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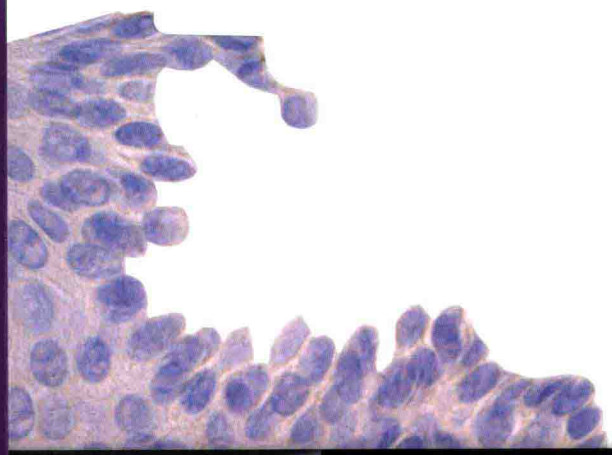
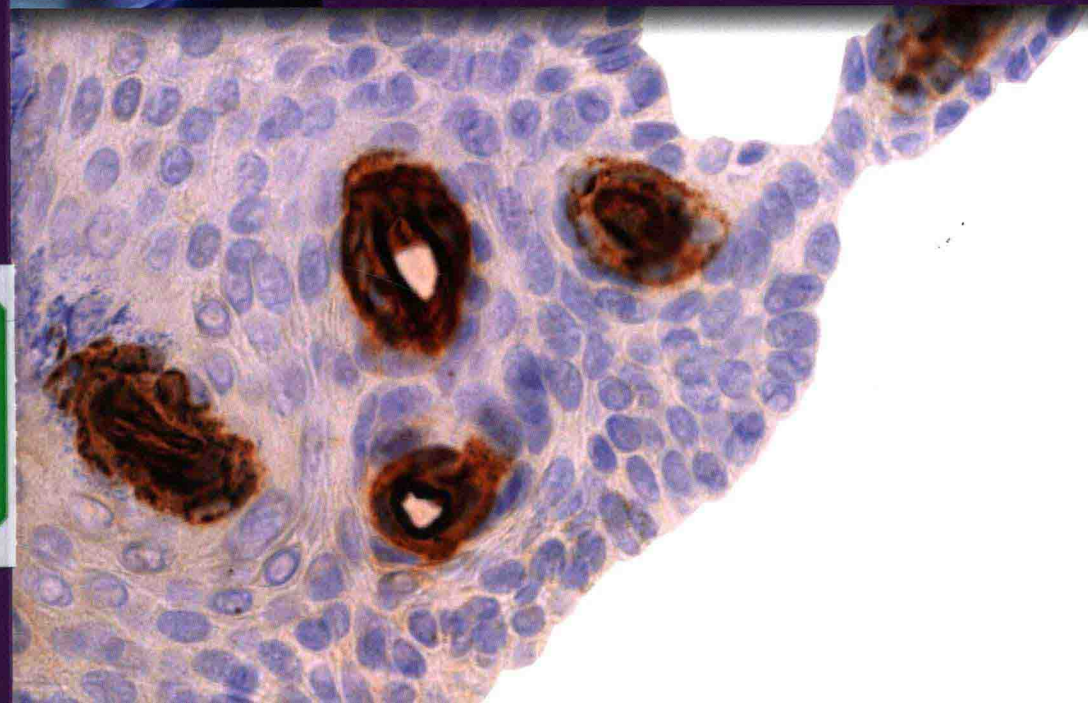


CELL STRUCTURE & FUNCTION

EDITED BY Guy Orchard & Brian Nation



IBMS
Institute of
Biomedical
Science

Cell Structure and Function

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Acknowledgments

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Special thanks are also due to our respective families, especially Sarah, Ross and Kim, for their understanding and forbearance during the many hours devoted to the completion of this, our second volume, in the Fundamentals of Biomedical Science series.

Guy Orchard

Brian Nation

Foreword

Of the trillions of cells that make up the human body, it's quite amazing to think that there exists absolute order within this vast sea of cellular diversity. A fundamental point to remember is that every cell belongs to a cell line, which in turn belongs to a system. The organs of the body play a pivotal role in maintaining the body systems and offer their own fascinating structural complexities.

As a student of biomedical science, you are taught early on that understanding the normal structural and functional features of the human body should always form the basis for understanding disease states. Put more simply, it's about how disease affects the normal cellular and body systems. In order to comprehend this, it is essential to appreciate fully what 'normal' looks like, and that's what this book is about.

Unlike textbooks and colour atlases that currently exist, this book attempts to link the systems and cross reference the interlinking themes. The early chapters set the scene and give the reader the fundamentals of cell structure and how they form systems and organs. There is also a chapter on the tools that enable us to study cells. The book then explores the body systems and organs chapter by chapter, from the inside out.

When looking at children's plastic interlocking bricks, one can see how clever the designer had been and how clearly thought through were the minor details of how to construct any number of different models. As a concept, this is not a million miles from the workings of the human body, in that every cell is part of a larger system or organ and has its own role to play within that matrix, just like the parts of a children's model.

Finally, this book is designed to complement the other volumes in the Fundamentals of Biomedical Science series; indeed, it sets the foundations for the series and cross references to other volumes throughout. As with the other books in the series, it follows a similar style that emphasizes key points, key terms and self-check questions to support and encourage the reader to check their understanding as they progress through the text.

'An investment in knowledge pays the best interest'
Benjamin Franklin

Guy Orchard
Brian Nation

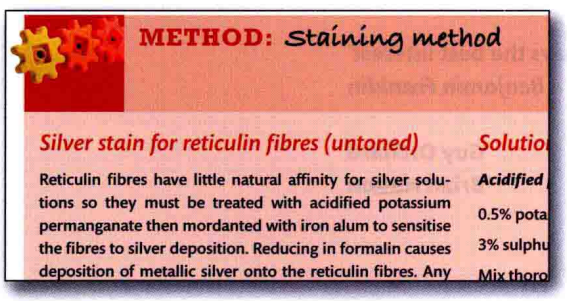
An introduction to the Fundamentals of Biomedical Science series

Biomedical scientists form the foundation of modern healthcare, from cancer screening to diagnosing HIV, from blood transfusion for surgery to infection control. Without biomedical scientists, the diagnosis of disease, the evaluation of the effectiveness of treatment, and research into the causes and cures of disease would not be possible. However, the path to becoming a biomedical scientist is a challenging one: trainees must not only assimilate knowledge from a range of disciplines, but must understand—and demonstrate—how to apply this knowledge in a practical, hands-on environment.

The Fundamentals of Biomedical Science series is written to reflect the challenges of biomedical science education and training today. It blends essential basic science with insights into laboratory practice to show how an understanding of the biology of disease is coupled to the analytical approaches that lead to diagnosis. Produced in collaboration with the Institute of Biomedical Science, the series provides coverage of the full range of disciplines to which a biomedical scientist may be exposed.

Learning from this series

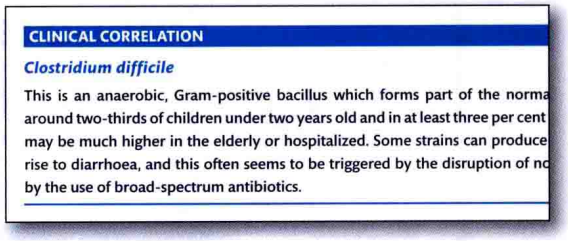
The Fundamentals of Biomedical Science series draws on a range of learning features to help readers master both biomedical science theory, and biomedical science practice.



Method boxes walk through the key protocols that the reader is likely to come across in the laboratory.

Additional information to augment the main text appears in **boxes**.

Clinical Correlation boxes emphasize at a glance how the material sits in a clinical context.

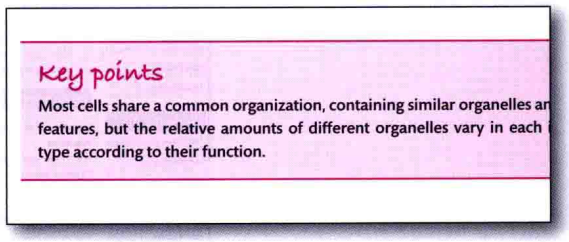

CLINICAL CORRELATION

Clostridium difficile

This is an anaerobic, Gram-positive bacillus which forms part of the norma around two-thirds of children under two years old and in at least three per cent may be much higher in the elderly or hospitalized. Some strains can produce rise to diarrhoea, and this often seems to be triggered by the disruption of nc by the use of broad-spectrum antibiotics.

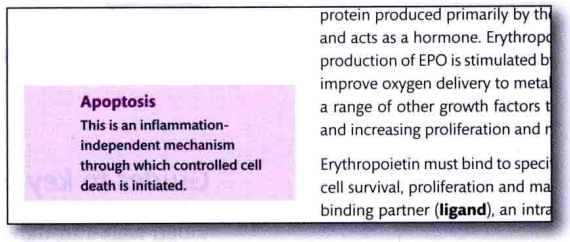
Further features are used to help consolidate and extend students' understanding of the subject

Key points reinforce the key concepts that the reader should master as they work through each chapter, while **Summary** points act as an end-of-chapter checklist for readers to verify that they have remembered the principal themes and ideas presented within the chapter.


Key points

Most cells share a common organization, containing similar organelles ar features, but the relative amounts of different organelles vary in each type according to their function.

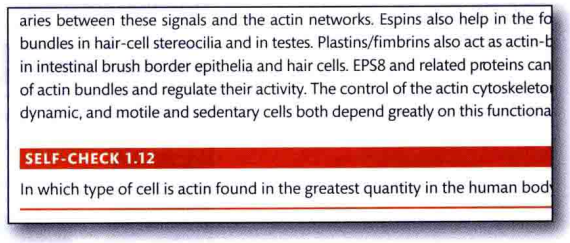
Key terms in the margins provide instant definitions of terms with which the reader may not be familiar; in addition, each title in the series features a **glossary**, in which the key terms featured in that title are collated.


Apoptosis
This is an inflammation-independent mechanism through which controlled cell death is initiated.

protein produced primarily by th and acts as a hormone. Erythropo production of EPO is stimulated b improve oxygen delivery to meta a range of other growth factors t and increasing proliferation and r

Erythropoietin must bind to speci cell survival, proliferation and ma binding partner (**ligand**), an intra

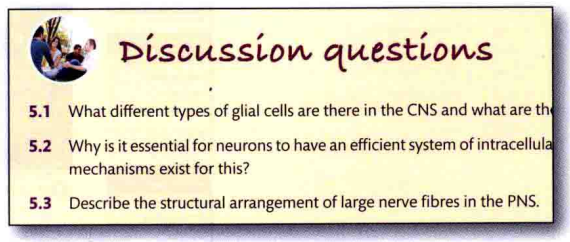
Self-check questions throughout each chapter provide the reader with a ready means of checking that they have understood the material they have just encountered; answers to self-check questions are presented in the book's Online Resource Centre.


aries between these signals and the actin networks. Espins also help in the fo bundles in hair-cell stereocilia and in testes. Plastins/fimbrins also act as actin-b in intestinal brush border epithelia and hair cells. EPS8 and related proteins can of actin bundles and regulate their activity. The control of the actin cytoskeleto dynamic, and motile and sedentary cells both depend greatly on this functiona

SELF-CHECK 1.12

In which type of cell is actin found in the greatest quantity in the human bod

Discussion questions are provided at the end of each chapter, to encourage the reader to analyse and reflect on the material they have just read. Hints and tips for answering the discussion questions are provided in the book's Online Resource Centre.

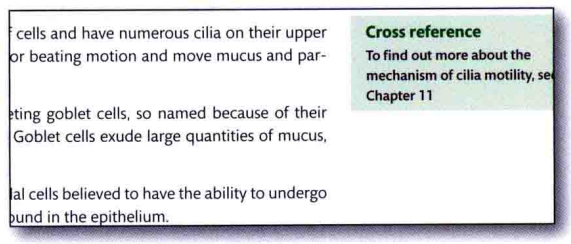

Discussion questions

5.1 What different types of glial cells are there in the CNS and what are th

5.2 Why is it essential for neurons to have an efficient system of intracellula mechanisms exist for this?

5.3 Describe the structural arrangement of large nerve fibres in the PNS.

Cross-references help the reader to see biomedical science as a unified discipline, making connections between topics presented within each volume, and across all volumes in the series.


cells and have numerous cilia on their upper or beating motion and move mucus and par-

ting goblet cells, so named because of their Goblet cells exude large quantities of mucus,

al cells believed to have the ability to undergo ound in the epithelium.

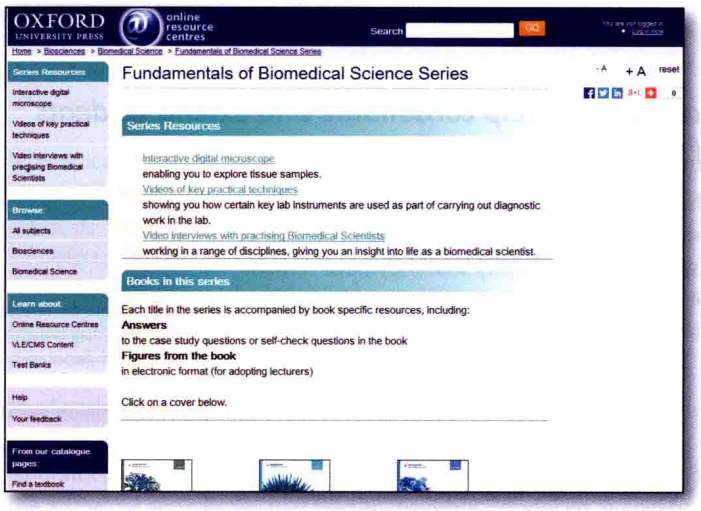
Cross reference
To find out more about the mechanism of cilia motility, se Chapter 11

Online learning materials

online resource centre

Each title in the *Fundamentals of Biomedical Science* series is supported by an Online Resource Centre, which features additional materials for students, trainees and lecturers.

www.oxfordtextbooks.co.uk/orc/fbs



Guides to key experimental skills and methods

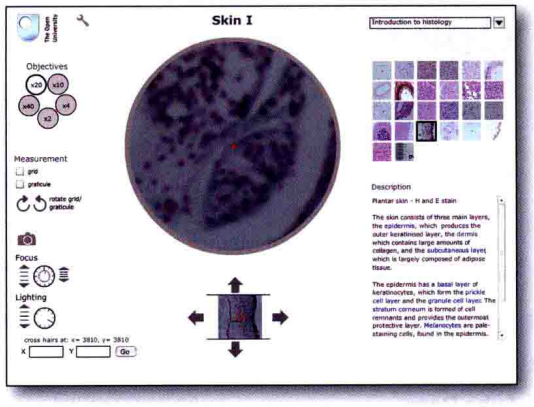
Video walk-throughs of key experimental skills are provided to help you master the essential skills that are the foundation of biomedical science practice.

Biomedical science in practice

Interviews with practicing biomedical scientists working in a range of disciplines give a valuable insight into the reality of work in a Biomedical Science laboratory.

Virtual microscope

Visit the library of microscopic images and investigate them with the powerful online microscope, to help gain a deeper appreciation of cell and tissue morphology.



Lecturer support materials

The Online Resource Centre for each title in the series also features figures from the book in electronic format, for registered adopters to download for use in lecture presentations, and other educational resources.

To register as an adopter visit **www.oxfordtextbooks.co.uk/orc/** and follow the on-screen instructions.

Any comments?

We welcome comments and feedback about any aspect of this series.
Just visit **www.oxfortextbooks.co.uk/orc/feedback/** and share your views.

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Contents

1 Introducing the cell: the unit of life

Carole Hackney and David Furness

Learning objectives

After reading this chapter you will have gained knowledge and understanding of:

- The range and diversity of cells in the three main domains of life.
- One possible route by which eukaryotic cells may have evolved from prokaryotic cells.
- The overall organization of the eukaryotic cell and the structure and function of subcellular organelles.
- Protein synthesis and the role of ribosomes in translating the genetic code.
- Membrane flow between organelles and its role in protein sorting.
- Lipid synthesis and the role of the endoplasmic reticulum.
- Metabolism and the role of mitochondria.
- The composition and organization of the cytoskeleton.
- Cell division and specializations.
- Cell death pathways.

The diversity of life is evident everywhere we look in our environment. Even in a tiny region of the world's biosphere, such as a pond or a few grams of soil, there is a huge richness of organisms; both visible and microscopic life abound and find ways to fill every ecological niche. Taxonomically, these organisms have until recently been classified into five major kingdoms: Animalia, Plantae, Fungi, Protista and Monera. The latest classifications divide life into three domains: the archaea (primitive bacteria-like forms), the bacteria and the eukaryota.

Despite the diversity, and the many differences between organisms, there are fundamental characteristics that all share. They are composed of specific types of organic molecules which can be subdivided primarily into proteins, lipids, carbohydrates and nucleic acids, arranged in various molecular structures (Box 1.1). Firstly, each organism carries the instructions for building and maintaining its structure in a