

Advances in Experimental Medicine and Biology

Volume 1041

Series Editors

IRUN R. COHEN, *Weizmann Institute Science, Rehovot, Israel*

ABEL LAJTHA, *N.S. Kline Institute for Psychiatric Research,
Orangeburg, New York, USA*

JOHN D. LAMBRIS, *University of Pennsylvania,
Philadelphia, Pennsylvania, USA*

RODOLFO PAOLETTI, *University of Milan, Milan, Italy*

NIMA REZAEI, *Tehran University of Medical Sciences, Tehran, Iran*

More information about this series at <http://www.springer.com/series/5584>

Alexander Birbrair
Editor

Stem Cell Microenvironments and Beyond

 Springer

Editor

Alexander Birbrair
Department of Pathology
Federal University of Minas Gerais
Belo Horizonte, MG, Brazil

ISSN 0065-2598 ISSN 2214-8019 (electronic)
Advances in Experimental Medicine and Biology
ISBN 978-3-319-69193-0 ISBN 978-3-319-69194-7 (eBook)
DOI 10.1007/978-3-319-69194-7

Library of Congress Control Number: 2017959608

© Springer International Publishing AG 2017

Chapter 10 is licensed under the terms of the Creative Commons Attribution 4.0 International License (<http://creativecommons.org/licenses/by/4.0/>). For further details see license information in the chapter.

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

The publisher, the authors and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, express or implied, with respect to the material contained herein or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Printed on acid-free paper

This Springer imprint is published by Springer Nature
The registered company is Springer International Publishing AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Preface

This book *Stem Cell Microenvironments and Beyond* presents contributions by expert researchers and clinicians in the multidisciplinary areas of medical and biological research. The chapters provide timely detailed overviews of recent advances in the field. The texts are about stem cell microenvironments in different tissues and under distinct pathophysiological conditions. The authors focus on the modern methodologies and the leading-edge concepts in the field of stem cell biology. In recent years, remarkable progress has been made in the identification and characterization of the stem cell niches using state-of-the-art techniques. These advantages facilitated the identification of cellular components of the stem cell niche and the definition of the molecular basis of physical interaction between stem cells and their niches and revealed key niche signals involved in stem cell regulation. Just like the ecological niche of an organism, a stem cell niche is unique to the individual or small population and guides its dynamics. This book describes the major components of various stem cell microenvironments such as soluble factors, cell-cell interactions, extracellular matrix proteins, and physical forces. Thus, this book is an attempt to describe the most recent developments in the area of stem cell behavior regulation which is one of the emergent hot topics in the field of molecular and cellular biology today. Here, we present a selected collection of detailed chapters on what we know so far about the stem cell niches in various tissues and under distinct pathophysiological conditions. Twelve chapters written by experts in the field summarize the present knowledge about the physiological and pathophysiological roles of tissue microenvironments in stem cell regulation.

Daniel Lucas from the University of Michigan School of Medicine introduces our current understanding of the hematopoietic stem cell niche and discusses some of the open questions in the field for future research. Marina Konopleva and Yoko Tabe from the University of Texas MD Anderson Cancer Center describe recent research on several key components of specific niches that provide a sanctuary where leukemia stem cells evade chemotherapy-induced death and acquire a drug-resistant phenotype. Teresa V. Bowman and colleagues from Albert Einstein College of Medicine discuss knowledge that we gained from zebrafish about niche factors critical for early hemogenic endothelial induction as well as hematopoietic stem cell

specification, migration, and expansion. Raúl E. Russo and colleagues from Instituto de Investigaciones Biológicas Clemente Estable focus on spinal cord ependymal neural stem cell niche regulation. Ilias Kazanis and colleagues from the University of Cambridge summarize the recent developments on the role of the microenvironment and how it affects neural stem cells in the brain. Akiva Mintz and his group from Columbia University Medical Center introduce the concept of glioblastoma stem cells and detail the latest findings within the microenvironment where these cells survive, proliferate, and differentiate. Christoph Handschin and colleagues from the University of Basel give an overview of the players in the skeletal muscle stem cell microenvironment and their mutual interactions with stem cells. Kiminori Sato from Kurume University School of Medicine addresses the importance of the maculae flavae of the human vocal fold as a stem cell microenvironment. Maria P. Alcolea from Wellcome Trust-Medical Research Council Cambridge Stem Cell Institute compiles recent observations on esophageal epithelial stem cell biology and how microenvironmental changes may lead to esophageal disease and cancer. Sujit K Bhutia and colleagues from the National Institute of Technology discuss the dynamic interplay between oral cancer stem cells and the tumor microenvironment in carcinogenesis. Maria Angelica Miglino and Phelipe Oliveira Favaron from the University of Sao Paulo describe the microenvironment and applications of yolk sac and amniotic membrane-derived stem cells for human and veterinary regenerative medicine. Finally, Carmine Gentile and colleagues from the University of Sydney update us with the latest technologies based on our knowledge of the stem cell niche and current approaches for engineering artificial stem cell microenvironments.

It is hoped that the articles published in this book will become a source of reference and inspiration for future research ideas. I would like to express my deep gratitude to my wife Veranika Ushakova and Mr. Sivachandran Ramanan from Springer, who helped at every step of the execution of this project.

Belo Horizonte, MG, Brazil

Alexander Birbrair

Contents

1 Stem Cell Microenvironments and Beyond	1
Alexander Birbrair	
2 The Bone Marrow Microenvironment for Hematopoietic Stem Cells.	5
Daniel Lucas	
3 Leukemia Stem Cells Microenvironment	19
Yoko Tabe and Marina Konopleva	
4 Developmental HSC Microenvironments: Lessons from Zebrafish	33
Sara Nik, Joshua T. Weinreb, and Teresa V. Bowman	
5 Spinal Cord Stem Cells In Their Microenvironment: The Ependyma as a Stem Cell Niche.	55
Nicolás Marichal, Cecilia Reali, Omar Trujillo-Cenóz, and Raúl E. Russo	
6 Being a Neural Stem Cell: A Matter of Character But Defined by the Microenvironment	81
Evangelia Andreopoulou, Asterios Arampatzis, Melina Patsoni, and Ilias Kazanis	
7 Glioblastoma Stem Cells and Their Microenvironment	119
Anirudh Sattiraju, Kiran Kumar Solingapuram Sai, and Akiva Mintz	
8 Plasticity of the Muscle Stem Cell Microenvironment	141
Ivana Dinulovic, Regula Furrer, and Christoph Handschin	
9 The Macula Flava of the Human Vocal Fold as a Stem Cell Microenvironment	171
Kiminori Sato	

10 Oesophageal Stem Cells and Cancer 187
Maria P. Alcolea

11 Oral Cancer Stem Cells Microenvironment 207
Prajna Paramita Naik, Prashanta Kumar Panda,
and Sujit K. Bhutia

12 Fetal Membranes-Derived Stem Cells Microenvironment 235
Phelipe Oliveira Favaron and Maria Angelica Miglino

**13 Current Technologies Based on the Knowledge
of the Stem Cells Microenvironments** 245
Damia Mawad, Gemma Figtree, and Carmine Gentile

Index 263

Contributors

Maria P. Alcolea Wellcome Trust-Medical Research Council Cambridge Stem Cell Institute, Cambridge, UK

Department of Oncology, University of Cambridge, Hutchison/MRC Research Centre, Cambridge, UK

Evangelia Andreopoulou Lab of Developmental Biology, Department of Biology, University of Patras, Patras, Greece

Asterios Arampatzis Wellcome Trust-MRC Cambridge Stem Cell Biology Institute, University of Cambridge, Cambridge, UK

School of Medicine, Aristotle University of Thessaloniki, Thessaloniki, Greece

Sujit K. Bhutia Department of Life Science, National Institute of Technology, Rourkela, Odisha, India

Alexander Birbrair Department of Pathology, Federal University of Minas Gerais, Belo Horizonte, MG, Brazil

Teresa V. Bowman Gottesman Institute for Stem Cell Biology and Regenerative Medicine, Albert Einstein College of Medicine, Bronx, NY, USA

Department of Developmental and Molecular Biology, Albert Einstein College of Medicine, Bronx, NY, USA

Departments of Molecular Biology and Medicine (Oncology), Albert Einstein College of Medicine, Bronx, NY, USA

Ivana Dinulovic Biozentrum, University of Basel, Basel, Switzerland

Phelipe Oliveira Favaron Surgery Department, School of Veterinary Medicine and Animal Science, University of Sao Paulo, Sao Paulo, SP, Brazil

Gemma Figtree Sydney Medical School, University of Sydney, Sydney, NSW, Australia

Regula Furrer Biozentrum, University of Basel, Basel, Switzerland

Carmine Gentile Sydney Medical School, University of Sydney, Sydney, NSW, Australia

Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, MA, USA

Christoph Handschin Biozentrum, University of Basel, Basel, Switzerland

Ilias Kazanis Lab of Developmental Biology, Department of Biology, University of Patras, Patras, Greece

Wellcome Trust-MRC Cambridge Stem Cell Biology Institute, University of Cambridge, Cambridge, UK

Marina Konopleva Department of Leukemia and Stem Cell Transplantation and Cellular Therapy, The University of Texas MD Anderson Cancer Center, Houston, TX, USA

Daniel Lucas Department of Cell and Developmental Biology, University of Michigan School of Medicine, Ann Arbor, MI, USA

Center for Organogenesis, University of Michigan School of Medicine, Ann Arbor, MI, USA

The University of Michigan Comprehensive Cancer Center, University of Michigan, Ann Arbor, MI, USA

Nicolás Marichal Neurofisiología Celular y Molecular, Instituto de Investigaciones Biológicas Clemente Estable, Montevideo, Uruguay

Institute of Physiological Chemistry, University Medical Center, Johannes Gutenberg University Mainz, Mainz, Germany

Damia Mawad Faculty of Science, School of Materials Science and Engineering, University of New South Wales, Sydney, NSW, Australia

Maria Angelica Miglino Surgery Department, School of Veterinary Medicine and Animal Science, University of Sao Paulo, Sao Paulo, SP, Brazil

Akiva Mintz Department of Radiology, Columbia University College of Physicians and Surgeons, New York, NY, USA

Prajna Paramita Naik Department of Life Science, National Institute of Technology, Rourkela, Odisha, India

Sara Nik Gottesman Institute for Stem Cell Biology and Regenerative Medicine, Albert Einstein College of Medicine, Bronx, NY, USA

Department of Developmental and Molecular Biology, Albert Einstein College of Medicine, Bronx, NY, USA

Prashanta Kumar Panda Department of Life Science, National Institute of Technology, Rourkela, Odisha, India

Melina Patsoni Lab of Developmental Biology, Department of Biology, University of Patras, Patras, Greece

Cecilia Reali Neurofisiología Celular y Molecular, Instituto de Investigaciones Biológicas Clemente Estable, Montevideo, Uruguay

Raúl E. Russo Neurofisiología Celular y Molecular, Instituto de Investigaciones Biológicas Clemente Estable, Montevideo, Uruguay

Kiran Kumar Solingapuram Sai Department of Radiology, Columbia University College of Physicians and Surgeons, New York, NY, USA

Kiminori Sato Department of Otolaryngology—Head and Neck Surgery, Kurume University School of Medicine, Kurume, Japan

Anirudh Sattiraju Department of Radiology, Columbia University College of Physicians and Surgeons, New York, NY, USA

Yoko Tabe Department of Leukemia, The University of Texas MD Anderson Cancer Center, Houston, TX, USA

Department of Next Generation Hematology Laboratory Medicine, Juntendo University of Medicine, Tokyo, Japan

Omar Trujillo-Cenóz Neurofisiología Celular y Molecular, Instituto de Investigaciones Biológicas Clemente Estable, Montevideo, Uruguay

Joshua T. Weinreb Gottesman Institute for Stem Cell Biology and Regenerative Medicine, Albert Einstein College of Medicine, Bronx, NY, USA

Department of Developmental and Molecular Biology, Albert Einstein College of Medicine, Bronx, NY, USA