Bailey's Textbook of HISTOLOGY

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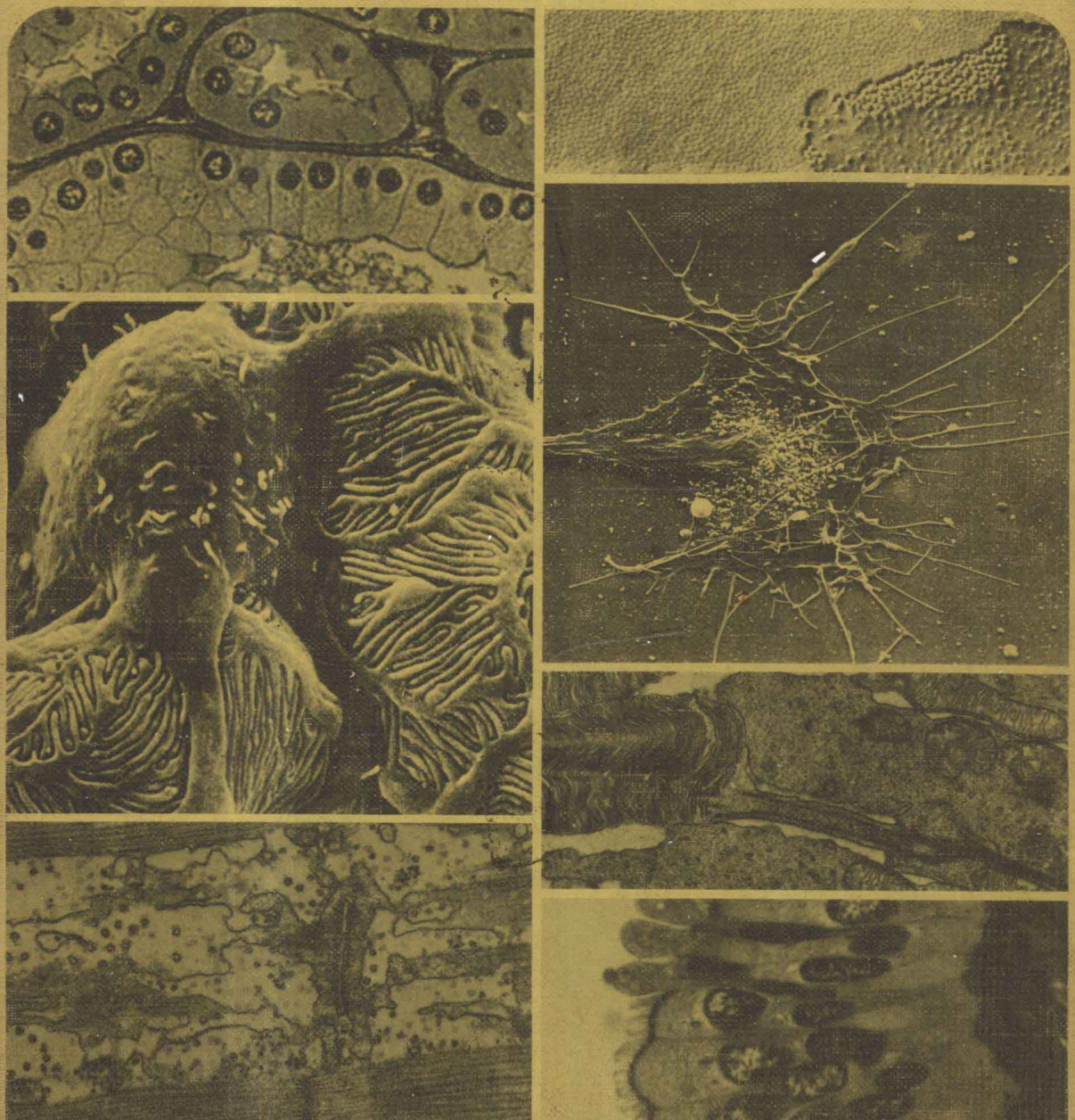
SEVENTEENTH EDITION



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Preface to The Seventeenth Edition

Since the last edition of this textbook was published (1971) there have been marked advances in histology and its related fields as a result of well conceived experimental studies combined with improved techniques. A wealth of new information has been obtained by electron microscopy through improvement in technical methods, such as those for freeze-fracture replication, improvement in instrumentation, and improvement in our interpretive abilities. Results obtained by scanning electron microscopy have also provided a better understanding of structure in three dimensions. As a result, a number of the older electron micrographs used in previous editions of this textbook have been replaced and numerous additional ones that reflect some of the recent advances have been included. Numerous light micrographs of thin (1 to 2 μm) sections of plastic-embedded tissue fixed by vascular transfusion have been added to provide better light microscopic detail and to give better correlation between light and electron microscopy.

In histology, as in other disciplines, new research not only answers some questions but also raises many new questions. In this revision, as in previous ones, we have tried to make the more important points stand out somewhat from the accompanying details. We have tried to present the material in a manner that is most useful for students and we have provided selected references for those who wish to pursue particular topics in more detail.

At the University of Southern California, we have found it advantageous to teach human embryology in a closely integrated fashion with histology. Students learn the embryonic body plan and emergent organ systems as arenas in which the differentiation of the basic cells and tissues is occurring. They learn the cells and tissues as products of developmental processes and recognize thereby both essential differences and similarities among differentiated cellular populations. In this spirit, we have departed somewhat from the usual histology textbook format to include an expanded chapter on early human development and to include added embryological insight into most discussions of tissues and organs. We hope this will prove helpful to the wide variety of patterns in which courses in microscopic anatomy are taught.

This textbook has been rewritten a number of times since the first six editions by Frederick R. Bailey, M.D., between 1904 and 1926. However, the book still contains passages and illustrations incorporated by many others into subsequent editions. A resumé of these contributions before the 15th edition is given in a part of the 15th edition Preface, which is reprinted on page vii of this edition.

The present edition also contains some text material and a number of illustrations in the chapters on the cell, nervous tissue, and sense organs which were added by Drs. Richard and Mary Bunge, who participated in the 16th edition revision.

A number of illustrations included in this textbook have been obtained from colleagues at other universities and we are grateful for their generosity. Credits for those illustrations are given in the figure legends. We are also grateful to Dr. Mikel Snow for providing the brief text of the section on muscle regeneration, to Mr. Pete Mendez and some of his students, who provided new drawings, and to technicians, secretaries, and many other colleagues who have contributed immeasurably to the preparation and the content of the book.

Finally, we wish to express our appreciation to the Publishers for their cooperation and assistance in the production of this book and for their patience in awaiting its completion.

WILFRED M. COPENHAVER, PH.D
DOUGLAS E. KELLY, PH.D.
RICHARD L. WOOD, PH.D.

Excerpts from the Fifteenth Edition Preface

A brief resumé of the history of this textbook seems appropriate at this time (1964). The first edition was written by Professor Frederick R. Bailey at the College of Physicians and Surgeons and was published by William Wood and Company in 1904. Professor Bailey, with assistance from Professor Oliver Strong on the nervous system, continued the book through the sixth edition, published in 1920. Although the text has been rewritten by a number of authors since the time of Professor Bailey, it has adhered to his objective of emphasizing fundamentals.

Professors Oliver S. Strong and Adolph Elwyn revised the seventh edition (1925) and a part of the eighth edition (1932). Professors R. L. Carpenter, C. M. Goss, and A. E. Severinghaus participated with Professor Philip E. Smith and myself in completing the eighth edition (1932) and in the subsequent revisions of the ninth and tenth editions. The text retains valuable contributions made by them.

Professor Philip E. Smith served as editor of the ninth and tenth revisions and as coauthor of the eleventh, twelfth, and thirteenth editions. His contributions of material plus his sound editorial judgment had an important role in whatever success the textbook achieved during editions eight to thirteen inclusive. Professor Dorothy D. Johnson assisted with the thirteenth edition and became coauthor in the fourteenth edition. She made particularly valuable contributions to the chapters on the digestive system, respiratory system, and endocrine glands. It is regretted that unavoidable circumstances prevented Professor Johnson from participating in this edition.

I am indebted to Mr. Robert Demarest for all new drawings for this edition and for those which were added in the previous edition. I am also indebted to Mr. Carl Kellner (now retired) for the drawings which appeared first in editions nine to thirteen inclusive.

Many valuable suggestions have come from my colleagues at Columbia and from those in other schools. I am indebted particularly to Professor Thomas E. Hunt for a number of constructive suggestions.

WILFRED M. COPENHAVER, PH.D.

Introduction

All living organisms consist of minute elements which are called cells. These cells are the smallest structural units possessing those properties which we commonly associate with life. They are able to nourish themselves, to grow, to respond to stimuli, and to reproduce. Some organisms, the protozoa, consist of one cell only; the higher types, metazoa, may consist of infinite numbers of cells varying greatly in structural characteristics. Each of these multicellular organisms starts its existence as a single cell, the fertilized ovum, which by a process of proliferation and differentiation gives rise to the adult body. At first the cells of the developing embryo are similar in shape and structure. As growth continues, differentiation leads to the formation of groups of specialized cells, each group differing in structure from the others, each group adapted to subserve one or more specific functions. These specialized groups form the *tissues* of the adult body. At a very early period the cells of the embryo become separated from each other by the formation of varying amounts of intercellular substance, which may be the result of cellular secretion or actual modifications of cellular substance. In some of the tissues this intercellular material assumes enormous proportions. Thus the adult body is composed of cells and intercellular material, all elements so interrelated as to form a normally functioning machine.

Histology in a restricted sense is the study of the tissues of the body, but because the tissues are composed of cells and their products, a knowledge of the structure and activities of the cell must necessarily form the basis of histology. The first two chapters of the book are therefore given to a discussion of cells in general, the first of these these dealing with cells after fixation and the second with living cells. Each of these chapters obviously supplements the other. Succeeding these, the structure of the tissues is presented. This is followed by the microscopic anatomy of the various organs.

Over the years, histologists have tended to categorize the various cells and tissues of the body. They have classified them largely according to apparent differences, somewhat more than according to similarities. Textbooks of histology have tended to emphasize the categorizations, and students often dismiss their study of histology once they have memorized the essential differences that distinguish the categories under scrutiny. Yet we now understand ever more clearly that the similarities and common properties are as important as the differences. Nature has, in fact, not designed separate, distinct categories, but rather has evolved a spectrum of structural and functional possibilities around which the living organism is fabricated. Thus, in histology it is ultimately more important to interrelate

and compare the properties of cells and tissues than it is simply to separate and name them.

Whereas histology is a structural science and complements at finer levels of resolution anatomical knowledge gained from dissection, its intimate relation to biochemistry, physiology, and pathology must be emphasized. The cell is a unit not only of structure but also of physiological activity. The formation of the specialized tissues is the structural expression of a physiological division of labor. The structures seen under the microscope assume a meaning only in the light of their functional significance. Thus the structure of muscles and glands can only be studied by constant reference to contraction and secretion. Normal physiological processes are associated with normal structure; abnormal processes are usually expressed in the altered structure and relationship of the cells and intercellular substance.

Recognition of these considerations, then, implies an awareness of increased breadth in the discipline of histology. To understand cells and tissues is to appreciate the common properties they have shared since their embryonic ancestry, the subtle and dramatic special propensities they have acquired during maturation, the minuteness of their most important parts, the delicate metabolic balance within which they normally operate, and the ease with which all of this can be altered to give conditions we define as disease. Understanding cells and tissues is not unlike understanding people and societies.

Contents

CHAPTER 1

The Cell

The goal of anatomical study is not just the acquisition of an accurate, static visualization of the structural elements of living systems. Rather, such visualization must lead eventually to an appreciation of those elements as dynamic, changing entities in the flux of activity that is life. Living *structure* is the fabric upon which *function* is organized; neither can be understood without reflection upon the other. Anatomists have traditionally striven to visualize and describe as directly as possible the structural components of cells, tissues, and organs in a manner which is most representative of the living state. It is a difficult task, for important structure is often not rendered visible unless the cell or tissue is killed, and the anatomist must try somehow to assure himself that death has not rendered a distorted image of the living state. Moreover, anatomists have found repeatedly that the most challenging aspects seem to lie just beyond the resolution of the naked eye or microscopic tools at hand. Hence, the major challenge has been to develop better methods for accurate visualization of ever smaller parts.

We have recently seen an enormous expansion of histology and cytology, the youngest of the anatomical sciences. Utilizing the methods of histochemistry, light and electron microscopy, and tissue culture, cytological studies have clarified much of the structure of subcellular elements. These revelations, combined with new knowledge from biochemistry and cell physiology, have led to a firmer basic understanding of many of the ongoing processes of the living cell.

Neither the term "cell" nor the term "cell concept" will be new to readers of this text. The 19th century histologist Leydig defined a cell as "a mass of protoplasm containing a nucleus." This simple and useful description is still appropriate for animal cells today, for the minimal structural unit of protoplasm is that unit having available the genetic material (within the nucleus) which allows it to carry out, relatively independently, all of the vital functions necessary to sustain life. Although cells in higher organisms may develop considerable dependence on one another, each retains within its nucleus identical sets of genetic information necessary to carry out all cell functions. Cells which lose their nuclei may continue to function for some time because the nucleus previously made provision for the manufacture of all of the substances needed during the remaining life of the cell.

The term *protoplasm* denotes the entire living substance of the cell. This includes the cell body and its extensions and the nucleus which lies in it. The substance of the cell outside the nucleus is called *cytoplasm*; the substance of the nucleus is *karyoplasm* or *nucleoplasm*. The entire cell is circumscribed by a membrane termed the *plasma membrane* or *plasmalemma*.