ADVANCES IN AQUATIC INVERTEBRATE STEM CELL RESEARCH

FROM BASIC RESEARCH TO INNOVATIVE APPLICATIONS

cost
EUROPEAN COOPERATION IN SCIENCE & TECHNOLOGY

Loriano Ballarin, Baruch Rinkevich and Bert Hobmayer (Eds.)

Advances in Aquatic Invertebrate Stem Cell Research

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From Basic Research to Innovative Applications

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Loriano Ballarin (ORCID: 0000-0002-3287-8550) is a Professor of Zoology at the Department of Biology, University of Padova (Italy). He is a member of the editorial board of the *Invertebrate Survival Journal* and the *European Journal of Zoology*, and is a founding member of the Italian Association of Developmental and Comparative Immunobiology (IADCI). His main research interests are the evolution of innate immunity and the study of the cellular and molecular basis of immune responses in marine invertebrates, with particular reference to the role of hemocytes/coelomocytes in immune defense and, more generally, in the stress response. Most of his studies were carried out using the colonial ascidian *Botryllus schlosseri* as a model organism. His interest in stem cells is directly related to their role in hematopoiesis, as they assure the continuous renewal of the circulating immunocytes of marine invertebrates. He is the chair of the COST Action 16203 MARISTEM "Stem cells of marine/aquatic invertebrates: from basic research to innovative applications" that supported the publication of this book. He is the author or co-author of more than 130 peer-reviewed publications in scientific journals, co-editor of scientific books, including "Lessons in immunity: from single-cell organisms to mammals" (Elsevier, 2016), and guest editor of Special Issues, including: "Ancient immunity. phylogenetic emergence of recognition-defence mechanisms" (Biology (Basel), 2020–2021).

Baruch (Buki) Rinkevich has been a professor and senior scientist at the National Institute of Oceanography, Haifa, since 1988, the University of Haifa, Israel, since 2008, and an adjunct professor at the Biology Department, Ben-Gurion University in Beer-Sheva, Israel, since 2006. He received his PhD at Tel Aviv University, Israel, on coral physiology, and spent two postdoctoral periods in the United States: at Scripps Oceanographic Institute, La Jolla, California, studying silicification in marine invertebrates, and at Stanford University Medical School, California, studying ascidian immunity. A marine biologist, he works on the immunity, allorecognition, and developmental biology of marine invertebrates (primarily corals and colonial tunicates); on cell cultures/stem cell biology of marine invertebrates; on pattern formation of colonial organisms; on the unit of selection; and on coral reef restoration. Other aspects studied by Rinkevich in the laboratory include marine genotoxicity, DNA barcoding, the eDNA of marine organisms, and studies on thraustochytrids. He was the head of the MINERVA Center on "Invertebrate immunology and developmental biology" (1995–2002) and the head of the Department of Marine Biology and Biotechnology, National Institute of Oceanography (2002–2008). He has served on the editorial boards of 18 scientific, peer-reviewed journals, has been the mentor of > 60 graduate students (already graduated and in process), and is the author of > 360 publications and three edited books.

Bert Hobmayer is a Professor of Zoology at the University of Innsbruck, Austria (since 2009). He received his doctoral degree (Dr. rer. nat.) at the University of Munich, Germany, working on mechanisms of regeneration and neurogenesis in the freshwater polyp *Hydra*. After spending two post-doctorate years at the National Institute of Genetics in Mishima, Japan (characterization of cell-cell adhesion proteins in *Hydra*), he continued as a zoologist and developmental biologist to study cellular and molecular mechanisms underlying regeneration, axial patterning, and adult stem cell behavior in simple animal models at the Universities of Frankfurt, Darmstadt, and Innsbruck. Focus areas of his research include the roles of Wnt signaling pathways in providing positional information and in orchestrating tissue morphogenesis, and the impact of Myc transcription factors on adult stem cell decision making. At the University of Innsbruck, he served as head of the Department of Zoology (2006–2013) and head of the Special Research Cluster Center for Molecular Biosciences Innsbruck (CMBI) (2016–2021). He also served as a member of the Austrian Ministry of Science Panel "Future Life Sciences" in 2016 and 2017. He mentored more than 20 graduate students and is the author of more than 50 publications, many of which were published in high-impact journals.

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Preface

Why publish a new book on invertebrate stem cells—and particularly one with a focus on aquatic invertebrates? The answer lies in a rapidly evolving stem cell discipline, driven by ever-advancing molecular tools and imaging techniques, today being one of the most dynamic areas in biology and biomedicine. This inevitably influences the research on invertebrates, with a noteworthy reference to aquatic organisms. Indeed, aquatic invertebrates represent the greatest majority of animal biodiversity. They exhibit various biological features that are of vast interest to stem cell researchers and biologists in general. These include the high regenerative power displayed by a broad range of taxa, the lack of early germ cell sequestering, and a widespread presence of asexual reproduction, dormancy, postponed aging and rejuvenation. All of these phenomena are associated with the action of pools of adult stem cells throughout the animals' life cycles (Ballarin et al. 2018).

Current research on aquatic invertebrate stem cells takes advantage from new experimental approaches and an increasing number of sequenced animal genomes and transcriptomes available in databases. The accumulated results reveal that aquatic invertebrate stem cells have unique features not recorded in the vertebrates and model terrestrial invertebrates, such as their high abundance (up to 40% of the entire body cells in some taxa) and their often indeterminate capacity for growth. They further express typical stemness genes, previously considered an attribute of germ cells, including piwi, vasa, nanos, and more (Rinkevich et al. 2022), and they are directly involved in the control and modulation of innate immune responses (Ballarin et al. 2021). Finally, aquatic invertebrate stem cells challenge the concept of the stem cell niche as defined in vertebrates and ecdysozoans (Martinez et al. 2022). The following chapters elaborate on several of these aspects.

This book stems from the activities within the COST Action 16203 MARISTEM Stem cells of marine/aquatic invertebrates: from basic research to innovative applications, which will end on 1 April 2022. It represents one of the final deliverables of four years of interaction and collects the contributions of a relevant part of its members. It holds 11 chapters dealing with sponges, cnidarians, flatworms, echinoderms and tunicates, highlighting the best-studied adult stem cell lineages among aquatic invertebrates. Four chapters review stem cell dynamics in regeneration, development, tissue homeostasis, and symbiosis. Another four chapters discuss profiles of stem cell-specific gene expression and the action of glycoproteins and fatty acids. Three chapters describe efforts to approach the long-term goal of establishing invertebrate stem cell cultures.

We thank all the contributors to this volume and Oliva Andereggen and Jelena Milojevic for their friendly support and for cautiously handling all editorial issues. Our hope is that this book can stimulate researchers to pay closer attention to

organisms from aquatic environments, as those—due to their simple Bauplan and to the high potentialities of their stem cells—will advance our knowledge in basic biological processes.

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