

Preface

The transition to multicellular life is associated with some of the most important events in the history of life, such as the evolution of animals, land plants, multicellular fungi and many groups of macroscopic algae, including seaweeds. Yet, despite its importance, we are far from fully understanding the forces driving this transition as well as the genetic and molecular basis for the evolution of multicellularity. However, in recent years, emerging data from various fields are providing new insight into the factors and processes underlying the evolution of multicellularity in different lineages.

The aim of this book is to offer a synthesis of the current issues and research into this fundamental biological question, by providing several complementary perspectives (both theoretical and experimental) and using examples from various lineages in which multicellularity evolved. The ultimate goal of the book is to integrate our understanding of how and why such transitions occurred and to facilitate the identification of general principles and mechanisms. We believe this book is a timely contribution to the field, given the research efforts, dedicated meetings and workshops that are being now committed to this question. The book will be of great interest to all researchers working in the field as well as to young scientists generally interested in evolutionary questions.

The chapters in this book have been written by leading researchers in their respective fields. Each chapter provides a review of the current state of the field and/or offers new perspectives for future research. We have tried to provide a balance of topics, model-systems and approaches; however, due to space limits, many interesting and important subjects had to be omitted.

The book starts out with a forward by Nicole King, a prominent scientist whose research program is devoted to understanding the early evolution of multicellularity in the animal lineages. The chapters are organized around five themes corresponding to the five parts of the book. Part 1—Multicellularity in the tree of life—emphasizes general issues and questions relevant to the evolution of multicellularity and provides an overview of the transition to multicellularity in the context of the history of life (when, why, how many times). Part 2—Model-systems—features several systems currently used to investigate independent origins of multicellularity in distinct taxonomic

groups (e.g., metazoans and their unicellular relatives, fungi, green algae, brown algae). Part 3—Theoretical approaches—highlights several distinct approaches (using mathematical modeling, computer simulations) and frameworks (based on cooperation and conflict, phenotypic plasticity, or physics) that have been recently developed to address the forces driving the transition to multicellularity and identify the main factors. Part 4—Genomics insights—stresses the use of genomic approaches to provides insights into the genetic basis for the evolution of multicellularity in distinct lineages, including the evolution of the metazoan developmental toolkit, the evolution of morphological complexity in the green plant lineage, the independent emergence of complex multicellularity in brown and red algae, and of aggregative multicellularity in social amoebae. Part 5—Molecular mechanisms—covers several molecular mechanistic issues related to the emergence of multicellularity in various lineages, including changes in transcriptional regulation, cell-cell signaling and changes in signaling patterns (e.g., evolution of developmental signaling), allorecognition, and co-option of cellular pathways already present in the unicellular ancestors.

Each chapter was reviewed by one or two external reviewers or chapter contributors, and at least one of the editors. We are extremely grateful to all reviewers for taking their time to read the submitted contributions and to provide very thoughtful, critical and helpful suggestions for improving the chapters. We are also indebted to Nicole King for contributing the foreword to this book.

Last but not least, our greatest thanks to all the contributors, for their dedication to this field and their willingness to share their knowledge, data and views as part of this book; without their enthusiasm, timely contributions, and patience during the entire process this book would not have been possible!

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