Preface

"Nothing in education is so astonishing as the amount of ignorance it accumulates in the form of inert facts."

—Henry Adams, *The Education of Henry Adams*

As the rate of discovering facts in the sciences continues to escalate, both students and instructors must confront the age-old problem of deciding what material matters most, especially at the introductory level. In my own experience, even the most enthusiastic students have great difficulty distinguishing essential facts in cell biology from more technical details. Given the heavy emphasis on memorization in most K–12 programs, many introductory-level college students resort to storing as much information as possible in short-term memory, only to discover later that they've missed the underlying concepts that give these facts their significance. In the past 20 years of teaching, I have spent as much time helping students navigate a conceptual path through the dense web of facts in cell biology as I have explaining the meaning of those facts. The purpose of this book is to help students build a conceptual framework for cell biology that will persist long after their coursework is complete.

Our Approach to Learning Cell Biology

The field of introductory cell biology enjoys a wealth of well-written texts by outstanding authors. Why write yet another introductory text? This book is needed for two important reasons. First, it overtly focuses on some of the underlying principles that illustrate both how cells function as well as how we study them. While many textbooks reference "principles" in their fields, few specifically identify these principles or explore them in detail. In contrast, this book identifies **10 specific principles of cell biology** (see page ix), and devotes a separate chapter to illustrate each one of them. As a result:

- We intentionally shift away from the traditional focus on technical details and toward a more integrative view of cellular activity that can be tailored to suit students with a broad range of backgrounds.
- Instructors have great freedom to organize technical subjects as they see fit while permitting students to build their own conceptual view of how cells solve problems. In short, because every cellular activity discussed in the text is tied directly to an overlying principle, these activities can be arranged and taught in many different combinations, at varying depths of detail, without losing focus on the Big Picture.
- Students develop a framework for evaluating facts as they encounter them, and this invites them to critically evaluate information as they learn. The principles in this book are not intended to be treated as laws, and are thus always subject to criticism and review.
- Instructors can capitalize on this organizing style to seamlessly merge supplemental material with the text as the field changes, or to emphasize specific subjects in a topics course.

- Professionals in the field can use these principles as starting points for identifying additional principles in cell biology and in other related fields, for comparing these principles in other fields of biology, and for developing a more integrated curriculum across multiple scales of biological organization. For example, mapping several courses to specific principles such as those identified in this text could assist in curriculum development and assessment at a department or program administrative level.

The second important distinguishing feature of this book is its informal, narrative writing style. This style is adopted to make even the most complex concepts accessible to students new to a scientific field, including stripping away some of the technical complexity that many introductory students find intimidating. Each chapter thus reflects my own lectures in introductory cell biology, in both style and content. Specifically, this includes:

- Liberal use of analogies that have proven effective over many years of teaching.
- Margin boxes throughout each chapter including studying tips, clarifications of apparent contradictions, explanations of naming schemes, FAQs, etc.
- Jargon is introduced gradually, after the concepts have been established, thereby de-emphasizing memorization of names.
- Ten principle-based chapters build on the foundation laid down in the first four chapters of the book, and include heavy emphasis on linking concepts across multiple chapters.
- Novel artwork is included, reflecting drawing exercises the author includes in his own lectures.

Audience

Principles of Cell Biology is written for introductory cell biology courses having an emphasis on eukaryotic cells, especially humans and other mammals. It is geared toward students in general biology, molecular biology, physiology, nursing, dental hygiene, and bioengineering. The book also provides a firm foundation for advanced programs in biological sciences, medicine, dentistry, and bioengineering.

Organization

The book consists of four chapters (1–4) that introduce the fundamental molecular building blocks of all cells: sugars, proteins, nucleic acids, and lipids. The remaining 10 chapters focus on explaining a single principle, supported by the topics typically discussed in cell biology courses. One important departure from most other books is that the topics of membrane transport and metabolism are covered in the same chapter (Chapter 10), though membrane transport is discussed in its own chapter subsection so it can be read independent of the metabolism sections if desired.

Through the use of cross-references, some chapters can be clustered into broader themes. Chapters 5 and 6 focus on the cytoskeleton and extracellular matrix, respectively, to explain how cells establish, maintain, and modify their shapes. Chapters 7–9 focus on DNA replication, transcription, translation, protein sorting, and the endomembrane system to illustrate the theme of information transfer from DNA to proteins. Chapters 11–13

use signal transduction as a unifying theme to illustrate the relationships among signaling pathways, control of gene expression, and cell growth/apoptosis. Finally, Chapter 14 evaluates the principles from earlier chapters at the tissue level, unifying the entire cell into a single functional unit of a multicellular organism.

Each chapter contains pedagogical features to assist instructors and facilitate student comprehension. These include:

- An introductory section, called The Big Picture, explains the learning objectives for the chapter, the relationship the chapter's subject matter shares with other chapters, and, in the last 10 chapters, introduces the Principle that the chapter illustrates.
- Every major section in each chapter includes a bulleted list of key concepts.
- Each chapter contains Concept Check questions at the end of major sections to test comprehension of the section, with answers provided at the end of the chapter. The test bank includes exam questions that link to these concept check questions.
- End-of-chapter questions ask students to integrate material across chapter sections and across different chapters.