

PREFACE TO THE THIRD EDITION

It doesn't seem like five years have passed since we were all involved in writing the second edition of *Instant Notes in Molecular Biology*. However, during that period there have been a number of events and discoveries that are worthy of comment. We are impressed with how popular the text has become with students, not only in the United Kingdom, but all around the world. The second edition has been translated into Portuguese, Turkish, Polish, French, and Japanese. We have received comments and suggestions from as far afield as Katmandu and Istanbul as well as from much nearer home and we would like to thank everyone who has taken the time to make their comments known, as they have helped our improvements to the third edition. Even though our text is a basic introduction to Molecular Biology, there have been some dramatic developments in the field since the last edition was written. These include the whole area of small RNA molecules, including micro RNAs and RNA interference and we have updated the relevant sections to include this material. Other important developments include the rapid growth in the areas of genomics, proteomics, cell imaging and bio-informatics and since we recognize that these areas will rapidly change in the future, we have pragmatically included two new sections at the end of the book to deal with these fast moving topics. We hope this will make changes to future editions less complex. Several people who have helped us to keep on track with writing and production on the third edition deserve our thanks for their encouragement and patience, including Sarah Carlson, Liz Owen and Alison Nick, not to mention all our families who have tolerated our necessary preoccupations. We sincerely hope that the third edition continues to help students to get to grips with this interesting area of biology.

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PREFACE TO THE SECOND EDITION

To assess how to improve *Instant Notes in Molecular Biology* for the second edition, we studied the first edition reader's comments carefully and were pleasantly surprised to discover how little was deemed to have been omitted and how few errors had been brought to our attention. Thus, the problem facing us was how to add a number of fairly disparate items and topics without substantially affecting the existing structure of the book. We therefore chose to fit new material into existing topics as far as possible, only creating new topics where absolutely necessary. A superficial comparison might therefore suggest that little has changed in the second edition, but we have included, updated or extended the following areas: proteomics, LINES/SINES, signal transduction, BACs, Z-DNA, gene gun, genomics, DNA fingerprinting, DNA chips, microarrays, RFLPs, genetic polymorphism, genome sequencing projects, SSCP, automated DNA sequencing, positional cloning, chromosome jumping, PFGE, multiplex DNA amplification, RT-PCR, quantitative PCR, PCR screening, PCR mutagenesis, degenerate PCR and transgenic animals. In addition, three completely new topics have been added. Arguably, no molecular biology text should omit a discussion of Crick's central dogma and it now forms the basis of Topic D5 – The flow of genetic information. Two other rapidly expanding and essential subjects are The cell cycle and Apoptosis, each of which, we felt, deserved its own topic. These have been added to Section E on DNA replication and Section S on Tumor viruses and oncogenes, respectively. Finally, in keeping with the ethos of the first edition that *Instant Notes in Molecular Biology* should be used as a study guide and revision aid, we have added approximately 100 multiple choice questions grouped in section order. This single improvement will, we feel, greatly enhance the educational utility of the book.

Phil Turner, Sandy McLennan, Andy Bates and Mike White

Acknowledgments

We thank all those readers of the first edition who took the trouble to return their comments and suggestions, without which the second edition would have been less improved, Will Sansom, Andrea Bosher and Jonathan Ray at BIOS who kept encouraging us and finally our families, who once again had to suffer during the periods of (re)writing.

PREFACE TO THE FIRST EDITION

The last 20 years have witnessed a revolution in our understanding of the processes responsible for the maintenance, transmission and expression of genetic information at the molecular level – the very basis of life itself. Of the many technical advances on which this explosion of knowledge has been based, the ability to remove a specific fragment of DNA from an organism, manipulate it in the test tube, and return it to the same or a different organism must take pride of place. It is around this essence of recombinant DNA technology, or genetic engineering to give it its more popular title, that the subject of molecular biology has grown. Molecular biology seeks to explain the relationships between the structure and function of biological molecules and how these relationships contribute to the operation and control of biochemical processes. Of principal interest are the macromolecules and macromolecular complexes of DNA, RNA and protein and the processes of replication, transcription and translation. The new experimental technologies involved in manipulating these molecules are central to modern molecular biology. Not only does it yield fundamental information about the molecules, but it has tremendous practical applications in the development of new and safe products such as therapeutics, vaccines and foodstuffs, and in the diagnosis of genetic disease and in gene therapy.

An inevitable consequence of the proliferation of this knowledge is the concomitant proliferation of comprehensive, glossy textbooks, which, while beautifully produced, can prove somewhat overwhelming in both breadth and depth to first and second year undergraduate students. With this in mind, *Instant Notes in Molecular Biology* aims to deliver the core of the subject in a concise, easily assimilated form designed to aid revision. The book is divided into 19 sections containing 70 topics. Each topic consists of a 'Key Notes' panel, with extremely concise statements of the key points covered. These are then amplified in the main part of the topic, which includes simple and clear black and white figures, which may be easily understood and reproduced. To get the best from this book, material should first be learnt from the main part of the topic; the Key Notes can then be used as a rapid revision aid. Whilst there is a reasonably logical order to the topics, the book is designed to be 'dipped into' at any point. For this reason, numerous cross-references are provided to guide the reader to related topics.

The contents of the book have been chosen to reflect both the major techniques used and the conclusions reached through their application to the molecular analysis of biological processes. They are based largely on the molecular biology courses taught by the authors to first and second year undergraduates on a range of biological science degree courses at the University of Liverpool. Section A introduces the classification of cells and macromolecules and outlines some of the methods used to analyze them. Section B considers the basic elements of protein structure and the relationship of structure to function. The structure and physico-chemical properties of DNA and RNA molecules are discussed in Section C, including the complex concepts involved in the supercoiling of DNA. The organization of DNA into the intricate genomes of both prokaryotes and eukaryotes is covered in Section D. The related subjects of mutagenesis, DNA replication, DNA recombination and the repair of DNA damage are considered in Sections E and F.

Section G introduces the technology available for the manipulation of DNA sequences. As described above, this underpins much of our detailed understanding of the molecular mechanisms of cellular processes. A simple DNA cloning scheme is used to introduce the basic methods. Section H describes a number of the more sophisticated cloning vectors which are used for a variety of purposes. Section I considers the use of DNA libraries in the isolation of new gene sequences, while Section J covers more complex and detailed methods, including DNA sequencing and the analysis of cloned sequences. This section concludes with a discussion of some of the rapidly expanding applications of gene cloning techniques.

The basic principles of gene transcription in prokaryotes are described in Section K, while Section L gives examples of some of the sophisticated mechanisms employed by bacteria to control specific gene expression. Sections M and N provide the equivalent, but necessarily more complex, story of transcription in eukaryotic cells. The processing of newly transcribed RNA into mature molecules is detailed in Section O, and the roles of these various RNA molecules in the translation of the genetic code into protein sequences are described in Sections P and Q. The contributions that prokaryotic and eukaryotic viruses have made to our understanding of molecular information processing are detailed in Section R. Finally, Section S shows how the study of viruses, combined with the knowledge accumulated from many other areas of molecular biology is now leading us to a detailed understanding of the processes involved in the development of a major human affliction – cancer.

This book is not intended to be a replacement for the comprehensive mainstream textbooks; rather, it should serve as a direct complement to your lecture notes to provide a sound grounding in the subject. The major texts, some of which are listed in the Further Reading section at the end of the book, can then be consulted for more detail on topics specific to the particular course being studied. For those of you whose fascination and enthusiasm for the subject has been sufficiently stimulated, the reading list also directs you to some more detailed and advanced articles to take you beyond the scope of this book. Inevitably, there have had to be omissions from *Instant Notes in Molecular Biology* and we are sure each reader will spot a different one. However, many of these will be covered in other titles in the Instant Notes series, such as the companion volume, *Instant Notes in Biochemistry*.

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We would like to acknowledge the support and understanding of our families for those many lost evenings and weekends when we could all have been in the pub instead of drafting and redrafting manuscripts. We are also indebted to our colleagues Malcolm Bennett and Chris Green for their contributions to the chapters on bacteriophages, viruses and oncogenes. Our thanks, too, go to the series editor, David Hames, and to Jonathan Ray, Rachel Robinson and Lisa Mansell of BIOS Scientific Publishers for providing prompt and helpful advice when required and for keeping the pressure on us to finish the book on time.