KARL A. STILES

HANDBOOK OF HISTOLOGY

Fourth Edition

THE BLAKISTON DIVISION
McGRAW-HILL BOOK COMPANY Inc.

HANDBOOK OF HISTOLOGY

(Formerly *Handbook of Microscopic Characteristics of Tissues and Organs*)

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With an Introduction by
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The Blakiston Division
McGraw-Hill Book Company, Inc.
New York Toronto London 1956

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Library of Congress Catalog Card Number: 56-9639

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THE MAPLE PRESS COMPANY, YORK, PA.

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Introduction

Histologic studies are made for a definite purpose: to help collect evidences from which to develop accurate concepts of the structure, functioning, and responses of the small parts of living bodies. When we have accurate concepts of the structure and behavior of small parts, we can deal inductively with this information and build up concepts of the functioning of whole organs and systems.

Each living animal lives in four dimensions: three of space and one of time. At any moment, each feature of an animal's anatomy exists in the three space dimensions. But many features of the spatial architecture undergo rapid or slow cyclic, intermittent, or progressive changes with time. The chemical and physical characteristics, the shapes, the magnitudes, and the positions of structures change as parts of development, of physiology, and of pathology. New structures appear and old ones disappear. These are changes along the time dimension.

A histologic section is not the original living material. It is only a two-dimension slice out of a four-dimension system, minus what has been lost and plus what has been added in its preservation and preparation for study. From mental pictures of serial sections, we construct some aspects of our concepts of the three dimensions of living structures. To get concepts of the changes of structures with time, we often select a group of animals, attempt to treat them all alike, hope they all respond alike in direction, degree, and rate, kill a few after selected time intervals, make two-dimension sections from each animal, and, from the resulting static pictures, by constructive imagination, synthesize mental concepts of life processes.

A course in histology has at least two major purposes: (1) to help the student begin to understand the structure and functioning of living things and (2) to give the student mental pictures of the two-dimension slices of "normal" organs. These picture concepts of "normal" organs serve as a base line against which to recognize and judge the abnormality of obviously altered organs. Each of these major purposes demands that the student shall be able to recognize as many dead tissues as possible, that he have firmly in mind the salient characteristics of each tissue and organ. For developing concepts of living microscopic anatomy, it is just as important for one to know the structure of tissues and organs as it is

for a mathematician to know the multiplication table, or the relationships commonly expressed in elementary algebra. The great complexity cannot be dealt with at all without a firm foundation, which in this case is the precise knowledge of the structure of sections of dead tissues and organs.

In too many courses in histology a large part of the time is spent teaching students to recognize histologic sections of tissues and organs. It is deplorable that students should have so much time wasted on this necessary but elementary phase of the subject. Would a mathematics department spend a corresponding proportion of the student's time on the multiplication tables?

The important functions of this book are to help students to learn to recognize tissues rapidly and to fix firmly in their minds the descriptive phrases which go with the salient features of the microscope image pictures presented by histologic sections. The handbook is a necessity, it presents outlines of the subject matter, it separates the trees from the forest; had Dr. Stiles not written the book, others would have attempted it. The book has great value to the student and teacher because it assists rapid learning of a group of basic phrase-plus-picture concepts, which is one of the necessary first steps toward learning and understanding the microscopic structure and functionings of living tissues and organs.

MELVIN H. KNISELY
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Preface

The enthusiastic reception and wide use of the three previous editions of this handbook demonstrate that it has made a definite contribution to the teaching of histology. The fourth edition is based on the same general plan as the others, but with many improvements. The entire text has been thoroughly revised. New data have been introduced on how to interpret sections, human blood, lymph, the reticuloendothelial system, nipple, areola, coccygeal body, and many other subjects. New illustrations have been included and new summary charts added; the enlarged glossary has been made self-pronouncing; and the bibliography has been expanded. This new edition reflects the valuable suggestions of many instructors and students who have been using the handbook.

There is a tendency for textbooks of histology to become so voluminous that they take on the character of a book of reference. The beginning student scans such a book with a feeling of discouragement and futility, under the impression that he will be expected to remember all the histologic minutiae which it contains. Only as the course progresses does he begin to realize that much of the subject matter is for reference, but even then he has great difficulty in distinguishing the grain from the chaff, a task for which he is poorly prepared. The handbook attempts to separate one from the other, and it assists the student of histology in the organization of his information. Because it is not a reference book, controversial material has been largely omitted. Where differences of opinion were unavoidable, the dominant concepts were adopted.

Diagrammatic line drawings of the fundamental tissues have been used because most teachers prefer them to high-power photomicrographs, since the drawings can be made to include several focal planes.

This handbook can be used as a laboratory manual. Since the premedical or medical student of histology has had some microscopic anatomy, detailed laboratory directions are unnecessary. It may be used as a syllabus with lectures. Some teachers use the handbook in their classes as a basis for review. It has also proved its worth for purposes of review to students of pathology. Students preparing for "spot" quizzes, or for state and national board examinations, find it invaluable. Today when many specialty boards require a review of the basic sciences in preparation for certification, this volume will aid materially in a quick review

of histology. Regardless of the method of handling the histology instruction, this book will be found most helpful for guiding the student in identification studies of tissues and organs in the laboratory.

Blank pages have been included to be used for lecture or laboratory notes and drawings. In fact, many teachers require their students to make laboratory drawings in the handbook, thus making it more valuable for reference purposes. Some students have requested more illustrations, but histology instructors in general have a conviction that the handbook will be of greater value to the student if he furnishes his own illustrations made from actual preparations studied in the laboratory.

Upon request to the author, a mimeographed copy of an outline on hemopoiesis with permission for its reproduction will be sent to any teacher adopting this handbook for class use.

KARL A. STILES

Acknowledgments

The author wishes to acknowledge with many thanks the advice and suggestions given by students and instructors in the preparation of this revised text. He wishes especially to acknowledge his indebtedness to Dr. Carl Vernon Weller, Professor of Pathology and Chairman of the Department of Pathology, University of Michigan; Dr. Ralph Janes, Department of Anatomy, University of Iowa; Dr. Paul A. Walker, Biology Department, Randolph-Macon Woman's College; Dr. L. M. Ashley, Walla Walla College; Drs. M. L. Calhoun and Robert Wolfer, Department of Anatomy, Michigan State University; Dr. R. A. Runnells, Department of Animal Pathology, Michigan State University; Dr. R. A. Fennell, E. F. Degenhardt, George F. Fisler, William Armstrong, Theodore Whitmoyer, and Bernadette McCarthy Henderson, all of the Department of Zoology, Michigan State University; Estelle Downer, Milwaukee County General Hospital; Dr. G. E. Braunschneider, Grand Rapids, Mich.; Dr. John E. Luke, East Lansing, Mich.; Dr. R. Dean Schick, State Teacher's College, Cortland, N.Y.; Dr. Douglas Eastwood, University of Iowa; and Patricia A. Stiles.

Nettie R. Stiles spent many hours assisting in the preparation of the manuscript and in reading proof.

K.A.S.

Tables

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How to Interpret Sections

Histology is the study of microscopic anatomy. The earliest histologists were of necessity restricted to the unaided eye and simple lenses in their observations of tissues and organs. The improvement of the microscope and the development of new technics with modern optical instruments have made possible great advances in the study of tissues. Most histology today is learned from the study of sections, thin slices cut through the various tissues and organs.

Slices cut through different planes or at various levels of an organ may give diverse impressions about its structure. As is shown in Figure 1, no single slice of a hard-boiled egg gives a correct idea of its structure. To obtain the whole picture of the structure of a complicated organ, it is necessary to study several sections taken from different sites and in different planes. This also demonstrates why a given section of an organ may not look the same under the microscope as it does in a textbook illustration.

When one looks at a section, he should try to visualize how it was cut. The student will gain help in doing this if he forms a mental image of some familiar object cut at different angles. Most of the organs of the vertebrate animal body contain tubes, partitions, and cords; and examples of these are, respectively, blood vessels, septa (partitions of connective tissue) in the spleen, and nerve cords. If the student knows how straight tubes, partitions, and bundles of cords appear in slices cut at different angles (Figs. 2, 3, and 4), he will not only gain skill in recognizing these structures, but he will also be able to better visualize similar structures of the body when they are cut in different planes.

It is, therefore, very helpful in interpreting sections to become familiar with the appearances of slices of straight tubes, partitions, and cords. Figures 2, 3, and 4 should give such assistance with this problem. The student will save a great deal of time if he studies these carefully, and then, as he undertakes the study of histologic sections, refers back to these figures frequently. Finally, he should try to visualize the structure of the entire tissue or organ from a series of sections. This involves making mental reconstructions in three dimensions when only two are actually seen.

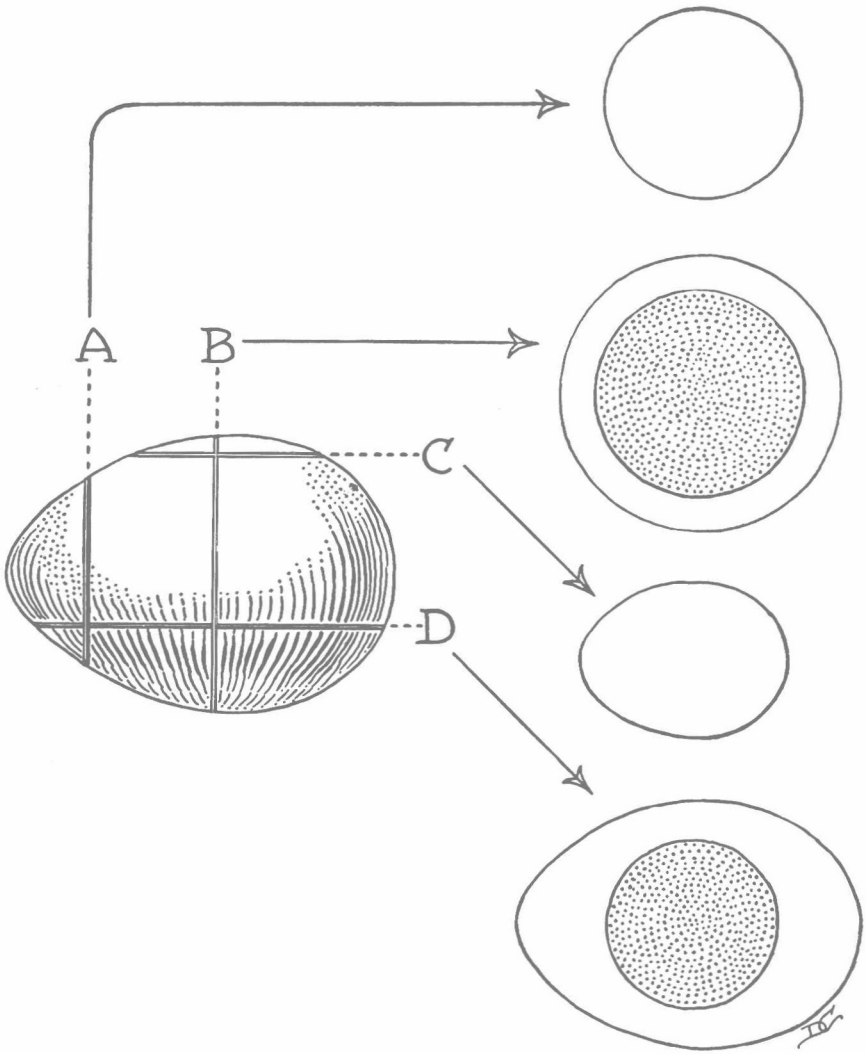

FIG. 1. Diagrams showing how sections cut through an object at different levels or in different planes may give different ideas regarding its structure. (*Courtesy, A. W. Ham: Histology, 2d ed., Philadelphia, J. B. Lippincott Company*, 1953.)

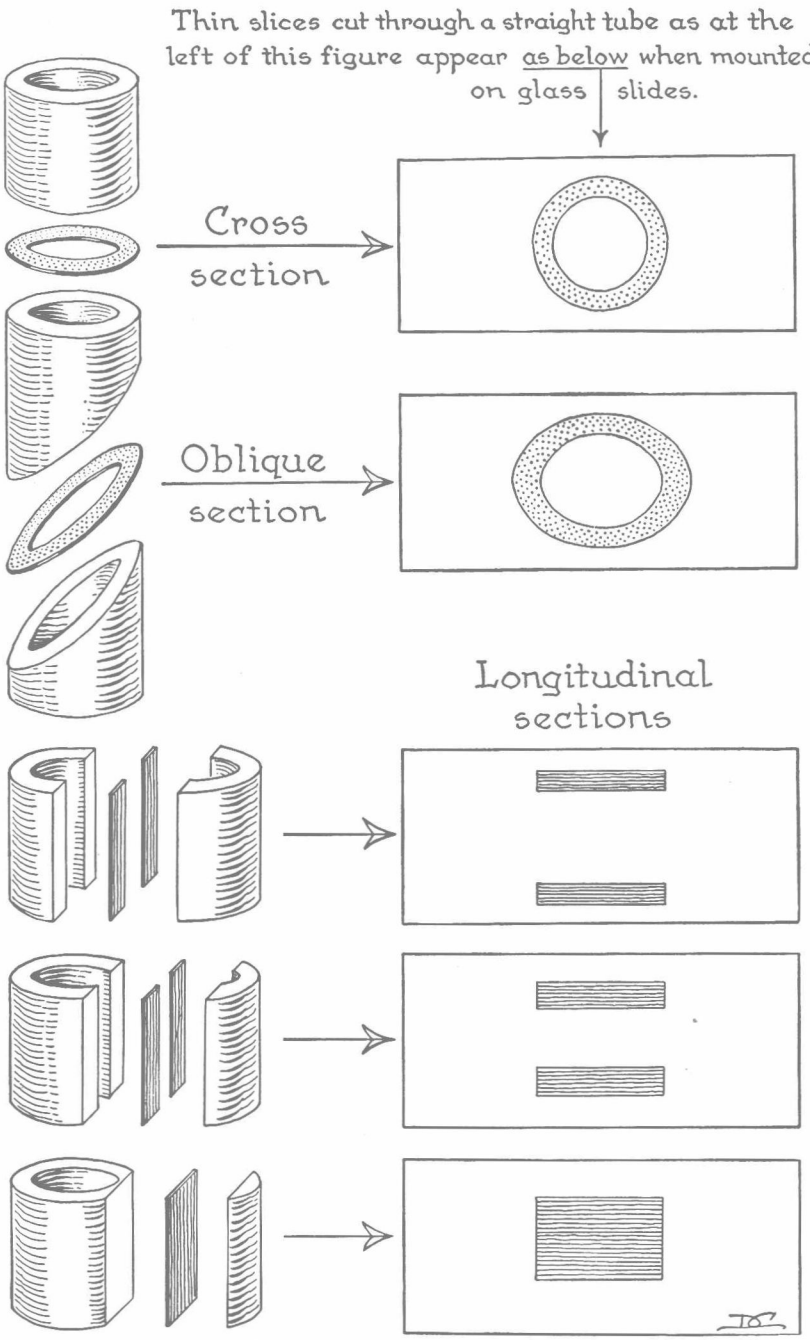

FIG. 2. Diagrams showing how sections cut through straight tubes in different planes appear different when mounted on a slide and observed through the microscope. Note that it is possible to cut a longitudinal section of a tube without the lumen showing in the section. (*Courtesy, A. W. Ham: Histology, 2d ed., Philadelphia, J. B. Lippincott Company*, 1953.)

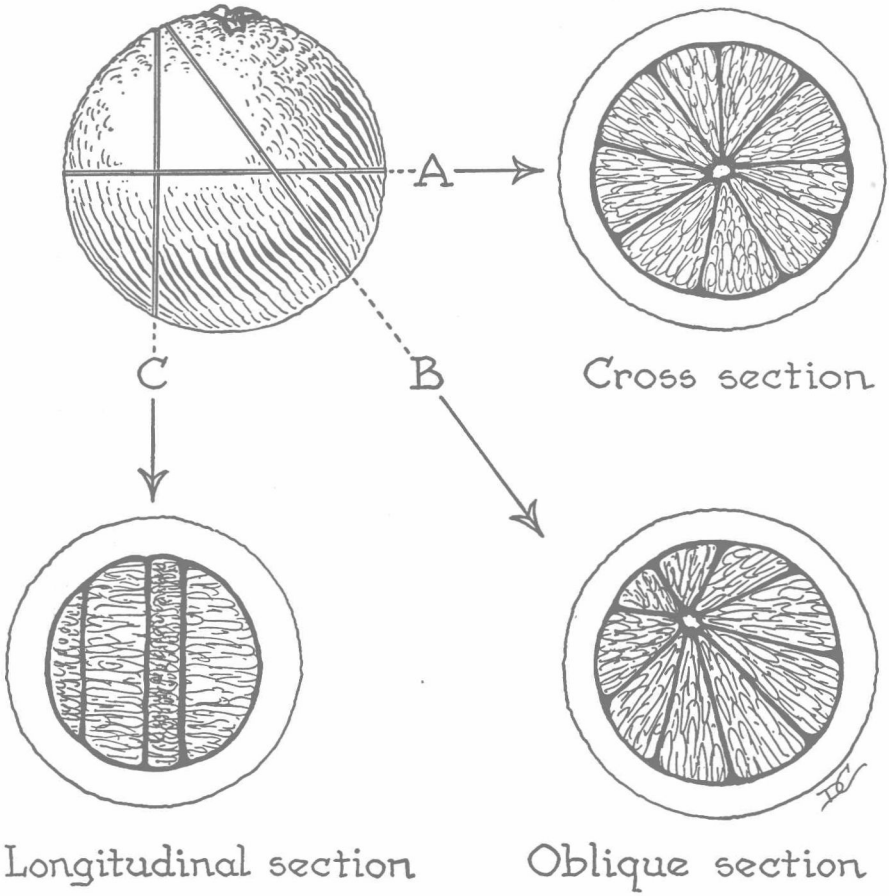

FIG. 3. Diagrams showing the different appearances presented by sections cut in different planes through an object which contains partitions (an orange). (*Courtesy, A. W. Ham: Histology, 2d ed., Philadelphia, J. B. Lippincott Company*, 1953.)

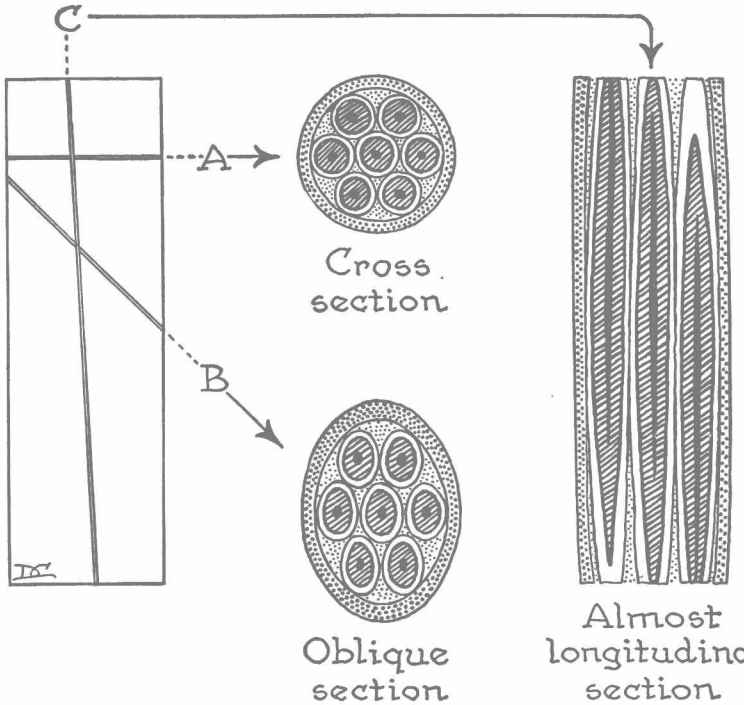

FIG. 4. Diagrams showing how the appearance of sections cut through a cable containing many insulated wires differs according to the plane in which the section is cut. (*Courtesy, A. W. Ham: Histology, 2d ed., Philadelphia, J. B. Lippincott Company,* 1953.)

2

How to Identify Tissues and Organs

In commencing a laboratory study of histology, one usually experiences great difficulty in selecting out of the confusing abundance of histologic information that which is most helpful for the purpose of recognizing tissues. This handbook should help the beginning student to overcome this difficulty.

An outline of this sort, however, has certain limitations. While only the principal characteristics of tissues and organs have been included, with some emphasis on identification characters, it cannot be too strongly emphasized that the more complete information one has about an organ the better he is prepared for an accurate diagnosis of a complex of tissues.

The beginning student in histology is likely to fall into the error of considering one good "spotting" character for a tissue sufficient, but this is erroneous; identification work is not that simple. It should be remembered that tissues are subject to the variations which occur in all living things, and constant exceptions will be found to almost any generalization. Also, the possibility must be considered that in any given section a favorite identifying character may be absent. For example, the pancreas may be identified positively by the presence of the islands of Langerhans; but if a section does not possess islands, then the tissue may be easily confused with parotid, unless one is fortified with a complete knowledge of the histology of the organ. Then, too, the histology of organs varies in different animals, depending on how far the animals are removed from one another phylogenetically. Despite the desirability of knowing as much as possible about the histologic structure of the organ to be identified, *the author has acceded to a general student demand that some of the most diagnostic characters be italicized.*

For the benefit of medical students who look forward to work in pathology, it may be said that certain tissues and organs show profound changes under the influence of disease. For instance, in fatty atrophy of the pancreas, only islands of Langerhans may be present; or, in voluntary muscle, only the neuromuscular spindles may persist. One who knows the neuromuscular spindles will recognize the area in which one is found as a region of striated muscle even though no contractile fiber is present.