants and animals. Therefore, in the final section, we give a perspective on the biomedical and economic applications and societal implications of stem cell science.

As mentioned, each chapter can be taken in isolation, and all adopt the same structure, involving an introduction followed by a series of major topics, which are extensively illustrated and accompanied by a number of "boxes" that provide additional material. This material includes "Background" describing concepts and underpinning information; "Case Studies" to elaborate through specific examples; "Pioneers," by which we mean some of the people who have had a major impact on progress in the respective area; and "Controversies," which speaks for itself. At the end of each chapter are a list of "Key points," which could also be called the learning outcomes, and "Further reading," which is not meant to be comprehensive or too detailed on any one topic but instead serves as an entry into wider reflection on the subject and illustration of some of the major discoveries in the field.

Although our principal goal is to provide a comprehensive introduction to stem cell biology to those new to the discipline, we also hope that our book can be an opportunity to a wider audience who have already engaged in some aspects of the field but who may benefit by taking a broader view. All too often in academic pursuit, the trend is to focus and specialize in a way that, although necessary to achieve a sufficient level of scholarship and discovery, can limit thinking outside the box. We are sure that we are not alone in having encountered, when giving a general stem cell lecture, somewhat surprised comments about the evolution of stem cell properties or the very fact that plants have stem cells! We hope there is something in our book for all, both newcomers and those who can already claim to be stem cell biologists.