

ABOUT MOLE

PREFACE

A contemporary perspective on molecular biology

Molecular Biology: Principles of Genome Function offers a distinctive approach to the teaching of molecular biology. It is an approach that reflects the challenge of teaching a subject that is in many ways unrecognizable from the molecular biology of the twentieth century – a discipline in which our understanding has advanced immeasurably, but about which many intriguing questions remain to be answered. Among the students being taught today are the molecular biologists of tomorrow; these individuals will be in a position to ask fascinating questions about fields whose complexity and sophistication become more apparent with each year that passes.

We have written the book with several guiding themes in mind, all of which focus on providing a faithful depiction of the key themes and challenges that surround molecular biology in the twenty-first century, and on communicating this reality to students in a way that will engage and motivate, rather than overwhelm and intimidate.

A focus on the underlying principles

Arguably one of the biggest challenges facing instructors and students of molecular biology today is the vast amount of information encapsulated by the field. It is impossible for an instructor to convey every last detail (and equally impossible for students to absorb everything that there is to know). Indeed, we believe that it is not necessary to delve into every fine detail in order to understand the main concepts. Therefore, our approach focuses on communicating the *principles* of the subject.

We believe it is better for students to truly understand the foundational principles rather than simply learn a series of facts. To this end, we do not try to be exhaustive in our coverage. In the digital age in which we live, it is easier than ever before for students to gather a vast amount of information on a particular topic of interest. This information is of little value, however, if the student lacks a conceptual framework within which to make sense of all the information to which they are exposed.

By focusing on key principles, we seek to equip students with a conceptual framework, which we believe will be invaluable to them during their later careers.

An emphasis on commonalities

Until relatively recently, much more was known about the molecular components and processes of bacterial systems than of their archaeal and eukaryotic counterparts. In recent years, however, our understanding of archaeal and eukaryotic systems has increased enormously. With this increased understanding has come the realization that bacterial, archaeal, and eukaryotic systems exhibit many commonalities – commonalities that point to the common ancestry of the three kingdoms of life.

Throughout this book, therefore, our emphasis is on the *common features* of bacterial, archaeal, and eukaryotic systems. Differences do exist, of course – an inevitable outcome of evolutionary processes generating biological diversity. However, we have strived where possible to present a single view of key topics based

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on conserved processes and components. We have then discussed key differences between bacterial processes and their archaeal and eukaryotic counterparts where they exist, and where they have helped to further our understanding.

We recognize that some may feel that the processes occurring in bacteria, and in eukaryotes and archaea, are best taught separately. However, our focus on principles – and on constructing an overarching conceptual framework – leads us strongly to believe that an emphasis on commonalities is a valuable educational approach.

Integration of key themes and concepts

One of the most startling realizations of recent years has been the widespread importance of certain molecular phenomena, such as chromatin modification, and regulatory RNAs, which have impacts on genome function in ways far more diverse than had previously been recognized. Rather than examining each of these phenomena in isolation, our approach reflects their diverse impacts by presenting them in the various contexts in which they function. We believe this overall approach reflects the reality of molecular biology, and helps students to appreciate molecular biology as a unified discipline, with many components and phenomena acting in concert, rather than as a series of isolated topics.

A demonstration of how we know what we know

At heart, molecular biology is an experimental science. Our understanding of the field is increased through the accumulation of experimental evidence, which leads to the gradual emergence of key ideas and paradigms. Therefore, a central element to the understanding of molecular biology is an appreciation of the approaches taken to yield the information from which concepts and principles are deduced.

However, as instructors, we face a potential conflict: a mass of experimental evidence can often be overwhelming for students, and can make it more challenging for them to grasp the central ideas and paradigms that the experimental evidence has allowed us to elucidate. On the other hand, ignoring the experimental evidence deprives students from fully understanding the fundamental aspects of molecular biology (and, indeed, of science in general). In response to this seeming conflict, our approach has been for the main body of the text to focus on the communication of key concepts, free from the layer of complexity that experimental evidence might introduce.

We have then complemented our coverage of key concepts in the main body of the text with separate ‘Experimental approach’ panels, which branch off from the text in a clearly signposted way. These panels describe pieces of research that have been undertaken and which have been particularly valuable in elucidating difference aspects of molecular biology.

Importantly, experimental research represents an ongoing journey of discovery, where the experimental approaches adopted develop as much as our understanding of the field. Uniquely, therefore, the experimental approach panels present, wherever possible, two approaches – one ‘classic’ and one ‘contemporary’. Although all approaches have revealed valuable insights, regardless of whether they could be considered classic or contemporary, we believe that coupling the approaches in this way has additional educational value in terms of showing how both experimentation and the knowledge gained from such experimentation can evolve with time.

In addition to the experimental approach panels, further support for encouraging students to engage with experimental evidence is provided by an online Journal

5.2 EXPERIMENTAL APPROACH

Discovery of the origin of life

One of the most fundamental questions in biology is the origin of life. The discovery of the origin of life is a complex process that involves the study of the chemical and physical processes that led to the emergence of life on Earth.

QUESTIONS

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FURTHER READING

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Club, as described more fully in the description of the Online Resource Center, which follows.

The methods used in molecular biology

Many of the experimental approach panels (and the research work featured in the Journal Club papers) draw on particular laboratory techniques that are used in different contexts throughout molecular biology research. The final chapter of this book, 'Tools and techniques in molecular biology', provides an overview of the basic techniques that are exploited during the course of much experimental work in molecular biology. Rather than describing general methods in detail within the experimental approach panels, we have directed the reader to appropriate coverage in Chapter 19, where they can learn more about the methodological tools that are at a molecular biologist's disposal, how these tools work, and what they can tell us.

New for this edition

The preparation of this second edition has given us a welcome opportunity to refine a number of aspects of the text, particularly in the light of valuable feedback from those who have taught from the first edition. Beyond updating all topics in line with current research findings, the most notable changes are:

A new chapter on regulatory RNAs. We now include a broad survey of an area of molecular biology whose centrality to fully understanding genome function has come to the fore in recent years.

Individual chapters on the regulation of transcription and translation. Whereas the previous edition devoted one chapter each to transcription and translation, each of these topics is now covered in two chapters: one devoted to the core processes and another exploring how those processes are regulated.

New questions at the end of each chapter. Each chapter now includes a range of end-of-chapter questions, provided by Deborah Zies, University of Maryland, Washington, and Claire Burns, Washington and Jefferson College.

Additional Experimental approach panels. We have prepared a number of new Experimental approach panels, bringing the total throughout the book to 44. The format of these panels has also been refined, with new sub-headings to guide the reader, and links to explanations of relevant techniques in Chapter 19, 'Tools and techniques in molecular biology'.

Video animations. We have worked with the winner of OUP's Student Animation Award, Connor Hendrich of Colorado State University, to develop sixteen animations that illustrate some of the central processes in molecular biology, including those that are particularly challenging to visualize.

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