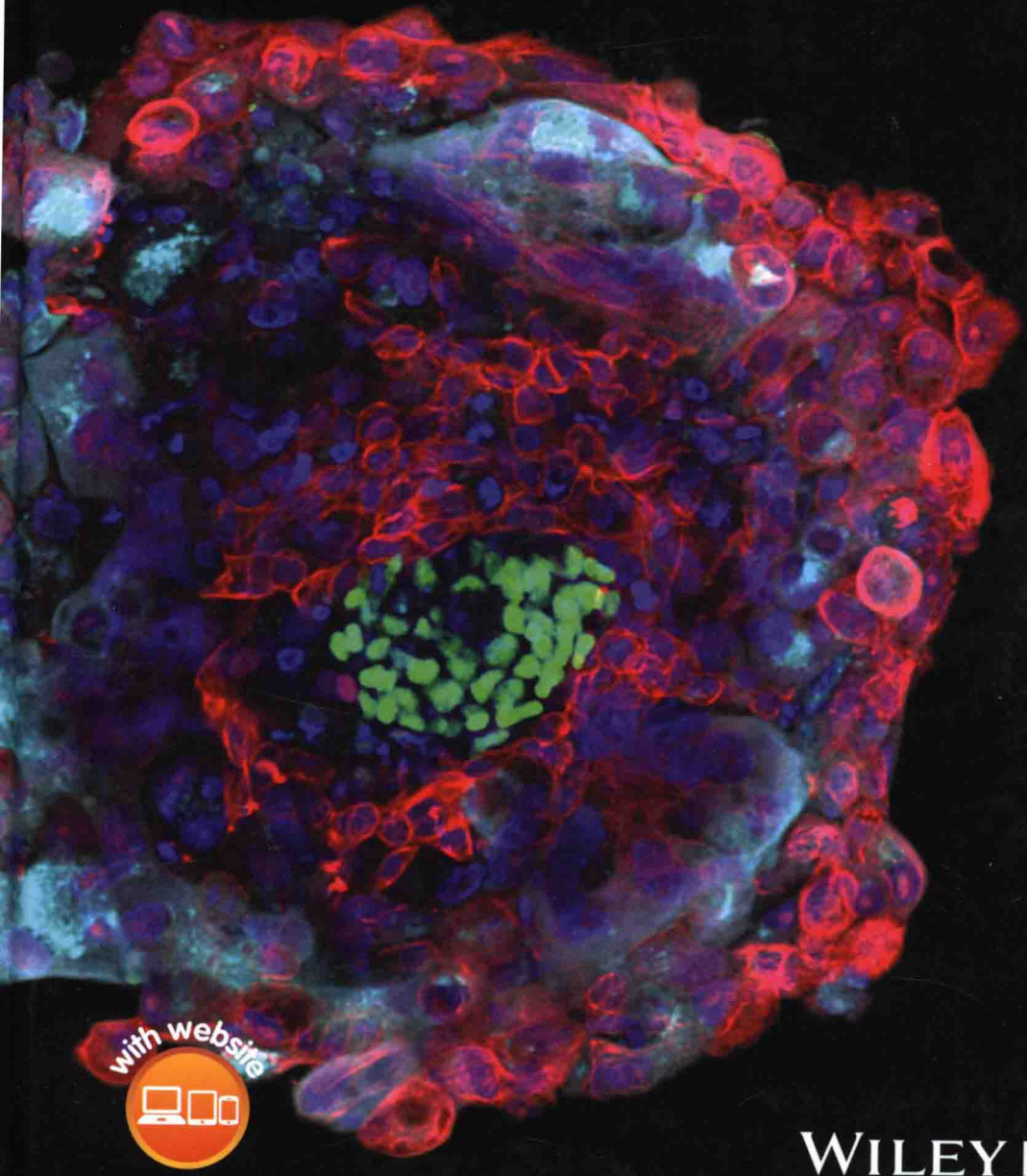
THE SCIENCE OF STEM CELLS

JONATHAN M. W. SLACK



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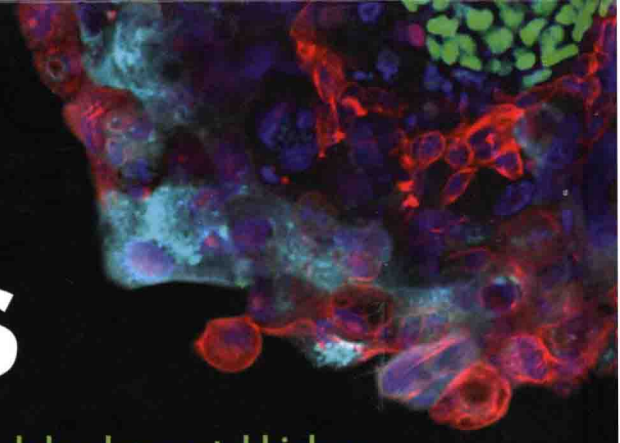

THE SCIENCE OF STEM CELLS

Introduces all of the essential cell biology and developmental biology background for the study of stem cells

This book gives you all the important information you need to become a stem cell scientist. It covers the characterization of cells, genetic techniques for modifying cells and organisms, tissue culture technology, transplantation immunology, properties of pluripotent and tissue specific stem cells and, in particular, the relevant aspects of mammalian developmental biology. It dispels many misconceptions about stem cells—especially that they can be miracle cells that can cure all ills. The book puts emphasis on stem cell behavior in its biological context and on how to study it. Throughout, the approach is simple, direct, and logical, and evidence is given to support conclusions.

Stem cell biology has huge potential for advancing therapies for many distressing and recalcitrant diseases, and its potential will be realized most quickly when as many people as possible have a good grounding in the science of stem cells.

- Content focused on the basic science underpinning stem cell biology
- Covers techniques of studying cell properties and cell lineage in vivo and in vitro
- Explains the basics of embryonic development and cell differentiation, as well as the essential cell biology processes of signaling, gene expression, and cell division
- Includes instructor resources such as further reading and figures for downloading
- Offers an online supplement summarizing current clinical applications of stem cells

Written by a prominent leader in the field, *The Science of Stem Cells* is an ideal course book for advanced undergraduates or graduate students studying stem cell biology, regenerative medicine, tissue engineering, and other topics of science and biology.

JONATHAN M. W. SLACK is a developmental biologist and author of five books and over 200 scientific papers. He is an emeritus professor at the University of Bath, UK, as well as the University of Minnesota, USA, where he was Director of the Stem Cell Institute from 2007–2013.

A companion website with additional resources is available at:
www.wiley.com/go/slack/thescienceofstemcells

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About the cover: Optical section through a day 12 human embryo which has developed in vitro. The epiblast (OCT4: green) has formed an amnion-like cavity. The trophectoderm has become cytotrophoblast (KERATIN 17: lilac) and multinucleated syncytiotrophoblast (hCG beta, acqua). DNA is stained red, showing cell nuclei. Image kindly supplied by Dr Ali H Brivanlou, Rockefeller University.

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The Science of Stem Cells

Preface

This book originates from a widespread perception that many students studying stem cell biology, and even many junior workers in stem cell research labs, lack essential knowledge of the scientific underpinnings of the subject. This can lead to undesirable consequences, most notably the tendency for clinics to offer to patients "miracle cells" whose injection can cure all ills rather in the manner of a medieval elixir. Such unrealistic attitudes are also, unfortunately, highly prevalent among the general public. Excellent educational work is done by bodies such as the International Society for Stem Cell Research, which has an accurate patient website open to all. However, a correct perception among the public about the capabilities of stem cell therapy cannot be expected until the practitioners themselves have a clear idea of what sort of cells they are working with and what these cells can, and cannot, be expected to do. This book seeks to improve the situation by exploring the scientific basis of stem cell biology in a concise and accessible manner. It is designed to be suitable for all students studying stem cell biology at undergraduate or graduate school level.

The book deals with basic science and so does not cover the current clinical applications of stem cells. I considered that to include clinical material would make the book too long, lose focus, and cause it rapidly to become out of date. However, because of the inevitable demand for such information the book has an online supplement which summarizes briefly the state of play in each clinical application of stem cells to date, and this may be found at www.wiley.com/go/slack/thescienceofstemcells.

The "parent science" of stem cell biology is, to a large extent, developmental biology. Embryonic stem cells were discovered by developmental biologists, and the methods used for controlling their differentiation rely heavily on our knowledge of the normal mechanisms of regional specification and cell differentiation in the embryo. So developmental biology is necessarily an important part of this book. However, this is by no means just another textbook of developmental biology: it is primarily a book about stem cells and the concepts, technology, and experimental facts needed to understand them properly.

Because the focus is on the discussion of approaches and concepts the level of molecular detail has been kept fairly basic. Modern molecular life sciences are all very fact-heavy and comprehension can be obscured by too many facts. However, where readers require more detail on specific topics than is given here, it can always be acquired by reading recent review articles or key primary papers, a selection of which are cited at the end of each chapter. Although I have been sparing with molecular detail, I have listed where possible the major gene products that are indicative of the particular cell types which are of interest to stem cell biologists, and also some of the key physiological properties of these cell types. Familiarity with these criteria for cell identification is very important when assessing the results of experiments

involving the directed differentiation of pluripotent stem cells or the direct reprogramming of one cell type to another.

A further type of detail that is worth paying careful attention to is the difference between species. Most of the experimental work in this area has been done on the mouse, but stem cell biology is inevitably oriented toward developing eventual applications for human patients. I have been careful where possible to distinguish normal events in human and mouse, and also occasional results from other model organisms such as the zebrafish, so that students are not misled by an exclusive focus on the mouse. In keeping with normal convention the names of genes are italicized when they refer specifically to the gene or the RNA, and are in normal type when they refer to the protein.

The central message of the book is that there is nothing magic about stem cells. In fact, it turns out that stem cell behavior is more important than the stem cells themselves. Certain cell populations in the body may adopt a stem cell type of behavior under particular circumstances, depending on their developmental history and their environment. So being able to work with stem cells successfully means being aware of how cells behave in different contexts and understanding how to characterize and manipulate them properly.

In the long term, stem cell biology does have huge potential for generating novel therapies for many common and recalcitrant diseases, and this potential will be realized most easily when all students and practitioners can become real masters of the science of stem cells.

Jonathan M. W. Slack
Bath 2017

About the Companion Website

This book is accompanied by a companion website:

www.wiley.com/go/slack/thescienceofstemcells

which summarizes the current clinical applications of stem cells.

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