

HISTOLOGY



ARTHUR W. HAM

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ARTHUR WORTH HAM, M.B.

*Professor of Anatomy, in Charge of Histology,
in the Faculties of Medicine and Dentistry,
University of Toronto, Toronto, Canada*

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TO MY
FATHER, MOTHER, WIFE

Preface

It is customary for the author, in his preface, to give reasons for having written that book. Psychiatrists are usually more cautious about this matter than most authors, tending to qualify their explanations with phrases such as "My conscious motivation was . . ." Probably the reasons advanced in many prefaces are not the author's real ones but only their rationalizations of ill-defined urges carried over from their youth. On thinking in this vein I suppose that my desire to write a book and, in particular, one that would be easy for students to understand, was born while I was a medical student as a result of having to use so many books that were difficult to understand. Direction was given to this impetus a few years ago by collaborating with Dr. M. D. Salter, a psychologist, in studying some of the common learning problems of students and in writing *Doctor in the Making*. These experiences suggested that the most obvious way to make a student's book understandable would be to take into account the common learning problems that students experience in the subject with which it deals. This has been done in this book which, therefore, deals to some extent with the problems of learning and remembering histology as well as with the subject-matter of histology itself.

The purpose of some of the measures adopted to facilitate the reader's understanding histology will be obvious on a casual glance; for example, the use of considerable space and many illustrations to help the student with the problems of three-dimensional visualization (Chap. 3). These problems are of peculiar importance in the study of histology, and if they are not understood they can be a major obstacle to a student's progress. Illustrating the common artifacts (Figs. 16-19), near the beginning of the book, is another measure, the purpose of which will be obvious to any readers who have taught histology, for they will know that artifacts, until they are explained, cause endless confusion. The order of the book, with its content divided into four sections, and with each section broken into main divisions and subdivisions, obviously is adapted to permitting the student to organize and classify its subject matter in his mind with a minimum of disorder.

On the other hand, some of the measures employed to make histology more readily understood and, in particular, more easily remembered are not so obvious as the foregoing one and perhaps should be explained here lest the informed reader who did not understand their purpose might think, on reading certain paragraphs, that unnecessary material was included.

First, it was kept in mind in writing every chapter that a student commonly studies histology before he has advanced very far with the study of gross anatomy and before he has begun the study of neuro-anatomy, physiology, biochemistry or pathology. This requires that a textbook of histology—if it is to present the subject in its proper perspective and be easily understood by the student reader—must contain much explanatory material that might seem superfluous to the *informed* reader.

Secondly, experience in teaching pathology years ago made me realize that students readily forget a great deal of what they are assumed to have learned in the usual course in histology. Psychologists tell us that whether or not a thing is remembered depends largely on the depth of the impression that it makes on the mind and on how firmly it is

tied into the mind with the bonds of association. The purpose, then, for correlating the subject matter of histology with that of as many other subjects as possible, and even with the practice of medicine itself in this book, is to put the facts of histology in such a perspective that they will make deeper impressions on the mind of the reader and at the same time provide the associations necessary for these impressions to be firmly tied into the mind for long-term retention.

In addition to the measures taken to facilitate the reader's understanding and remembering histology, there are other features of this book which perhaps should be mentioned here.

Since this is a new book it was comparatively easy to make an attempt to proportion the space allotted to the different aspects of histology in relation to the trends of the times. According to life-insurance statistics, degenerative diseases of the heart and arteries now account for more than half of the deaths for which claims are made. Accordingly, a considerable amount of space is allotted to the histology of the tissue ingredients and structures in the body in which degenerative phenomena occur. Thus a full chapter is devoted to intercellular substances and in this an account of the evolution of knowledge about hyaluronidase (spreading factor) is included. The problems that arise from the intercellular substances having to serve the dual role of providing support and of acting as a medium through which the nutrition of cells is achieved are emphasized. A discussion of this matter leads naturally to a full consideration of tissue fluid, and a full chapter is allotted to this subject and to the various mechanisms that account for edema (Figs. 59-64). The peculiar problems involved in the nutrition of arterial walls, as a possible background for the understanding of the prevalence of arteriosclerosis, is commented on at length. The mechanism of thrombosis is also explained; indeed, a full chapter is devoted to platelets and fibrin.

A background for the understanding of cancer, the second greatest cause of death in recent years, is laid in the chapter dealing with the cell. Here growth and differentiation are dealt with at some length, and the nature of cancer itself receives comment. Some of the newer work on nucleoproteins is also included. The morphologic differences between somatic cells of males and females, very recently discovered by Barr and Bertram, are described and illustrated (Fig. 358). Although the chapter dealing with bone includes much original work and is written with many clinical applications in mind, it is longer than usual, chiefly because adequate space was taken to explain properly this topic which, of all those in histology, students commonly find to be the most difficult. Although it would be premature to use the new terminology recently suggested by a committee of the American Association of Clinical Pathologists and endorsed by the International Society of Hematologists, in the text dealing with the blood and hemopoietic tissues, the new names for blood cells and their antecedents are listed beside their synonyms used in the text at the end of the section dealing with hemopoietic tissues so as to be available as the new terminology becomes more widely used.

The modern trend in teaching anatomy accounts for the inclusion of no more than a general description of the microscopic structure of the tissues comprising the central nervous system; the details of this structure are given in the modern course in neuroanatomy and hence in the textbooks that deal with this subject. This is as it should be, for microscopic anatomy in this field is scarcely intelligible until the gross anatomy of the brain and the cord is also studied. However, the tissues of the peripheral nervous system, including nerve endings and the organs of special sense, still seem to be the property of the general histologist; hence, these matters are dealt with at some length in

this book. An introductory discussion of the autonomic nervous system is also included in order that students may have some appreciation of the type of innervation with which the smooth muscle and the glands of the body are supplied. So far as may be accomplished in histology, an effort was made in this connection to lay the groundwork for students developing a psychosomatic point of view.

In accord with the general theme of illustrating the practical applications of histology, the subject of burns and skin grafting commands considerable attention in the chapter on skin. Much original work, particularly with regard to the different capillary beds affected by burns of different depths, the repair of skin, and the methods by which skin grafts are vascularized, is included. Original work also influenced the account of the development of the lung and the concept of the nature of respiratory tissue that is presented. The new findings described by Trueta and his associates regarding the circulation of blood through the kidneys are presented in some detail. The fact that the various forms of arthritis constitute the greatest single cause of disability in the civilized world was thought to be sufficient justification for a full chapter on articulations.

The great advances made in endocrinology during the last two decades justify much more space being devoted to endocrine glands and the reproductive system than was necessary in the past. Moreover, in writing the chapter dealing with these systems the view was taken that in this field microscopic structure and hormone balances are so interrelated that they cannot be separated effectively; hence, the treatment given these chapters is histophysiologic in type and therefore somewhat extensive. Since diabetes in 1946 ranked ninth as a cause of death in the United States, it was thought only proper to devote a considerable amount of space to a discussion of the islets of Langerhans and their relation to diabetes and to the other endocrine glands concerned in this condition. This and other parts of the account on endocrine glands are salted with personal experiences in this field of research.

Over ninety per cent of the illustrations are new or original and almost all of these were prepared specially for the purpose. Over one hundred and forty new drawings, the majority of which were made by Dorothy Chubb and Louise Gordon, are included, together with over four hundred new photographs, mostly photomicrographs. Particular attention was paid to labeling both the drawings and the photomicrographs clearly so that students would be able to use the book efficiently in the laboratory. Some illustrations were taken from eminently suitable material already in the literature, and I wish to acknowledge the kindness of those who granted permission for their use.

Enough has been said to suggest the manner in which this book may exhibit individuality. I should like to remind the reader that, since the time of Virchow, histology has been the chief basis in reality for our concepts of normal and disease processes. With modern medicine becoming more complex every day, this is a very impressive function for histology to perform, and its contemplation leads to the conclusion that present-day students should be learning more rather than less histology. It also suggests that although this book is primarily designed as a text for such general courses in histology as are given to students in medicine, biologic science and dentistry, it may be found useful also to those graduates of medicine who feel the need of increasing their background knowledge in one or in many fields in order to understand better some of the problems of the day.

ARTHUR W. HAM

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Acknowledgments

The rapid growth of knowledge in medical science is making it increasingly difficult for anyone to write authoritatively about more than a very limited field. Any single individual who now tries to write a reasonably comprehensive book about histology and makes any substantial attempt to correlate histology with other subjects requires help. It would be difficult to find a more friendly and helpful group of colleagues than those of the Department and Medical School in which this book was written, and many of them have given me a great deal of assistance.

The influence of example, as a stimulus to industry and accuracy, is vast, and for this reason I am greatly indebted to Dr. J. C. B. Grant, the head of this Department. I wish to thank him also for consistently encouraging me to write this book and to write it in my own way, a way that has been immeasurably improved as a result of his influence. I am also greatly indebted to Dr. H. A. Cates, who read and improved a great deal of the manuscript and devoted many hours of his time to helping me achieve some degree of correlation between microscopic and gross anatomy. Dr. C. G. Smith and Dr. J. C. Watt also read many sections of manuscript and gave me many helpful suggestions.

My immediate colleagues in histology have been equally helpful. Dr. S. H. Bensley, during the last year and a half, has assumed cheerfully many of my duties to give me more time for finishing the book. She also read much of the manuscript and made excellent suggestions about it; she gave special assistance in connection with the section dealing with the "Ear," both in helping to prepare the manuscript and in supervising the making of illustrations for this section from slides in her own collection. I am exceedingly grateful to Dr. M. M. Mosbaugh, who was of the greatest help in preparing the bibliography and in reading manuscript and proof. This talented individual also made several of the drawings, including the color plate illustrating the formation of blood cells. Miss W. C. Riddle, my colleague in Dental Histology, was of the greatest assistance in helping to prepare the portion of the book dealing with the development and the structure of teeth and in supervising preparation of the illustrations for this section. Dr. K. Baldwin gave real assistance with many chapters, and Dr. M. I. Armstrong was also most helpful in reading both manuscript and proof.

Three recent graduates of medicine, while pursuing full-time research studies with me during 1947-1948, gave special and substantial help in preparing parts of the manuscript dealing with the objects of their investigations. Specifically, Dr. W. R. Harris wrote the first draft of the chapter on "Articulations" and prepared the photomicrographs that illustrate this chapter. In addition, he assisted with the chapter on "Intercellular Substances." Dr. R. K. MacDonald prepared the first draft of the section dealing with the "Eye" and planned and supervised the making of most of the illustrations for this section. He assisted me in preparing each subsequent draft and finally in correcting the proof for the section. Likewise, Dr. A. Carrie prepared the first draft of the section dealing with the "Ear." I was indeed fortunate to have had three such able young men as postgraduate students during a year when I was greatly pressed for time. I wish also to thank Dr. M. L. Bunker for assisting in the teaching of histology that same year

and for preparing the draft of the section dealing with cutaneous and deep sensibility, a matter in which his researches had given him a special interest.

Members of several other departments also read and criticized sections of manuscript. For this service I wish to thank Drs. J. Campbell, E. S. Goranson and R. E. Haist, of the Department of Physiology; Drs. C. G. Butler, J. Fisher and A. Wynne, of the Department of Biochemistry; Dr. J. K. Ferguson, of the Department of Pharmacology; Drs. Wm. Boyd and W. L. Robinson, of the Department of Pathology; Dr. Wm. Dafoe and Dr. N. Henderson, of the Department of Obstetrics and Gynecology; Dr. S. Gordon, of the Department of Surgery; Dr. K. J. R. Wightman, of the Department of Medicine; and Dr. W. S. Hartroft, of the Department of Medical Research. I wish to thank Dr. Henderson and Dr. Gordon, for providing sections for photomicrographs, and Dr. Hartroft, for several photomicrographs. I wish also to thank Dr. Gordon Scott, of Wayne University, for reading and criticizing a section of manuscript.

Most of the drawings were made by Dorothy Chubb and Louise Gordon, and they also labeled most of the photomicrographs. It would be superfluous to comment on the quality of their work, but I should like to say that working with two medical artists in whom insight, talent and charm are so generously blended converted what might have been a vexing task into a most enjoyable experience. I wish also to thank Miss Maria Wishart, director of the School of Medical Art, University of Toronto, for taking such an interest in the illustrations for this book and for arranging for Mrs. Gordon, then one of her students, to prepare illustrations for me during the summer months. I wish to thank Miss Wishart also for arranging for several other illustrations to be made for me by her other students. Among these I am particularly grateful to Mr. L. E. Masoure, who made several illustrations, including the colored plate illustrating blood cells.

Most of the sections from which the photomicrographs were obtained were cut and stained by Mr. H. Whittaker, my chief technical assistant. About half of the photomicrographs were taken by Mr. Whittaker, and the remainder by myself. Mr. Whittaker, however, was responsible for all the developing and printing. His special talents, always so cheerfully proffered, are in no small measure responsible for the quality of the illustrations. I also wish to acknowledge the great help of Mr. George Ross, my chief laboratory assistant, whose skilled help in experimental work made it possible to include many illustrative examples of this phase of histology in the text and in the illustrations.

Miss Mary McConnell was responsible for most of the secretarial work involved in the preparation of the book, and I wish to thank her for performing this extensive task with such accuracy, despatch and good humor.

Finally, I wish to thank my publishers for their trust and complete co-operation. I hope that they feel, as I do, that if the book had been written more quickly we would not have had time to have become such good friends.

A. W. H.

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