

TEXTBOOK OF

# Physiology

# TEXTBOOK OF PHYSIOLOGY

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THE ACTIVITIES OF THE LIVING BODY

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# TEXTBOOK OF PHYSIOLOGY



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## P R E F A C E

There are certain fundamental problems that confront students of physiology, regardless of their primary interests. These problems center around:

1. Maintaining a Balance between Rest and Exercise, Work and Play
2. Maintaining an Awareness to the Environment
3. Maintaining Circulation
4. Maintaining a Constant Oxygen Supply
5. Maintaining the Protective Mechanisms of the Body
6. Maintaining the Nutrition of the Body
7. Maintaining the Fluid and Electrolyte Balance of the Body
8. Perpetuating the Human Race

While an effort has been made to organize the materials in this book around these problems, in some instances questions have been raised that require much and varied kinds of further study.

In reality, the problem-solving approach to learning cuts across all areas of physiology, functional anatomy and physiological histology, chemistry, physics, and other subject matter areas. Seeing the individual as a whole also must include principles of psychology and sociology, as the impact of the environment affects materially physiological function as related to daily living.

The solving of problems aids students to assume responsibility for their own learning, and, if given freedom, the students will bring problems to the classroom for solving and for further clarification.

It does not matter materially where "digging in" begins. However, a basic understanding of cells, tissues, and body fluids forms "tools" with which to begin the "digging in."

It is evident that the study of physiology does not end at the close of a course, so that it becomes necessary continually to "dig in" to physiology and other sciences for the answers to practical problems and the reasons behind problems which confront us in our daily work. It is hoped that this book will also serve this purpose.

Study of diagrams and their legends, with a going backward or forward for further clarification, is an important step in learning. In addition, there are questions placed at the close of each chapter of this book which may be used as a guide in crystallizing the learner's ideas about certain aspects of the chapter or may be used as a basis for discussion. The study of physiology is also helpfully clarified by laboratory studies. These need not be elaborate or require expensive equipment, and will pay dividends in the end.

This book is a culmination of many years of experience in teaching physiology and functional anatomy to professional groups. We are indebted to students in the field of nursing, health, physical education, nutrition, and to teachers of biology in colleges and high schools, for presenting needs which have served as a basis for selection of materials. The authors wish to acknowledge gratefully their indebtedness to Frances Ruszel, R.N., M.S., for the preparation of many of the illustrations. Other acknowledgements are made in the text.

We wish to express indebtedness to Mr. W. Holt Seale and his staff of the Medical Department of The Macmillan Company, and especially to Miss Joan C. Zulch, who has been most helpful in handling the editorial details of the book.

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# SECTION ONE

## **Maintaining a Balance between Rest and Exercise, Work and Play**

The maintenance of a balance between rest and exercise, work and play is important from several points of view and ramifies into many aspects of physiology, daily living, and nursing care. All of the answers to various questions that can be raised may not be found within this section, but should be kept in mind at all times. Such questions might concern: energy requirements related to various activities; the amount of sleep needed by different individuals; what is meant by relaxation, by play, and by recreation. The relationship between mental and physical rest, the difference between sleeping and resting, the effect of change of work or activity when one feels tired or bored are all important aspects of daily living.

Basic to the understanding of this problem is a knowledge of cells and their liquid environment, the tissues and their physiological implications, and what takes place in muscles during activity.

This section includes chapters dealing with "The Activities of the Living Body," "Cells and Their Liquid Environment," "The Tissues and Their Physiological Implications," and "Muscle Physiology."



## CHAPTER 1

### *The Activities of the Living Body*

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OUTLINE: General Principles of Physiology. Structure of the Body as a Whole.

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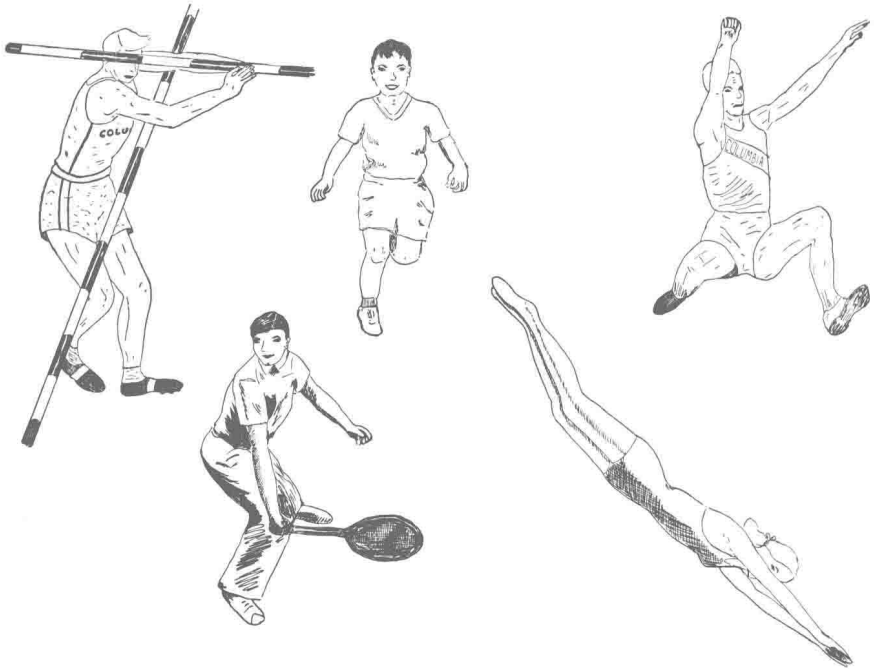
Physiology may be thought of from many points of view and its subject matter may be organized in many different ways. Physiology is concerned with function and functions are concerned with specific activities, as, for instance, the changing relationships within cells and between cells and their liquid environment. Changing relationships in one small area of the body may cause widespread physiological implications.

The activities of the body may be thought of as being external and internal. The external activities include bodily movements of all kinds that are necessary for living an active physical life. Many external activities require skill and involve proprioceptive memory. This means that in the acquisition of a skill which involves increased motor ability the stimuli from muscles, tendons, and joints (proprioceptive) leave traces which regulate subsequent movement and posture. The movements are constantly modified and perfected, and unessential movement is eliminated. This in turn increases speed and accuracy seen in the "learned" or skilled reactions, as typified by the playing of a violin. Voluntary movement is most likely the reception of proprioceptive stimuli from skeletal muscles by the cerebral cortex, which results in proprioceptive traces or memories.

The internal activities of the body include all physiological processes necessary to maintain life, such as movement of blood, manufacture and secretion of all fluids, keeping concentrations constant, movement of substances across membranes and along the alimentary canal, the absorption of nutrients and maintenance of their constancy in blood, keeping oxygen and carbon dioxide concentrations optimum, the building of supplies into products, the elimination of the products of metabolism,

the protection of the body against harmful substances, and many other activities.

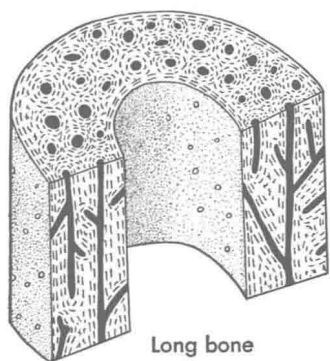
The external and internal activities are interdependent and interrelated. Since the metabolic needs of cells must be met at all times, changing relationships within cells bring about changing relationships between



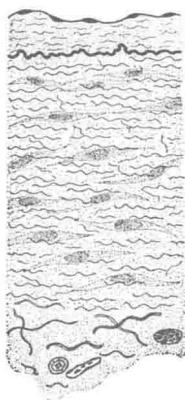
**Fig. 1.** External activities of the body are dependent upon internal activities, which include the maintenance of constancy of all body fluids.

cells and their environment. For example, as muscle cells go into activity, changing needs must be met by opening of capillaries, thereby increasing the amount of blood to the part per unit of time. As more blood is needed by the tissues, more blood is moved on into the veins and eventually into the right heart. Hence, more blood moves on through the lungs per unit of time and respiratory depth and rate as well as heart rate are adjusted to meet the changing needs. In addition to these changes there are many other widespread physiological adjustments necessary to maintain constancy of the fluids and other requirements of cells.

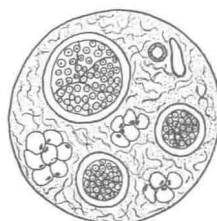
In many instances the internal activities are entirely dependent upon external activities. For example, consider the long sequence of events that is necessary before foods can be placed on the table, that will provide the nutritive materials necessary for the maintenance of life. (Think this idea through; it becomes most complicated.)



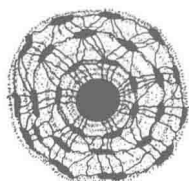
Long bone



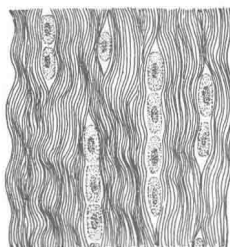
Artery



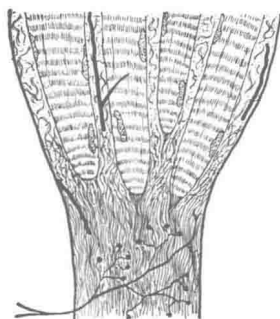
Cross section of nerve



Cross section of bone



Tendon



Muscle-tendon junction with nerve



Cartilage

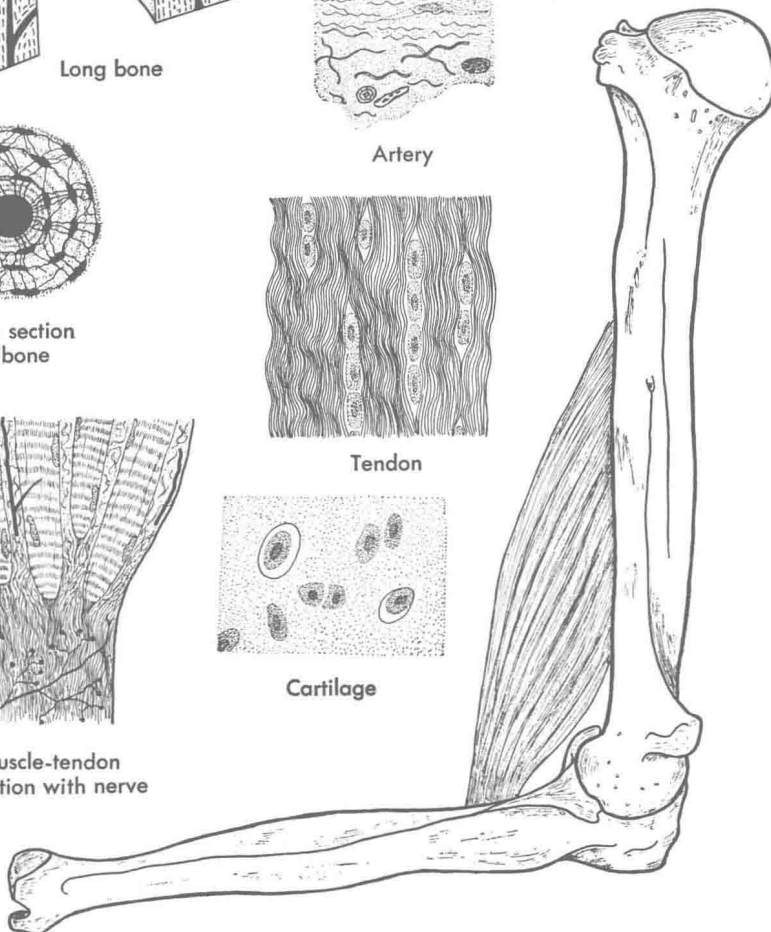


Fig. 2. The bone-muscle joint unit concerned with external activities.

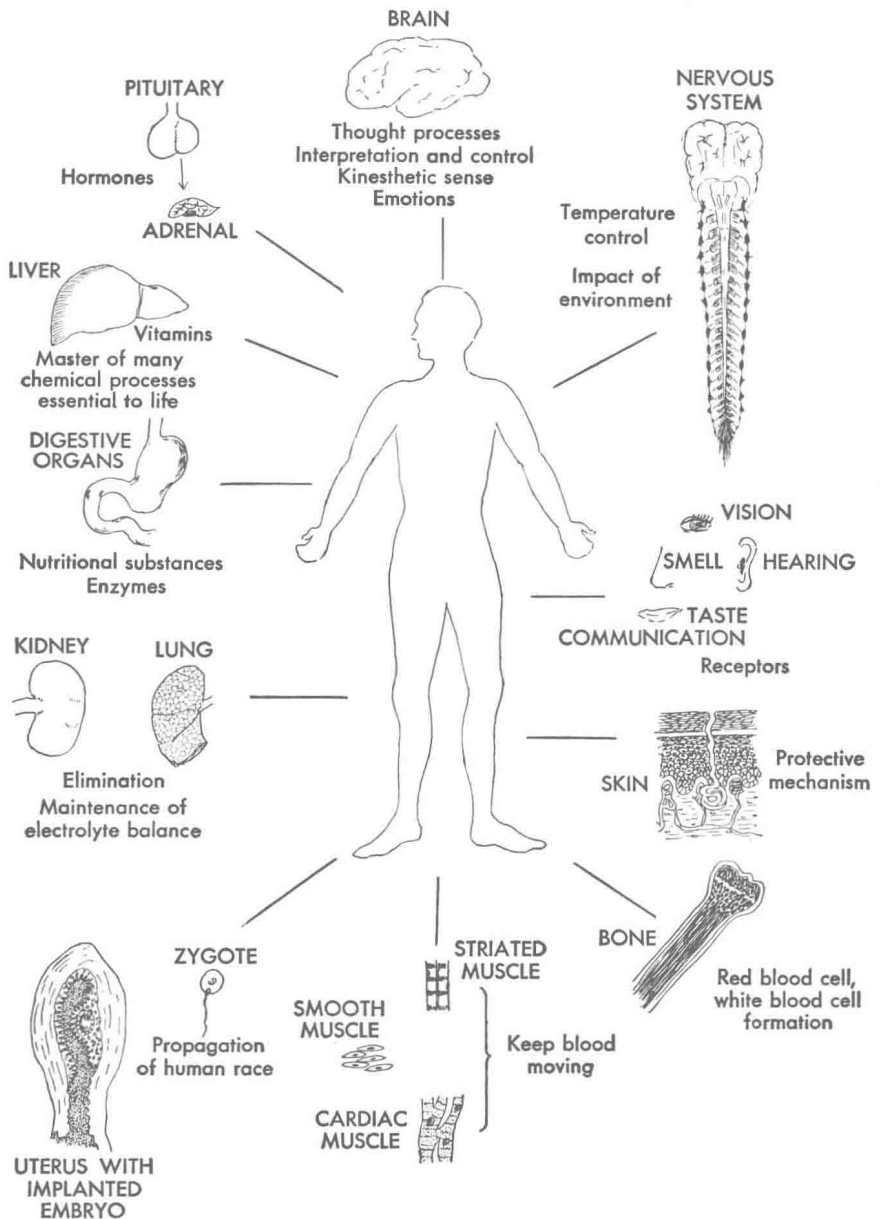


Fig. 3. Diagram illustrating some of the internal activities of the body.

In the last analysis of these activities, the problem resolves itself around the cell, its needs, how the changing needs are met, and how the liquid environment around cells is kept constant in all respects at all times, and the physiological adjustments necessary to maintain homeostasis or constancy of body fluids. The cells form the building blocks for the body; they are held together by "cell cement" and connective tissue. All

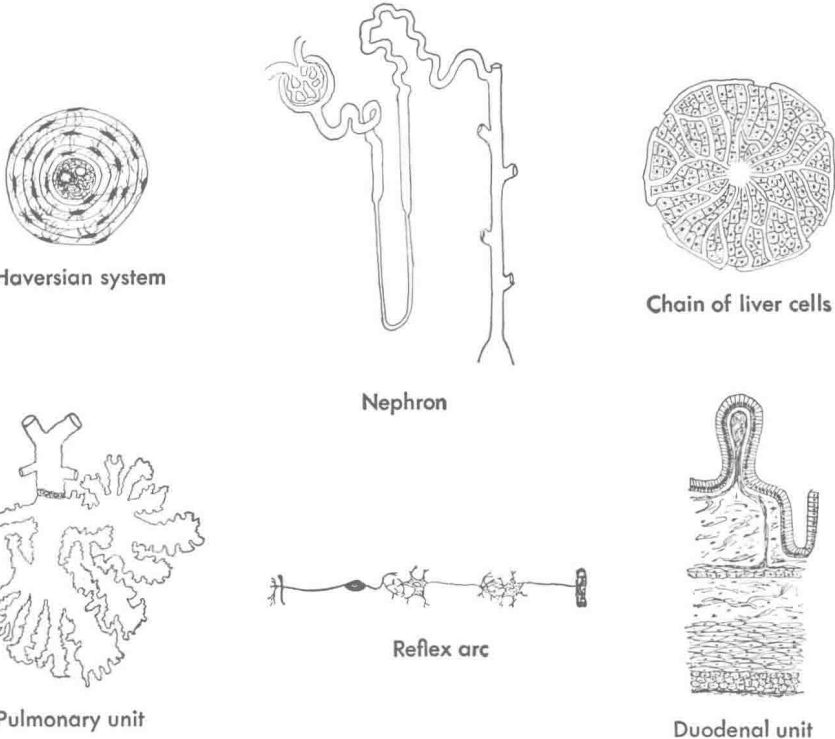


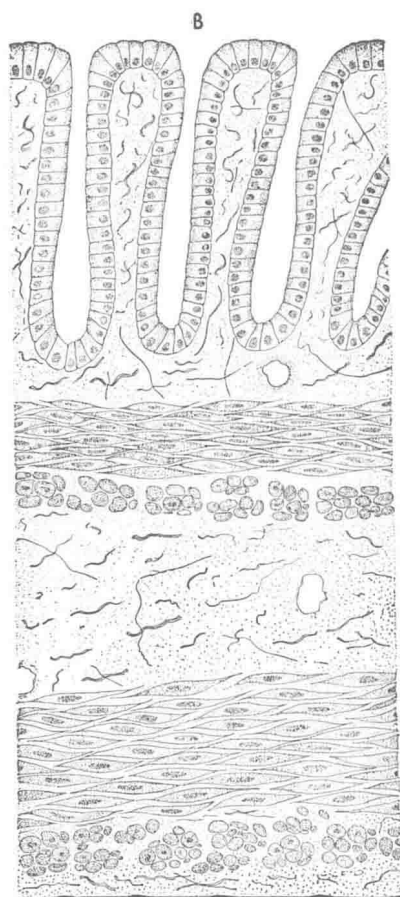
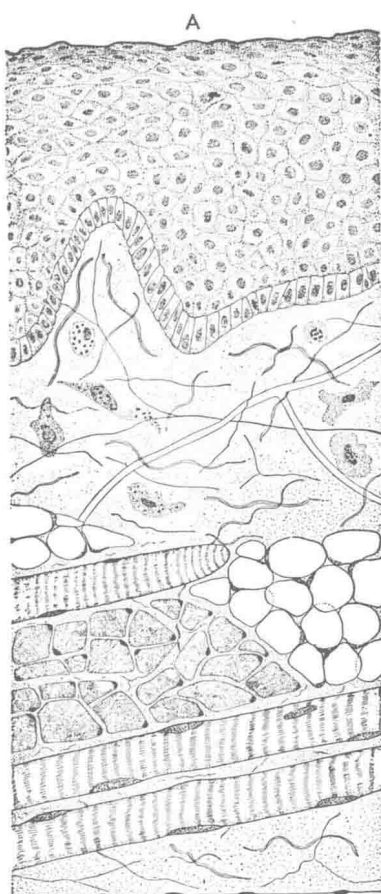
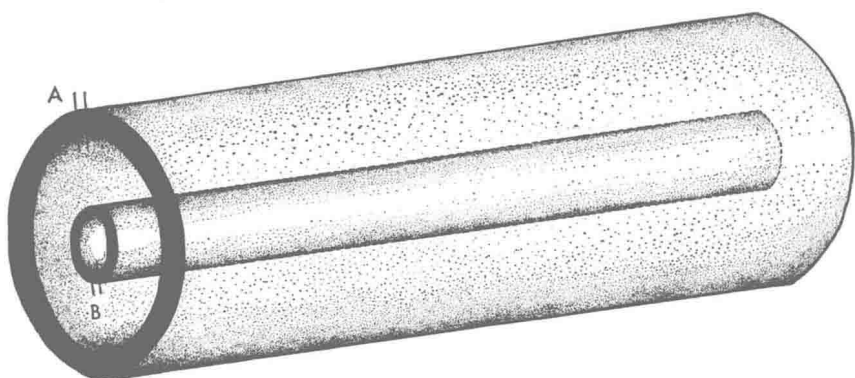
Fig. 4. Diagram of some of the known unit patterns of organs.

cells are arranged in definite patterns to form tissues. These are called the unit patterns; they are simple and are repeated an enormous number of times to form organs. Organs are arranged as working units (systems) with definite functions to perform. The working units are all interrelated and interdependent. No one activity can take place without causing widespread physiological adjustments. All activities are controlled by physical, nervous, hormonal, or chemical activity, or by a combination of these controls.

### STRUCTURE OF THE BODY AS A WHOLE

On the whole, the body is constructed as a tube within a tube, the body wall or soma enclosing a tube, the viscera. The space between the





**Fig. 5.** A tube within a tube. **A**, the outer tube forming the body wall; **B**, the inner tube forming the viscera. See text for structure, page 9.