A Laboratory Manual of Mammalian Anatomy and Physiology

FOURTH EDITION

SIGMUND GROLLMAN

A Laboratory Manual of Mammalian Anatomy and Physiology

FOURTH EDITION

SIGMUND GROLLMAN
University of Maryland

Macmillan Publishing Co., Inc.
New York
Collier Macmillan Publishers
London

Macmillan Publishing Co., Inc.
866 Third Avenue, New York, New York 10022

Collier Macmillan Canada, Ltd.

ISBN 0-02-348090-4

Printing: 1 2 3 4 5 6 7 8 Year: 8 9 0 1 2 3 4

Preface

Anatomy and physiology form the basis of contemporary medicine, and knowledge of these subjects is also necessary for those other than doctors who will be involved with human health in their life's work. This manual is designed to suit the needs of the modern nursing and paramedical curriculum and undergraduate programs in physical education, behavioral and social sciences, agricultural sciences, and prelaw.

It is customary and correct to look upon the human body as a machine; in order to understand how this machine functions (physiology), we must also have a knowledge of the various working parts (anatomy) because structure and function are inseparable. Although the body must be regarded as an integral unit, a clear understanding of the organ systems forming it is best conveyed when they are discussed separately. The order of presentation sets forth clearly and vividly the close correlation between morphology and physiology. This manual gives a complete survey of anatomy and physiology with pervading emphasis on the interworking relationship of the various parts. We hope the presentation will help the student grasp the over-all hierarchy of biological organization rather than viewing the various systems as totally separate entities.

Like the text, the new edition of the laboratory manual has been updated and revised to aid the student in acquiring a practical knowledge of basic scientific facts and to reinforce and help clarify information covered in lectures. Many new anatomical drawings have been included to make dissection easier and more understandable. In addition, many of the physiological experiments have been rewritten so that they may be performed by inexperienced students with less help from teaching assistants. Each of the physiological experiments is designed to help students develop scientific curiosity and powers of observation and to stimulate their interest and intellectual abilities. The manual is designed for use in either a year course in human anatomy and physiology or a semester course. Although specifically designed to accompany the author's text, it will also work well with other introductory human anatomy and physiology texts.

S. G.

Illustrations

General Laboratory Directions

Dissection

All dissections should be carefully and neatly made. The best results are obtained by examining the organs in their natural position. When it becomes necessary to study deeper structures, push the overlaying organs aside and cut as few structures as possible.

Proceed slowly, being certain that you understand the work as it progresses. Remove no structure you may later wish to study.

The quality of laboratory work can be judged by the appearance of the dissection.

Drawings

All drawings should be made as simple outlines and stippled, unless otherwise instructed, with label lines drawn with a straightedge and parallel to the bottom of the page. Where many similar cells or structures are seen, draw a few carefully on a large scale.

The secret of accurate drawing is close observation.

Experiments

When practicable, every student will perform each experiment either individually or in cooperation with other members of the class. Some experiments will be conducted by the instructor as class demonstrations. Each student must write a description of the experiment as though he were conducting it himself. The description should include

1. The purpose of the experiment
2. A description of the apparatus
3. Results
4. A discussion in which the results are correlated with other data

Scientific Terms

The language of anatomy seems complicated to the beginner. Most terms are taken from Latin or Greek and in the original language have commonplace meanings. The easiest way, therefore, to associate structures with their scientific names is to learn the meaning of the original roots. These are found in the dictionary.

Contents

PART II – PHYSIOLOGY

PART I

Anatomy

1

Histology

Histology is the study of tissues. In the body many cells of the same type are joined together in groups for the purpose of performing a specific function. For example, lining the digestive tract are cells that perform the function of manufacturing digestive juices, which they pour into the digestive cavity. Another example of a tissue is a group of muscle cells capable of contracting and, while doing so, bringing closer together the parts to which they are attached. Cells capable of contraction constitute the muscular tissue.

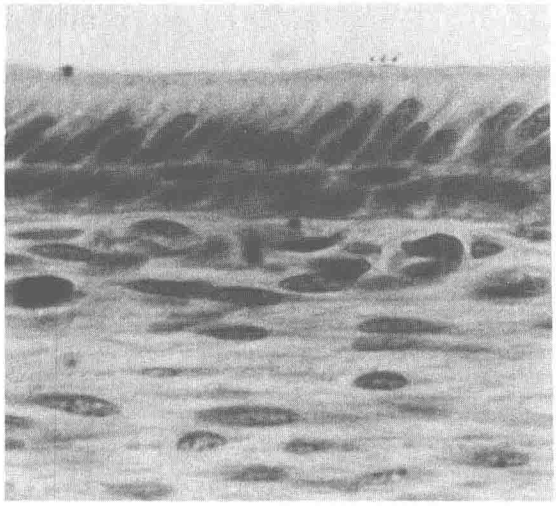
A. **Epithelial tissue** (epi = upon; thelium = to cover) covers the outer surfaces of the body and all organs, as well as lining all tubes and cavities (including the coelom, or body cavity) (Fig. 1).

Several types of epithelial tissue are recognized and are generally named according to their shape.

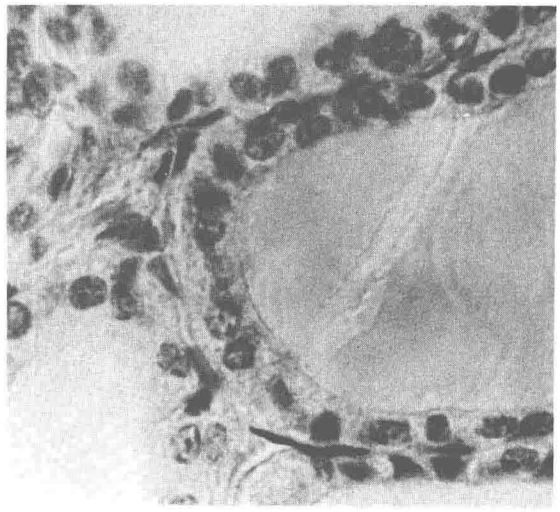
1. **Squamous epithelium** (squamous means a scale) are broad flat cells found lining the inside of the mouth cavity and covering the surface of the skin. They largely make up the mesenteries, which hold internal organs in place and also form the sheet of peritoneum that lines the abdominal and thoracic cavities.

   A prepared slide of salamander (or frog) epidermis may be used in place of fresh material. Find the material first with the medium power of the microscope; note the shape and arrangement of the cells. Now turn to high power, following directions given for use of the microscope.

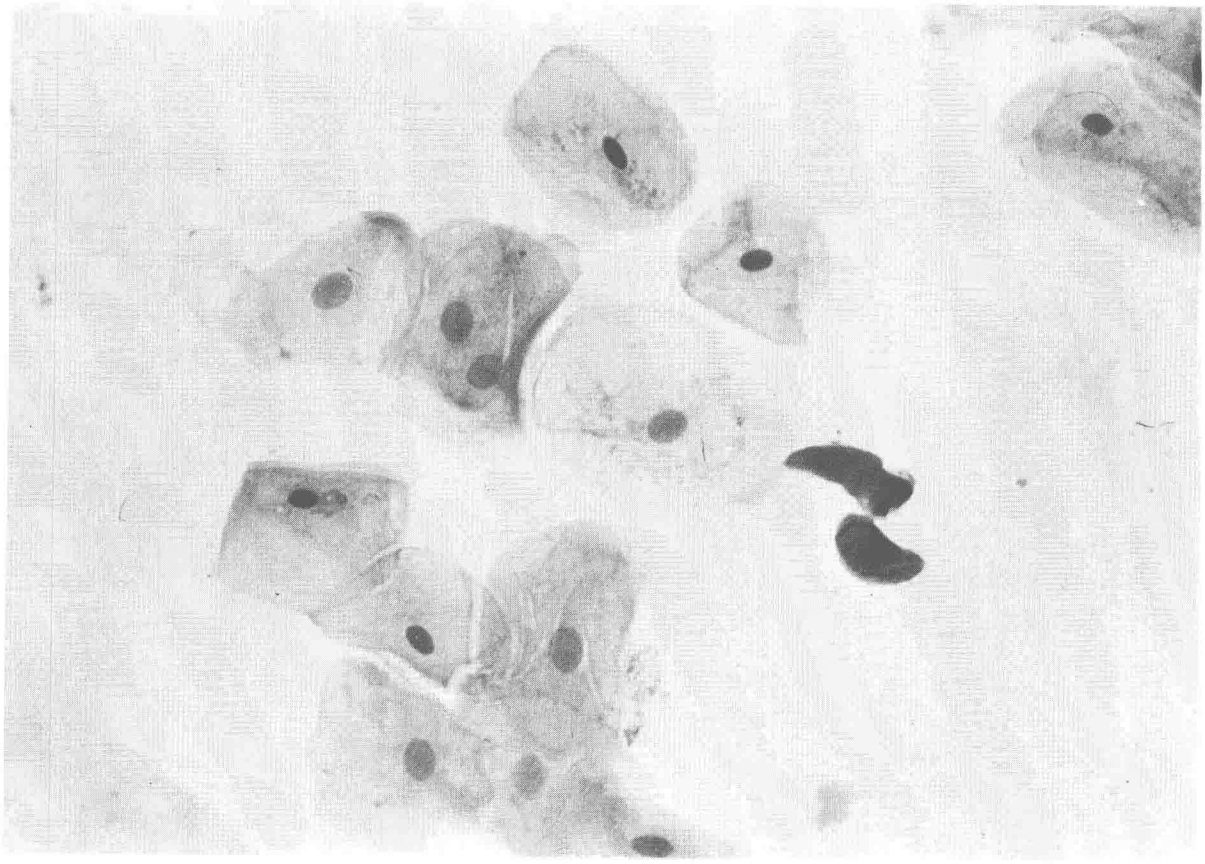
   Note the shape of the compartments that make the cells. Does the boundary, or **cell membrane**, of one cell fit up against the adjacent cell? What is the shape of the deeply stained **nucleus** located near the center of the cell? The **cytoplasm** is that part of the cell between the nucleus and the cell membrane. Is it as deeply stained as the nucleus? May it be said that the nucleus has a greater affinity for staining than the cytoplasm? Are chromatin granules visible in the nucleus? Can the **nuclear membrane** be seen readily?



(A)



(B)



(C)

Fig. 1. Types of epithelial tissue. (Courtesy Histology Section, Zoology Department, University of Maryland, College Park, Md.)

A. Simple columnar cells in developing human tooth. 1000 X.
B. Simple cuboidal cells enclosing follicle of thyroid gland. 1000 X.
C. Squamous cells from inside mouth (cheek).

Draw a group of five or six cells three times the size they appear to you and show their relation to other cells (p. 8).

When labeling drawings, print a legend, or title, under the drawing to tell what it is, giving also the source of the material. In this case use:

SQUAMOUS EPITHELIUM SHED EPIDERMIS FROM THE FROG

Put labels of the parts of the drawing to the right of the drawing, using straight guidelines and printed labels. Here you should label the nucleus, cytoplasm, and cell membrane. Use *descriptive labels* on all drawings. This means to write a brief description of each part under the label and give its function. Use descriptive labels throughout the course.

2. **Columnar epithelium** lines the greater part of the digestive system posterior to the mouth. The cells are elongated, often tapered at their base, and broad at the surface where secretions leave the cell to pour into the digestive cavity. They are also found in other parts of the body, and in some cases, as in the lining of the trachea, are equipped with hairlike processes called **cilia**.

   Focus some of the material under low power, then turn to high power to see detail. Can you observe column shaped cells? If they are massed together, lift the cover glass and tease them apart again. The cells are wider at the top than at the bottom. Do you find some cells swollen with large vacuoles at one end? These are **goblet cells** containing secreted material about to leave the cell.

   Permanently prepared stained slides of isolated, ciliated, columnar epithelium from the trachea of the frog may be used in place of fresh material.

Draw two or three cells, each about 1½ in. long. Indicate length, width, and the amount of magnification (p. 8).

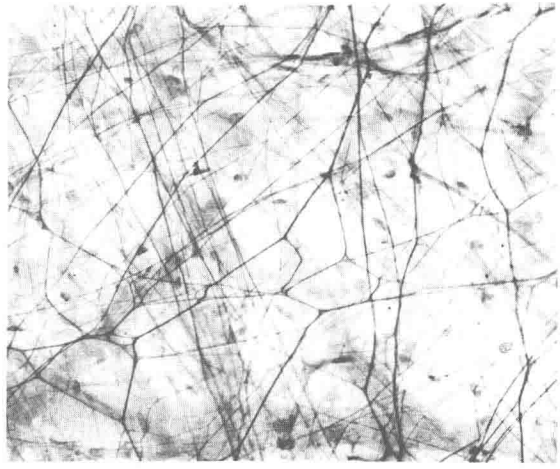
3. **Cuboidal epithelium.** In some places cuboidal (cubelike) secretory cells are grouped around a small cavity into which they pour their secretion. The alveolar glands in the skin are so constituted that the secretory portion is well protected below the surface with a duct to carry the secretion to the outside. Cells lining the kidney's uriniferous tubules are of this type. Observe a preparation of cross sectional and longitudinal sections of kidney tubules. Note the cilia on these cells. Note also the nucleus and its location and size.

Draw a section of a kidney tubule to show these features (p. 9).

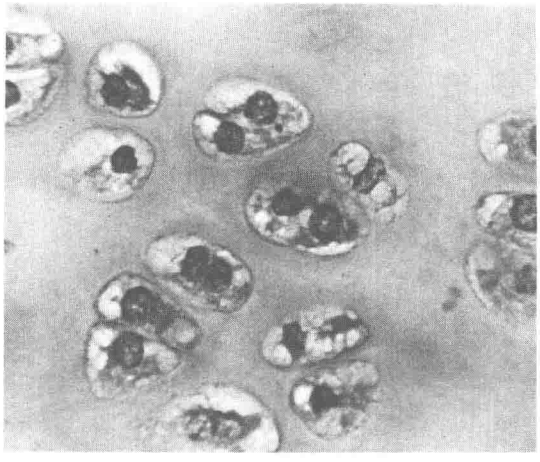
B. Substantive, supportive, or connective tissue forms the framework of the body and binds organs and parts together (Fig. 2).

   1. **White fibrous and yellow elastic connective tissues.** The material surrounding muscle bundles is very thin, nearly transparent, and tough. Prepare a mount of the material taken from between the muscles of the thigh of the frog. As this is picked away from

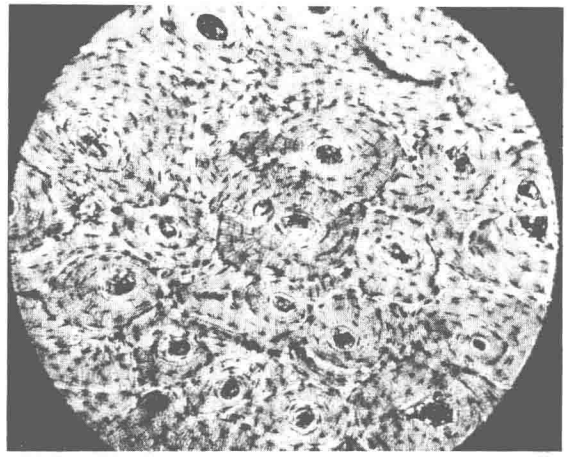
(A)



(B)



(C)



(D)

Fig. 2. Types of connective tissue. (Courtesy Department of Medical and Dental Illustration, Georgetown University School of Medicine, Washington, D.C.)

A. Cartilage. 800 X.
B. Areolar connective tissue showing white and yellow elastic fibers and interstitial cells.
C. Developing bone of human finger. 500 X.
D. Cross section of human bone.

the muscles with a pair of forceps, it tends to fold and curl. Place it with a drop of salt solution and spread out flat before adding the cover glass. Very thin material is better than a thick piece.

Observe under low power to obtain the focus, and then turn to high. The small fibers may be seen running throughout the material; the ones that are very fine and in wavy bundles are **white fibrous** connective tissues. The heavier, straight, and often branched fibers occurring singly are **yellow elastic** fibers. Stain for about 1 min. with methyl violet and rinse in water before remounting on a clean slide with clear water. Prepared slides of connective tissue may be used.

Draw a few fibers of each type (p. 9).

2. **Cartilage.** Cartilage is found at the ends of bones and forms the pliable framework of the ear and the tip of the nose. This material is quite transparent. The cells do not touch each other. Try to identify cells with the low power before turning to high. Do all the cells touch one another? The material between the cells is **matrix**, secreted by the cells. A **lacuna** (little lake) is the space in the matrix occupied by the cell. Are the cells found singly, in pairs, or in larger groups? Stain with methyl green to see more clearly. Prepared slides of cartilage may be used.

Draw about six cells large enough to clearly show the structure (p. 10). Give actual size and amount of magnification. Use descriptive labels on all your drawings. The matrix may be lightly shaded or left clear.

3. **Human bone.** Observe prepared slides of human bone tissue. These preparations are expensive, so be careful of them. Under low or medium power, does this appear like a group of cross sections of trees? Under high power, note in the center of each group a large cavity, or tube, generally cut crosswise. This is a **Haversian canal** (named after its discoverer). This canal contains an artery, vein, and nerve, which supply the surrounding bone area. Note model. The black dots arranged in concentric circles around the Haversian canals are the **lacunae** (little lakes), which in life were occupied by the bone cells manufacturing and secreting the hard **matrix**. The matrix is harder than that in cartilage largely because of the deposition of calcium salts in it. Look closely at one lacuna; are there tiny processes radiating in all directions from it? These tubes are generally black in microscopic preparations because they are filled with "bone dust" when the thin slices are mounted. These are **canaliculi** (little canals) (singular is canaliculus), which in life contained tiny processes from the center of cells and transported the newly manufactured matrix from the cell body to points between the cells. The Haversian canal with its surrounding lacunae constitutes a Haversian system. Bone matrix, which is hard and firm, is made of calcium and phosphorus salts; cartilage matrix is pliable.

Draw a Haversian system in outline (p. 11).

Draw one lacuna greatly enlarged showing several of the canaliculi radiating from it (p. 0). Indicate size and magnification. The matrix may be lightly shaded or left clear.