Preface

> For every type of animal there is a most convenient size, and a large change in size inevitably carries with it a change of form.
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> —J.B.S. Haldane, *On Being the Right Size*, 1926

SIZE IS A FUNDAMENTAL FEATURE OF LIVING THINGS, from the dimensions of an animal to its component organs, cells, and organelles, but despite the central importance of size for organismal life, we are only just beginning to understand mechanisms regulating and coordinating size so that all parts fit and function together. The sizes of the building blocks of life, including amino acids, lipids, and nucleotides, are mostly invariant between diverse organisms, and yet, beyond the molecular level, there is tremendous variation in the sizes of organelles, cells, tissues, and organisms. More remarkably, there is also variability in the **interrelationships between dimensions at different levels**. For example, the size of an organ or organism could change because of a difference in cell number, cell size, or both. Similarly, there is considerable variability in terms of whether and how different organelles alter their sizes as cell size changes. The chapters in this volume address multiple aspects of size control, as well as their underlying mechanisms. To capture the breadth of size-related questions in biology, the editors chose authors whose research represents a diverse range of species and experimental approaches.

The book is organized in such a way that successive chapters deal with size regulation at progressively smaller scales. The early chapters address size at the level of the entire organism, which results from the interplay of growth with organismal development. Subsequent chapters deal with mechanisms regulating organ size in both plants and animals, including the effects of mechanical forces and cell size on tissue growth and morphology. The final chapters address size regulation at the cellular and subcellular levels. Cells of a given type usually maintain a characteristic "convenient" size that is suited for their ecological or organismal context. Because cells are the primary unit of life, understanding mechanisms controlling their growth and proliferation is relevant across multiple scales and levels of organization. At the scale of millimeters to meters, the size of an organ or animal depends mainly on the size and number of cells it contains. At the millimeter to micron scale, cellular contents must adapt to cell sizes that can vary a billion-fold in volume. Several chapters in the book describe signaling pathways controlling cell growth and proliferation, but some basic mysteries remain. For example, there is a strong correlation between genome size, nuclear size, and cell size, but causality relationships are unclear, as are underlying molecular mechanisms.

Two important themes emerge from this book. The first is the power of taking an evolutionary perspective. By comparing organisms across the tree of life, we can begin to understand the different ways that nature solves problems of size and growth control at multiple levels to generate organisms of diverse shapes and sizes. The second theme is that principles of size control necessarily vary at each level. The sizes of simple organelles are primarily governed by the nature of interactions between their molecular components. At progressively higher levels of organization, size regulation becomes more and more complex and involves interplay among the intrinsic properties of individual components, properties generated by their organization in specific ways, physical forces, and the interactions of these organs or organisms with the environment. Once again, the evolutionary history of an organ or organism might offer important clues as to how it has arrived at its present size and

shape. Many aspects of size control contain important unsolved questions, and it is hoped that this volume will pique the interest of readers in working on some of these problems.

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