BASIC ANATOMY AND PHYSIOLOGY OF THE HUMAN BODY

J. Robert McClintic

Second Edition

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Copy Editor: Rosemary Wellner
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This book designed by Joseph Gillians
Cover illustration by Joseph Gillians
Production supervised by Linda Indig

Library of Congress Cataloguing in Publication Data:
McClintic. J. Robert, 1928–
Basic anatomy and physiology of the human body.

Includes bibliographies and index.
1. Human physiology. 2. Anatomy, Human.
I. Title.
QP34.5.M3 1980 612 79-14295
ISBN 0-471-03876-8

Printed in the United States of America
10 9 8 7 6 5 4 3 2 1

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Chapter 1

An Introduction to the Structure and Functioning of the Human Body

Objectives

After studying this chapter, the reader should be able to:

- List the disciplines that constitute the science of biology and what each contributes to our understanding of anatomy and physiology.
- Outline the levels of organization of the body.
- List the "criteria of life" common to all living things.
- Point out and name the major descriptive areas of the body.
- Define the terms of direction used to locate body structures.
- Enumerate and describe the planes of section employed in the study of portions of the body and its parts.
- List the body cavities, the organs they contain, and describe the projections of organs on the body surfaces.

If one were to consider what the human body is worth, the often quoted figure of about three dollars is no longer valid. Harold J. Morowitz has calculated that the raw materials alone contained within the body—that is, its enzymes, hormones, amino acids, inorganic substances, and other

materials—would probably carry a price tag of six million dollars at today's prices. The cost of fashioning these materials into the intricate individual functioning cells of the body has been estimated at six thousand trillion dollars, and no dollar value can be assigned to the expense involved in assembling those cells into a functional human being; each human being is priceless. Perhaps such figures will emphasize the wonderful complexity and amazing resiliency of this shell in which we spend our days and point out the necessity for taking proper care of it to ensure its optimum operation during our lives. The body is constructed so as to be virtually indestructible, and research has indicated that human life spans measured in hundreds of years are possibilities in the very near future. Care for our bodies must begin before conception, with proper nutrition of the body of the prospective mother, and at conception of the new individual, a care must begin that will terminate only with the death of that individual. In short, if your body is to serve you well, do not abuse it; it is the only one you will have.

The study of living organisms

The science of biology studies living things, and includes many subdivisions. ANATOMY is the subdivision that deals with the study of the structure of an organism. In the study of the human body, considerable knowledge of structure may be gained by looking with the naked eye; this acquaints us with the *gross anatomy* of the object being viewed. Dissection, which involves cutting and teasing of body parts, aids the viewing of items of interest that lie covered by other structures, and is, in fact, the basis of the word anatomy (G. *ana,* up + *temnein,* to cut). Viewing the smaller units of body organization may require the use of microscopes of various types. *Microscopic anatomy,* including cytology (study of cells), histology (study of tissues and organs), and developmental anatomy or embryology (study of how the body develops and grows), enables us to study the fine structure and origins of the body components.

PHYSIOLOGY studies how the body and its parts work or function. The word physiology means the study of the nature of things (G. *physis,* nature, + *logos,* study) and the discipline draws on many other areas of knowledge to explain body function. For example, physiology draws on *anatomy* for a structural basis of function; on *chemistry* and *physics* to aid in the definition of basic substances the body contains and laws the body operations follow; on *biochemistry* to aid in the understanding of the complex chemical reactions that occur in the body; on *biophysics* to aid in the explanation of electrical and physical phenomena that occur in the body; and on *genetics* and *embryology* to explain the processes involved in determination of body function, growth, and development.

Anatomy and physiology thus combine to give one a broad and exciting view of the makeup and activity of the shell we inhabit during our days on earth (or in space).

Some generalizations about body structure and function

As we proceed with the study of the human body, it is well to keep in mind some basic ideas about the body. These ideas, or generalizations, will give a direction and purpose to our study. Readers are encouraged to add their own generalizations to those given below.

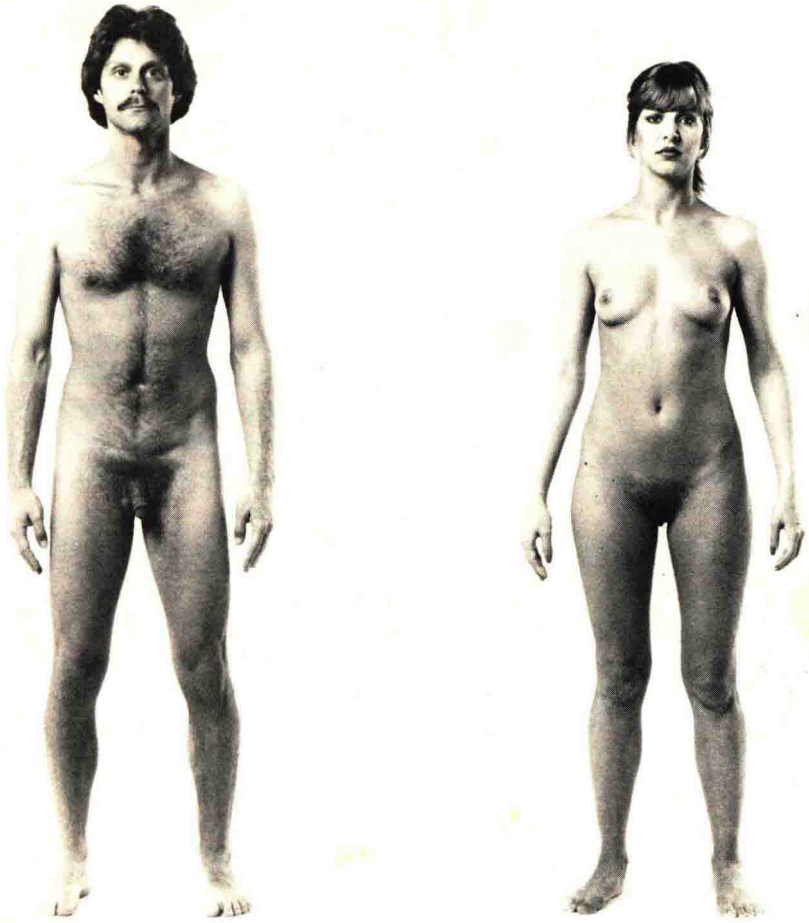

FIGURE 1.1 Male and female adults. (Joel Gordon © 1979)

1. THE BODY HAS SEVERAL LEVELS OF ORGANIZATION. The basic units of structure and function of the human body are its CELLS. It has been estimated that there are 1×10^{14} (1 followed by 14 zeros, or 100 trillion) cells in the body. With this many individual units demanding nutrients and producing wastes, problems of supply and removal would seem to be too much to overcome, yet the organization of the body has solved these problems. Cells that are similar in structure and function, together with their associated intercellular material (the substance between the cells), form TISSUES. There are four primary tissue groups that compose the body.

Epithelial tissues cover and line internal and external body surfaces.

Connective tissues connect and support body parts.

Muscular tissues can shorten or contract to cause movement.

Nervous tissues conduct nerve impulses through the body.

Two or more tissues put together in a specific pattern to carry out a particular job, form an ORGAN. Several organs working together to carry out a larger body process form a SYSTEM. Many systems are combined to form the human body (Fig. 1.1). Although there are obvious external

TABLE 1.1 Body systems, their organs, and functions

System	Major organs or tissues	Main function(s) of the system
Integumentary	Skin, hair, nails, skin glands	Protection; temperature control
Skeletal	Bones and joints, cartilages	Support; protection; storehouse of minerals; blood cell formation
Muscular	Skeletal muscles	Cause body movement
Circulatory	Blood, heart, blood vessels	Carry nutrients and wastes; circulate the blood; carry the blood
Lymphatic	Lymph, lymph organs (tonsils, nodes, spleen, thymus), lymph vessels	Return tissue fluid to blood vessels; create immunity; form blood cells
Respiratory	Nose, throat, larynx, trachea, lungs	Supply oxygen; eliminate carbon dioxide; regulate acid-base balance
Digestive	Mouth, esophagus, stomach, intestines, liver, pancreas	Digest and absorb nutrients; excrete wastes
Urinary	Kidneys, ureters, bladder, urethra	Excrete wastes and regulate blood composition
Reproductive	Male: testes, ducts, accessory glands	Produce sperm and secretions of the semen
	Female: Ovaries, uterine tubes, uterus, vagina, mammary glands	Produce eggs; nourish offspring
Nervous	Brain, spinal cord, peripheral nerves, organs of special sense	Control many body activities, allow appreciation of changes internally and externally
Endocrine	All glands secreting hormones into the blood stream (e.g.: pituitary, thyroid, parathyroid, adrenals, pancreas, testes, ovaries)	Control metabolism, growth, and development of the body
Reticuloendothelial	The cells of the body (e.g., lymphocytes, plasma cells) that protect from foreign chemicals.	Provide protection against bacteria, viruses, and other disease-causing or potentially harmful agents

differences between the male and female, "inside" we are all nearly the same. The only basic differences between the sexes lie in the organs of the reproductive systems. All other functions are carried out by nearly identical organs with similar functions. Table 1.1 presents an introduction to the systems and organs of the body and their functions.

2. THE FUNCTIONS CARRIED OUT BY THE LOWER LEVELS OF ORGANIZATION ARE ALSO CARRIED OUT BY THE BODY AS A WHOLE. Thus, understanding of the cellular level contributes to knowledge of tissue, organ, and system levels, and ultimately to knowledge of the whole organism. As examples of the dependence of whole body function on cells, we may cite the following comparisons between cellular and organism activity.

Cells are EXCITABLE or capable of responding to changes in the external and internal environments of the body; so the body as a whole responds to change.

Cells INGEST or take in materials; the whole body eats food.

Cells DIGEST foods and metabolize them to release energy for body activities or formation of new materials; the body as a whole carries on digestion and metabolism.

Cells EXCRETE or rid themselves of wastes of their activity; the body rids itself of wastes in the urine and feces, and through the skin.

Cells produce, from body fluids, useful products known as secretions; the process of SECRETION is widely utilized to produce digestive enzymes, hormones, and other materials used in the body.

Most cells REPRODUCE themselves for purposes of repair, growth, and continuance of a given line of cells; the body reproduces itself for continuance of the species.

MOVEMENT of materials occurs within cells, and the whole organism may be caused to move through its environment.

These functions are not merely lists of what the cell or organism does, but are CRITERIA OF LIFE as well. Something that exhibits these activities may properly be considered living.

3. THE BODY, PARTICULARLY ITS FUNCTIONS, IS ORGANIZED TO MAINTAIN HOMEOSTASIS AND ENSURE SURVIVAL OF CELLS. A system of checks and balances operates to maintain body composition and function nearly constant within the very narrow limits necessary for survival of individual cells, and therefore the organism. The term HOMEOSTASIS describes this nearly constant internal state the body normally maintains in such functions as composition of body fluids, body temperature, and levels of acids and bases. Much of physiology deals with discovering and describing the controlling mechanisms that ensure continued body homeostasis. Alterations of homeostasis form the basis for diagnosis of disease and abnormal function, and also the basis for instituting treatment intended to restore normal function.

4. MANY BODY FUNCTIONS ARE DETERMINED BY STRUCTURE, and knowledge of structure may enable prediction of function. A "common sense" relationship often exists between structure and function. For example, muscle cells must be elongate structures or they cannot shorten effectively; bone must be a hard strong tissue to protect and to serve as the support for the body. Many examples of the relationship between structure and function are cited in the chapters that follow.

5. BOTH STRUCTURE AND FUNCTION CHANGE AS THE INDIVIDUAL AGES. A newborn is mostly water and fat, and many body functions are not mature. An adult is different chemically from an infant, containing more solids and relatively less water. Old age is associated with lowered levels of body function and a "return to infant state" in terms of teeth and certain other body structures. Each age group has certain attributes that characterize it, and an infant should not be considered a "small adult" any more than a young or middle-aged adult should be considered to have the same structure and level of function as an octogenarian (someone 80 years of age).

Application of these generalizations to the study of the human body is made in later chapters.

The following sections introduce some basic terminology that will be encountered many times in later chapters. These terms will increase understanding and appreciation of body structure and function.

Gross body areas

An aid to the naming of gross body areas is presented in Figure 1.2. These commonly used terms are often referred to in identifying an area in which organs may be located, or in which there is discomfort or pain in the individual.

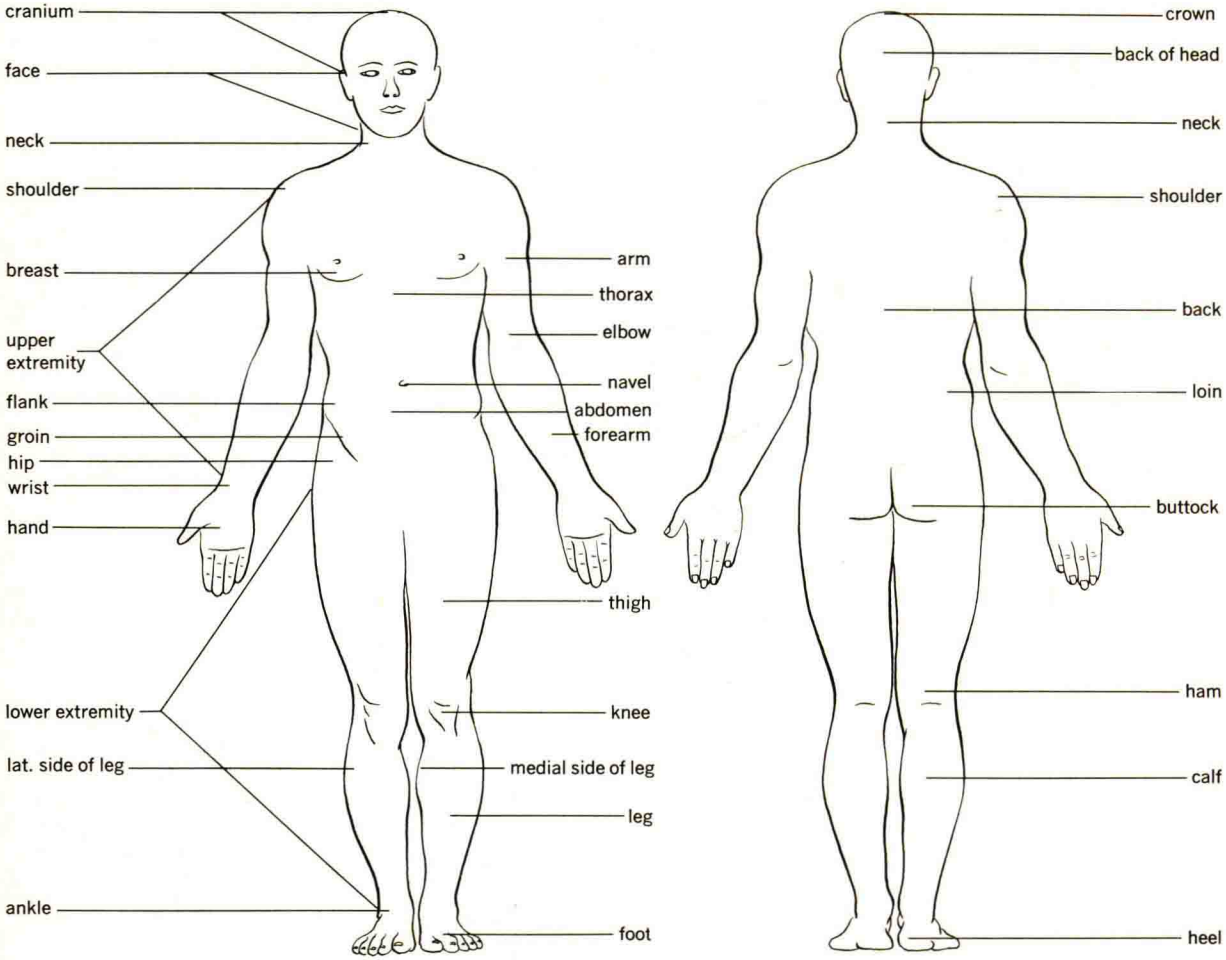

FIGURE 1.2 General descriptive areas of the body.

Terms of direction

The location and relationships of many body parts may be described by words that are used when the body is in ANATOMICAL POSITION (Fig. 1.3). In this position, the body is standing erect, the eyes are level and directed forward, the arms are at the sides with the palms forward, and the feet are parallel, with the heels close together. The terms of direction are:

Anterior or ventral. The front or belly side of the body, or something in front of the original point of reference; for example, the sternum (breastbone) is located on the anterior or ventral part of the thorax.

Posterior or *dorsal.* The back side of the body, or something in back of the original point of reference; for example, the spine is located on the posterior or dorsal part of the body.