

PREFACE

This book is written for students who are learning about viruses for the first time in a university course at the undergraduate or graduate level. As the title implies, it concentrates on the molecular mechanisms of virus replication, and on the interactions between viruses and the cells in which they replicate. The book approaches learning about virology by presenting a set of chapters each of which covers a specific virus family, using one or two well-studied viruses as examples. These chapters are each designed to tell a story about the viruses being considered, and to portray the "personality" of those viruses, with the idea that this will help students to learn about and remember each virus group.

This organizational scheme has been used in a number of successful virology textbooks, including Salvador Luria's classic 1953 book, *General Virology*. Luria was one of the founding members of the "phage group", a coalition of physicists, biologists and chemists who chose during the 1940s to study bacteriophages in order to understand the molecular basis of life, and who invented the field of molecular biology. Their approach was to study how the proteins and nucleic acids of viruses interact with cellular molecules and organelles, transforming the cell into a factory that can produce many new progeny virus particles. Their underlying hope, largely achieved, was to use viruses as a tool to help understand how cells work.

The amount of knowledge that has accumulated about viruses has expanded enormously in recent years, as in many other areas of biomedical sciences. *Fields Virology* has become the classic reference book for knowledge about human and animal viruses during the past 25 years; that book is also organized in chapters that cover specific virus families. My own teaching experience and conversations with numerous colleagues convinced me that there is a real need for a concise, up-to-date textbook organized around the concept of virus families and designed specifically for teaching university students.

The problem was to make such a book accessible for beginning students but not to over-simplify the material. My approach was to ask a number of prominent virology researchers and teachers to write chapters on viruses that they knew well, using a set of criteria that I provided. I then edited and sometimes rewrote these chapters into a common style, and in many cases I created or redesigned the illustrations.

No individual can possibly write knowledgeably about the large spectrum of viruses that a virology course

should cover, so a collaborative approach was necessary. However, a textbook that is an effective learning tool must have a coherent organization and a clear and consistent style of writing and illustration. My job has been to craft the original chapters that I received into what I hope are readable and easily understood units.

The emphasis of this textbook is on virus replication strategies; it is directed towards university students studying microbiology, cell and molecular biology, and the biomedical sciences. It does not go deeply into pathogenesis, epidemiology, or disease symptoms. However, substantial information and stories about medical and historical aspects of virology are included, particularly in introductory sections of each chapter. Students who understand what diseases are caused by particular viruses, and the importance of these diseases in human history, may be motivated to learn more about those viruses.

What Is New in the Second Edition

The first edition of this book was well-received and was adopted as a text by over 100 university-based virology courses in North America and overseas. When we considered creating a second edition, my editor and I solicited reviews and suggestions for improvements from a number of university teachers. We also set out to improve the graphic qualities of the book, by introducing full-color figures and by incorporating the impressive computer-generated figures of viruses created by Philippe Lemercier, of the Swiss Institute of Bioinformatics, Swiss-Prot Group, University of Geneva. These virion figures and many others can be found on the web at Viralzone: <http://ca.expasy.org/viralzone/>.

The second edition includes five new chapters: two survey chapters, "Viruses of Archaea" and "Viruses of Algae and Mimivirus"; a chapter on a well-studied plant virus, "Cucumber Mosaic Virus"; and two chapters on the host response, "Cellular Defenses Against Virus Infection" and "Innate and Adaptive Immune Responses to Virus Infection". To make room for these chapters, a chapter on human T-cell leukemia virus was removed, but it is available for book users on the text's companion website (www.wiley.com/college/acheson). Additionally, parts of the chapter on Interferons were incorporated into the new chapter on Cellular Defenses. Furthermore, all but one of the remaining chapters in the first edition were revised and updated by the original contributors

or, in several cases, by other contributors recruited for that purpose. For example, the original chapter on herpes simplex virus now is entitled "Herpesviruses", and includes a substantial section on Epstein-Barr virus.

How To Use This Book

This textbook is designed to be used in a modular fashion. No course would be expected to use all the chapters in the book, nor necessarily in same order in which they appear. The organization of the book gives wide latitude to course coordinators to make their own choices of which virus groups will be covered. Chapters are designed to accompany a 50-minute lecture on the subject, or in some cases, two or three such lectures. It should be possible to read each chapter in 30–60 minutes, including examination of figures and tables. Lecturers might want to supplement material given in the text with experimental methods or results, which are not covered because of lack of space.

The book is organized into ten sections and 37 chapters. Four introductory chapters in Section I cover the history of virology and the virus life cycle, virus structure, virus classification, and the entry of viruses into animal cells. Four chapters in Section II cover well-studied bacteriophages. These are included because bacteriophages are among the best-known viruses, and because much of our knowledge of molecular biology and virology began with their study. Furthermore, bacteriophages are the source of many tools commonly used in modern molecular and cell biology laboratories. A final chapter in Section II covers exciting new knowledge about the sometimes bizarre viruses that infect archaea, members of the third domain of life alongside bacteria and eukaryotes.

Sections III through VII cover viruses of eukaryotes, with some emphasis on viruses that infect humans, although included are chapters on viruses that infect plants, insects, and algae. The division into sections is based on the nature of the virus genome and virus replication strategies: positive-strand RNA viruses (Section III), negative-strand and double-stranded RNA viruses (Section IV), DNA viruses (Sections V and VI), and viruses that use a reverse transcriptase (Section VII). Within a section, smaller and simpler viruses are discussed first, then larger and more complex viruses. In this way, concepts that are learned about simpler viruses can be applied when more complex viruses are encountered.

Section VIII covers small infectious entities that are not viruses: viroids, which are virus-like nucleic acids that replicate but code for no proteins; and prions, which are infectious proteins that contain no detectable nucleic acid. Section IX includes the two new chapters on host responses to virus infection, with important new information on detection of virus infection, intrinsic

cellular responses to virus infection, and innate and adaptive immune responses. Finally, Section X finishes the book by reviewing some important applications in virology: antiviral vaccines, antiviral chemotherapy, and virus vectors.

Each chapter begins with an outline. For chapters that cover virus families, these outlines are "thumbnail sketches" that contain some basic information about virion structure, genome organization, replication strategies, diseases caused, and distinctive characteristics shared by viruses in that family. These outlines are designed to serve as study aids that will help students understand and remember common features of the viruses they study.

Subheadings within each chapter are explanatory phrases, telling the reader what will be discussed in the next several paragraphs. These subheadings (collected in the Table of Contents) can also be read separately to provide an overview of the material presented in the chapter, and to follow the steps of the virus replication cycle. Figures concentrate on individual well-studied steps in virus replication. Most figures are designed to be simple and easily understood while one is reading the accompanying text, rather than comprehensive (and sometimes complicated!) descriptions of the entire replication cycle. Figure legends are kept to a minimum.

Specialized terms that may be unfamiliar to students are presented in bold type at their first appearance in each chapter. These Key Terms are collected at the end of each chapter as a review aid, and definitions are given in a combined glossary at the end of the book. Many chapters have text boxes that cover intriguing applications or recent developments in research. Each chapter finishes with a list of Fundamental Concepts, statements outlining the most important facts or conclusions that the reader should have learned. Finally, a set of Review Questions is included as a further review tool and to alert the student to the kinds of knowledge that might be expected in test questions.

Answers to Review Questions are available to course instructors at the Instructor Companion Site of Wiley Higher Education at: www.wiley.com/college/acheson. The full text and figures of the chapter on Human T-cell Leukemia Virus Type I that appeared in the first edition but was not included in the second edition are also available at that site.

Key Features of This Book

- A concise, up-to-date textbook designed for university-level virology courses for students in biomedical sciences and microbiology
- Written in a simple and clear style for students with a background in cell and molecular biology

ACKNOWLEDGMENTS

- Explains replication mechanisms of viruses representing many of the major virus families
- Many full-color figures complement the text and illustrate virus structure, genome organization and individual steps in virus replication
- Each chapter is designed to tell a story about a specific virus family and to portray the "personality" of the virus covered
- Chapter introductions give historical background and information about viral diseases
- Includes study aids such as thumbnail sketches of each virus group, informative chapter subheadings, text boxes outlining recent research and applications, a list of fundamental concepts after each chapter, sample test questions, and a comprehensive glossary with definitions of numerous terms
- An introductory section provides basic information about the history of virology, virus replication, virus structure, classification of viruses, and virus entry into cells
- A section on viruses of bacteria and archaea covers four of the best-known bacteriophages: single-stranded

RNA phages, ϕ X174, T7 and lambda; as well as a survey of the known viruses of archaea

- Five sections containing 21 chapters cover a wide variety of viruses that infect animals, plants, algae and insects, with emphasis on viruses that cause human disease
- Includes chapters that cover important human pathogens such as Ebola virus, hepatitis B and C viruses, herpes viruses, human immunodeficiency virus, influenza viruses, measles virus, poliovirus, SARS coronavirus, smallpox virus, West Nile virus and others
- A chapter on viroids: small infectious nucleic acids that do not code for proteins but cause important plant diseases
- A chapter on prions: infectious proteins that cause mad cow disease and Creutzfeldt-Jacob disease in humans
- A section on host defenses, with discussion of intrinsic cellular responses, innate and adaptive immune responses to virus infections
- A concluding section with chapters on antiviral vaccines, antiviral chemotherapy, and virus vectors

Kevin Witt, under whose tutelage the book first saw the light of day. Kevin also launched the present second edition, and both Associate Editor Michael Colchester and Senior Production Editor Joyce Polinger lent of constant and unwavering help throughout this process.

A number of university and college teachers of virology reviewed the content of the book at various stages of the manuscript at various stages and offered helpful suggestions and comments. On behalf of all of my colleagues who contributed chapters to this book, I would like to thank the following reviewers:

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