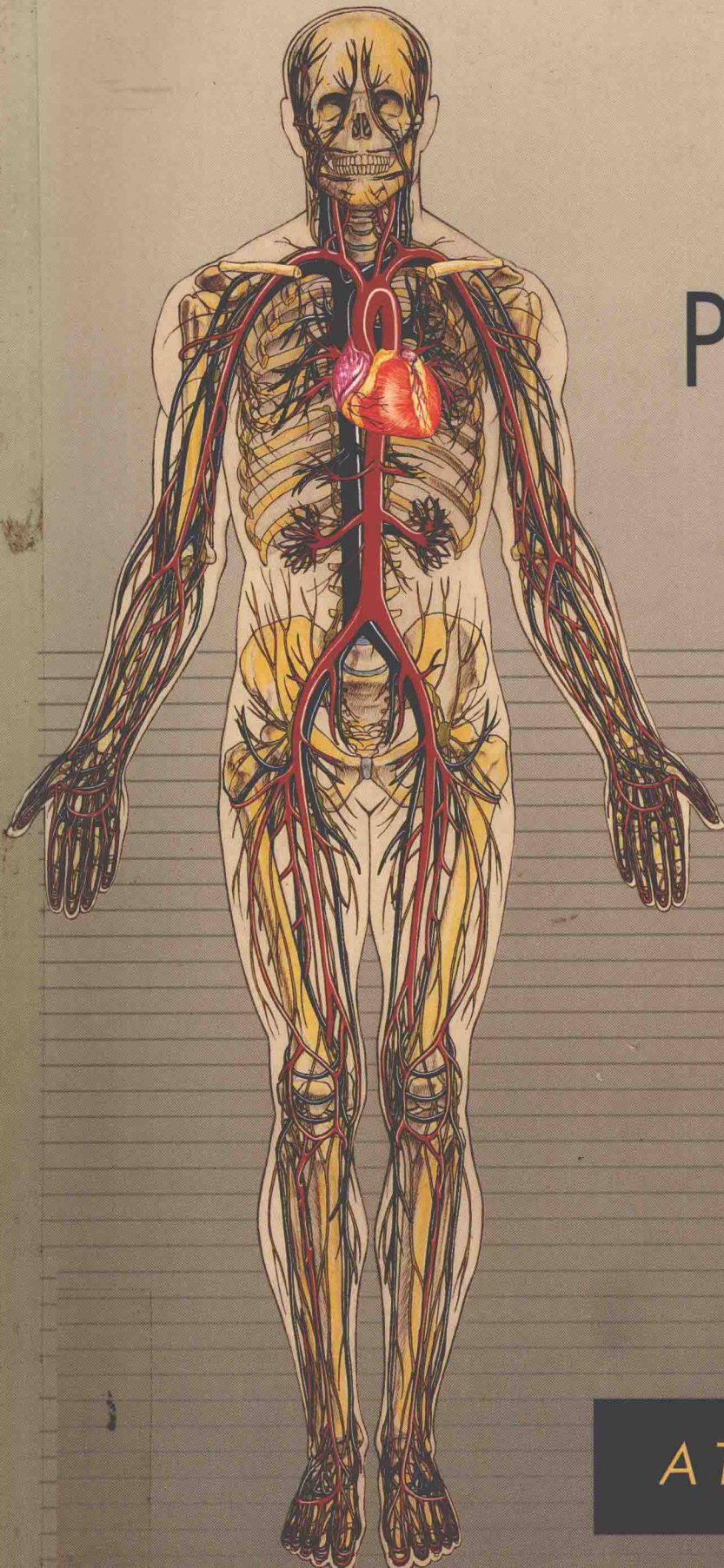


ANATOMY AND PHYSIOLOGY

AN EASY LEARNER

ETHEL SLOANE

A TEXT IN OUTLINE FORM



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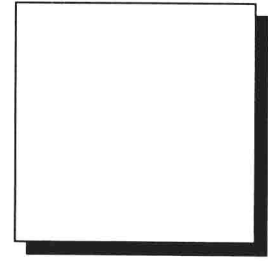
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Preface and Acknowledgments



Anatomy and physiology courses, in common with basic science courses taught in universities across the country, are staggering under the burden of massive amounts of information accumulated in the last decade. Textbooks have become thicker with new material, detailed explanations, multicolored illustrations, and an abundance of study guides and other pedagogical aids. This book is designed to help students (and instructors) wend their way through the vast and complex amount of information in the textbooks by presenting the core facts of anatomy and physiology in outline form.

The treatment of the material, although it is condensed, is comprehensive and up to date. The book includes, in abbreviated form, all of the concepts in approximately the same sequence as those in the major anatomy and physiology texts on the market. The outline format, however, eliminates lengthy descriptions. It provides the essentials in an organized framework that encourages easier learning and rapid recall. The back-to-basics approach of this text can serve students currently enrolled in anatomy and physiology as a stand-alone primary text or as a companion book to a more detailed volume. The book also can be used as a review for class examinations and as generic lecture notes that allow students to do more listening and thinking and less writing during their lectures. In addition, this text can assist students in the review of anatomy and physiology for various board examinations, the Medical College Admissions Test, or the Graduate Record Examination. Each chapter ends with questions that are designed for self-evaluation of knowledge derived from the information presented. The questions are in the objective style most often used in anatomy and physiology courses and are followed by extensive explanations, which cite the location of the answer in the outline, reinforce the learning of the material, and assist the student in identifying information needing further study.

Anatomy and physiology is a dynamic and exciting discipline. But, as students strive to master it, they can get so bogged down in the intimidating amount of material to be assimilated that they lose confidence in their ability to learn and understand it. My hope is that this concise text helps to provide an easier path to learning and understanding—one that encourages students to see the whole picture quickly, so that they can experience both the joy of mastery and the excitement of knowing how the human body works.

I acknowledge with gratitude the consistent encouragement and valuable suggestions I received from Joseph E. Burns, Vice President of Jones and Bartlett. I also ex-

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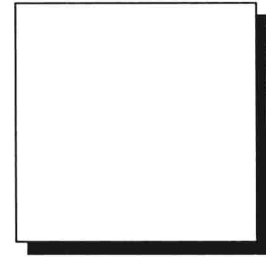
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Contents



Preface and Acknowledgments vii

1. OVERVIEW OF HUMAN ANATOMY AND PHYSIOLOGY 1

- Introduction 1
- Taxonomic Classification of Humans 2
- Structural Levels of Body Organization 3
- Characteristics of Living Matter 4
- Homeostasis 4
- Structural Plan of the Body 5

2. THE CHEMICAL BASIS OF LIFE 11

- Introduction to Basic Chemistry 11
- Chemical Reactions 16
- Biochemistry 17
- Energy, Enzymes, and Enzyme Activity 28

3. THE CELL 34

- Introduction 34
- Components of a Cell 35
- Movement of Materials across Cell Membranes 41
- Cell Metabolism 45
- Cell Division 46
- Protein Synthesis 52

4. HUMAN GENETICS 58

- Introduction 58
- Terminology of Genetics 58
- Mendelian Laws of Genetics 61
- Human Inheritance 61
- Chromosomal Abnormalities 64

5. TISSUES 69

- Introduction 69
- Epithelial Tissues 69
- Connective Tissues 74
- Muscle Tissue 79
- Nervous Tissue 80

6. INTEGUMENTARY SYSTEM 84

- Introduction 84
- Skin 85
- Skin Derivatives 86
- Role of Skin in Thermoregulation 88

7. SKELETAL SYSTEM 92

- General Introduction to the Skeletal System 92
- Skeletal Anatomy: Axial Skeleton 97
- Skeletal Anatomy: Appendicular Skeleton 105
- Articulations 113

8. THE MUSCULAR SYSTEM 119

- Part I: General Structure and Physiology* 119
 - Introduction 119
 - Skeletal Muscle 120
 - Smooth Muscle 127
 - Cardiac Muscle 128
- Part II: Major Skeletal Muscles and Their Actions* 129
 - General Principles 129
 - Muscle Tables 131

9. THE NERVOUS SYSTEM 155

- Part I: Organization, Cells, and Nerve Impulses* 155
 - Introduction 155
 - Cells of the Nervous System 156
 - The Nerve Impulse 158
 - Neuronal Pools and Circuits 164
 - Reflexes 165
- Part II: Central Nervous System and Peripheral Nervous System* 167
 - Brain 167
 - Spinal Cord 175
 - Peripheral Nervous System 178
- Part III: Sensory Receptors* 185
 - Classification of Sensory Receptors 185

Eye and the Sense of Vision 186
 Ear: Senses of Hearing and Equilibrium 191
 Gustation: The Sense of Taste 196
 Olfaction: The Sense of Smell 197

10. ENDOCRINE SYSTEM 202

Introduction 202
 Hypophysis (Pituitary Gland) 206
 Thyroid Gland 211
 Parathyroid Glands 212
 Adrenal Glands 213
 The Endocrine Pancreas 215
 Pineal Gland 217
 Thymus Gland 217

11. CIRCULATORY SYSTEM 221

Introduction 221
 Blood 222
 The Heart 231
 Cardiac Physiology 235
 Hemodynamics: Blood Flow and Blood Pressure 240
 Circulatory Pathways 243
 Capillary Exchange and the Lymphatic System 247

12. NONSPECIFIC DEFENSES AND THE IMMUNE SYSTEM 255

Introduction 255
 Nonspecific Defenses 255
 The Immune System: Specific Defenses 258

13. RESPIRATORY SYSTEM 269

Introduction 269
 Functional Anatomy of the Respiratory Tract 269
 Mechanics of Breathing (Pulmonary Ventilation) 273
 Gas Exchange 275
 Transport of Gases by the Blood 276
 Control of Respiration 279
 Respiratory Problems 280

14. DIGESTIVE SYSTEM 283

Introduction 283
 Oral Cavity, Pharynx, and Esophagus 285
 Stomach 288
 Small Intestine 290
 Large Intestine 296

15. METABOLISM, NUTRITION, AND BODY TEMPERATURE REGULATION	301
Introduction	301
Metabolism of Absorbed Carbohydrates	302
Metabolism of Fats	308
Protein Metabolism	310
Absorptive (Feasting) and Postabsorptive (Fasting) States	311
Metabolic Rate and Nutrition	312
Temperature Regulation	313
16. URINARY SYSTEM	320
Introduction	320
Formation of Urine	324
Concept of Clearance	326
Urine Concentration and Dilution Mechanisms	326
Characteristics of Urine	329
The Ureters, Urinary Bladder, and Urethra	330
Disorders of the Urinary System	332
17. FLUIDS, ELECTROLYTES, AND ACID-BASE BALANCE	336
Introduction	336
Body Fluids	336
Electrolyte Balance	339
Acid-Base Balance	341
18. THE REPRODUCTIVE SYSTEMS, PREGNANCY, AND DEVELOPMENT	348
Introduction	348
Embryonic Development	348
The Male Reproductive System	350
The Female Reproductive System	356
Fertilization	365
Contraception	366
Pregnancy and Early Development	367
<i>Index</i>	377

2 Overview of Human Anatomy and Physiology

- f. **Developmental anatomy** is the study of growth and differentiation of structures throughout the life span of an organism.
- g. **Pathology (pathological anatomy)** is the study of body structures and changes associated with disease or injury.
- h. **Radiographic anatomy (radiology)** is the study of body structures using x-rays or other imaging techniques.

B. **Physiology** is the study of the functions of the living body.

- 1. Like anatomy, physiology includes specialized areas that consider the function of particular organ systems; for example, **neurophysiology**, **cardiac physiology**, or **reproductive physiology**.
- 2. The study of physiology is based on cellular and molecular function. It requires knowledge of the principles of chemistry and physics.

C. Some **historical figures** in anatomy and physiology include the following:

- 1. **Hippocrates** (460–375 B.C.), the founder of the most ancient school of medicine in Greece, is commonly known as “the father of medicine.” He provided scientific foundation for the field of medical practice and his name is associated with the Hippocratic oath, which is the ethical guide of the medical profession.
- 2. **Aristotle** (384–322 B.C.), the first comparative anatomist, understood the relationship of structure and function. He undertook a systematic classification of animals.
- 3. **Galen** (131–201), after Hippocrates, is considered the most important figure in the history of medicine; he was the first experimental physiologist. His book, **Uses of the Parts of the Body of Man**, showed how organs are perfectly constructed for and adapted to their function.
- 4. **Leonardo da Vinci** (1451–1519) was an artist, engineer, inventor, and scientist who left extraordinary drawings of muscle action and cardiovascular activity.
- 5. **Andreas Vesalius** (1514–1564) was a teacher and dissector whose work **De Humani Corporis Fabrica Libri Septem** (Seven Books on the Structure of the Human Body) laid the foundation for modern anatomy and physiology.
- 6. **William Harvey** (1578–1657), one of the most distinguished anatomists of all time, discovered the circulation of the blood, a milestone in the history of medicine.

II. TAXONOMIC CLASSIFICATION OF HUMANS

A. **Taxonomy** is the branch of biology that names and classifies all living things. Taxonomy is a part of **systematics**, the science that studies the diversity of organisms.

- 1. The process of taxonomy classifies organisms into a hierarchy of units that is based on the degrees of similarity among them. Each level of classification is a **taxon**.
- 2. Some of the characters used in classifying organisms into the units (taxa) include their gross morphology, developmental stages, probable evolutionary relationships, and the comparison of their proteins and gene structure.
- 3. Each organism is assigned a two-part Latin name: the **genus** (plural, genera) and **species**. Species are grouped into genera, genera into **families**, families into **orders**, orders into **classes**, classes into **phyla**, and phyla into **kingdoms**.
- 4. The broadest taxonomic unit is the kingdom. The five kingdoms include the **Monera** (microscopic organisms lacking a nucleus), **Protista** (one-celled nucleated organisms), **Plantae** (multicellular plants), **Fungi**, and **Animalia**. Humans are in the kingdom Animalia.

B. Classification of a human

1. **Kingdom: Animalia.** All organisms in the animal kingdom obtain their nutrition by consuming and digesting other organisms.
2. **Phylum: Chordata.** Humans, like fish, amphibians, reptiles, birds, and other mammals, are animals that at some time during their life cycle have the following three distinct characteristics that group them into the phylum:
 - a. A **notochord** is a tough, flexible supporting rod located along the back.
 - b. A **tubular (hollow) nerve cord** is located dorsally, or above the notochord.
 - c. **Paired gill slits** (clefts) are located on the sides of the pharynx (throat region) at least sometime during development.
3. **Subphylum: Vertebrata.** Vertebrates include all animals having an internal bony skeleton and an articulated (jointed) backbone. The vertebrates are divided into eight classes; humans are included in the class Mammalia.
4. **Class: Mammalia.** Mammals are vertebrates that are **warm-blooded**. Additional characteristics of mammals include the following:
 - a. **Hair**, an insulating and protective covering, helps to maintain a constant body temperature.
 - b. **Mammary glands**, which produce milk, serve to nourish their young.
 - c. A muscular **diaphragm** functions in respiration.
 - d. A **four-chambered heart** separates oxygenated from unoxygenated blood.
 - e. An intrauterine **placenta** nourishes the young during prenatal development.
 - f. **Three ear ossicles** (bones) and **differentiated teeth** adapted to chewing a variety of foods also are characteristic to mammals.
5. **Order: Primata.** Primates include lemurs, monkeys, and great apes as well as humans. They have **grasping hands**, an **opposable thumb**, claws modified to finger and toe **nails**, and relatively large, **well-developed brains**.
6. **Family: Hominidae.** Hominidae include both the extinct and the living races of humans.
7. **Genus: Homo** and **species: sapiens.** **Homo sapiens** includes all the ethnic varieties of humans.

C. Uniquely human characteristics include the following:

1. Humans are **bipedal**, which is the ability to stand upright and walk on two feet.
2. Humans have a **large skull** with a huge cranial capacity. In absolute weight, humans' brain size is among the heaviest of all existing animal brains.
3. Humans have an **expanded pelvis**, which enables them to bear large-headed children.
4. Humans have a **prominent chin**, **weak jaws**, and **small teeth** relative to other mammals.

III. STRUCTURAL LEVELS OF BODY ORGANIZATION. The structural organization of the human body progresses from the lowest level of organization (atoms and molecules) through higher, more complex levels to make up the total body.

- A. **Chemical level.** **Atoms**, such as hydrogen, oxygen, carbon, nitrogen, and sodium, combine to form **molecules**, such as water and salt, and macromolecules, such as carbohydrates, proteins, and fats.
- B. **Cells.** The cell is the fundamental unit of living things. Cellular structures, such as the nucleus, ribosomes, mitochondria, and lysosomes, perform the life-sustaining functions of the cell.
- C. **Tissues.** A group of cells of similar structure that perform the same functions is called a **tissue**. There are four basic tissues: **epithelial tissue**, **connective tissue**, **muscle tissue**, and **nervous tissue**. (Tissues are described in detail in Chapter 5.)

4 Overview of Human Anatomy and Physiology

- D. **Organs.** Two or more tissues combine to form an organ, such as the stomach, kidney, or eye. An organ functions as a specialized physiological center for the body's activities.
- E. **Organ systems.** When several organs combine to perform related functions, they constitute an organ system. The organ systems of the body are the **integumentary, skeletal, muscular, nervous, endocrine, cardiovascular (circulatory), lymphatic, respiratory, digestive, urinary, and reproductive** systems.

IV. **CHARACTERISTICS OF LIVING MATTER** are the properties that distinguish living material from nonliving things and that enable living cells to carry on the activities necessary for their survival. They include the following:

- A. **Irritability** or responsiveness is the ability to respond to internal or external stimuli in the environment.
- B. **Conductivity** is the ability to conduct or transmit the irritability (stimulus) from one site to another. This property is highly developed in nerve and muscle cells.
- C. **Movement** is the result of shortening or contracting of cells and is a property particularly well developed in muscle cells.
- D. **Growth** is an increase in the size of individual cells or an increase in the number of cells.
- E. **Reproduction** is the ability of living things to replicate themselves.
- F. **Metabolism** is the sum total of all the chemical reactions that take place in living material. Such chemical processes include **catabolism**, or the breakdown of complex molecules to simpler substances, and **anabolism**, the synthesis of complex macromolecules from simpler building block substances. (See also Chapter 15.) Metabolism in the body depends on the following processes:
 - 1. **Digestion** is the process whereby complex foods (carbohydrates, proteins, and fats) are broken down into simple molecules (simple sugars, amino acids, fatty acids, and glycerol) for **absorption**.
 - 2. **Respiration** refers to the processes whereby oxygen and carbon dioxide are exchanged between the body cells and the external environment.
 - 3. **Cellular respiration** includes the processes whereby oxygen nutrients are utilized by the body cells to produce energy and carbon dioxide.
 - 4. **Circulation** of body fluids transports oxygen and nutrients to the cells and removes the products of metabolism from the cells.
 - 5. **Excretion** is the elimination of waste products of metabolism from the body.

V. HOMEOSTASIS

- A. The **concept of homeostasis** (steady state) refers to the maintenance, within physiological limits, of relatively constant chemical and physical conditions within the environment of the cells of the organism. Chemical requirements to maintain constancy include the appropriate amounts of water, nutrients, and oxygen; the physical requirements include the appropriate temperature and atmospheric pressure.
- B. **Mechanisms of homeostasis** involve almost all organ systems of the body. Although internal conditions vary constantly, the body is protected against extremes by self-regulating control mechanisms such as **feedback systems**, which refer to the feeding of information from a system (output) back into the system (input) to cause a response.
 - 1. **Components of a feedback system**
 - a. The **setpoint** is the normal physiologic value of any body variable, such as normal temperature, concentration of substances in the extracellular fluid, or blood acidity or alkalinity.

- b. The **sensor (receptor)** detects a deviation from any given normal variable.
- c. The **control center** receives information from the various sensors, integrates and processes the information, and determines the compensatory response to get back to the setpoint.
- d. The **effectors** implement the response, which is continued until the set point is again reached.

2. Examples of feedback systems

- a. **Negative feedback mechanisms** are those in which the information returned to the system (input) **decreases** the change (output) in order to get back to the appropriate setpoint. One example is the way in which the blood glucose is maintained at a relatively constant level of 90 to 110 mg/100 ml blood.
 - (1) After a meal, a rise in the blood glucose level stimulates the release of insulin from special cells in the pancreas.
 - (2) Insulin facilitates the passage of glucose into the body cells and thus lowers the blood glucose level.
 - (3) The lowered glucose level affects the insulin-releasing cells (negative feedback) to decrease the release of insulin and the blood glucose is maintained at the appropriate level.
- b. **Positive feedback mechanisms** are those in which the information returned to the system **increases or prolongs**, rather than decreases, the deviation from the original physiological state.
 - (1) One example of positive feedback occurs when a nerve membrane is stimulated.
 - (a) The stimulus changes the permeability of the membrane to sodium ions, which then flow across the membrane.
 - (b) The influx of sodium ions further increases the membrane's permeability to sodium ions and results in even more sodium ions flowing inward. The result is the initiation of a nerve impulse.
 - (2) Positive feedback also occurs in the mechanism of blood clotting. The initiation of the blood clotting process causes the release of chemicals that accelerate the blood clotting process.

VI. STRUCTURAL PLAN OF THE BODY. The study of anatomy requires positional and directional terminology and reference points.

- A. **Planes** (sections) of the body are imaginary flat surfaces that pass through it to provide reference points (Figure 1-1).
 - 1. A **sagittal plane** divides the body into a right and a left side.
 - a. A **midsagittal plane** divides the body into equal right and left halves.
 - b. A **parasagittal plane** divides the body into unequal left and right parts.
 - 2. A **frontal or coronal plane** is one at right angles to the sagittal plane. It divides the body or organs into front and back parts.
 - 3. A **transverse (horizontal, cross-sectional) plane** divides the body or organs into upper and lower portions.
- B. The **anatomical position** of the body is used as a reference so that all body parts can be described in relation to it. In anatomical position, the body is erect with eyes forward, feet together, arms at the sides, palms up with the thumbs pointing away from the body, and the little fingers pointing toward the body (Figure 1-2).
 - 1. The **anterior** of the body (**ventral** in animals) is the front or belly side. For example, the nose is anterior to the rest of the face.
 - 2. The **posterior** is the back side (**dorsal** in animals). For example, the buttocks are posterior to the abdomen.
 - 3. **Superior** is toward the head or uppermost part; it is also referred to as **cephalic, craniad, or rostral**. For example, the head is superior to the neck.

6 Overview of Human Anatomy and Physiology

Figure 1-1. Body planes and directions.

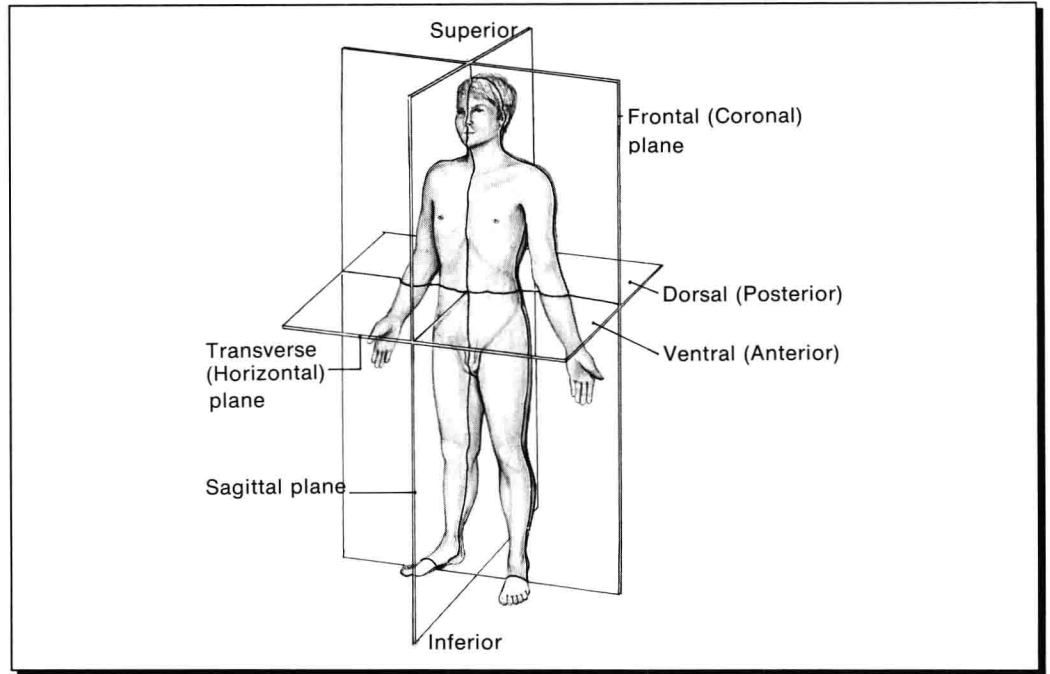
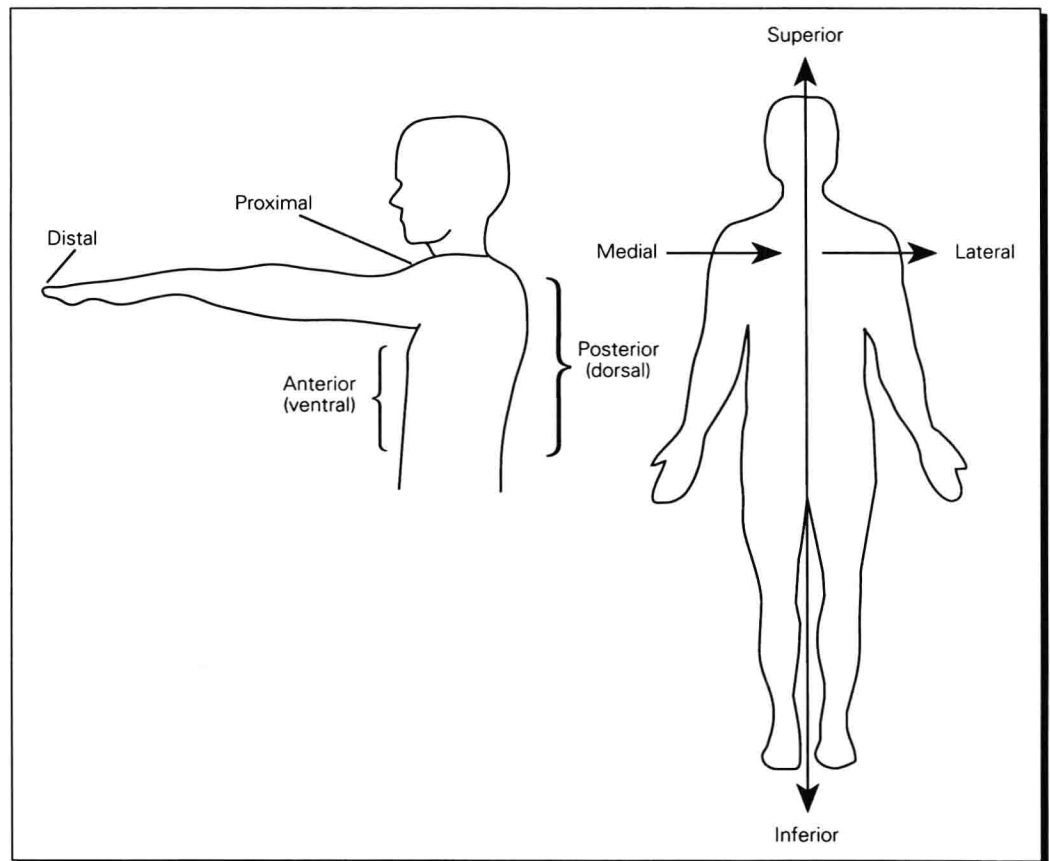


Figure 1-2. Direction terms in anatomical position.



4. **Inferior** is away from the head and toward the lower parts of the body; it is also called **caudad**. For example, the chest is inferior to the neck.
 5. **Medial** is any structure closest to the imaginary midline of the body. For example, the nose is medial to the eyes.
 6. **Lateral** is to the side, away from the midline of the body. For example, the ears are lateral to the eyes.
 - a. **Ipsilateral** means located on the same side.
 - b. **Contralateral** means located on the opposite side.
 7. **Proximal** refers to that part of a structure that is closer to the midline or, with reference to a limb, nearer to the origin or point of attachment closest to the trunk. For example, the elbow is proximal to the wrist.
 8. **Distal** means farthest from the midline or away from the origin or the point of attachment to the trunk. For example, the foot is distal to the ankle.
 9. **Superficial** means anything near the surface of the body. For example, skin is superficial to the muscles.
 10. **Deep** means located internally, within the body. For example, the intestines lie deep to the abdominal muscles and skin.
- C. **Body cavities** are the spaces within the axial part of the body that contain the internal organs or viscera. Two main cavities lie within the axial portion of the body: the **dorsal cavity** and the **ventral cavity** (Figure 1–3). The **appendicular** or limb portion of the body contains no cavities.
1. The **dorsal body cavity** is located posteriorly (dorsally) and is subdivided into the **cranial cavity** and the **spinal cavity**.
 - a. The **cranial cavity** is surrounded by bone and contains the brain.
 - b. The **spinal (vertebral) cavity** is formed by the backbone and contains the spinal cord.
 2. The **ventral body cavity** is located anteriorly (ventrally) and is subdivided into the **thoracic cavity** and the **abdominal cavity** separated by the **diaphragm**.
 - a. The **thoracic cavity** is the chest cavity. It contains the right and left pleural cavities (sacs) and the mediastinum.
 - (1) The **pleural cavities** each contain a lung.
 - (2) The **mediastinum** contains the heart, which is located within the **pericardial cavity**, the thymus gland, part of the esophagus, and many large blood vessels.
 - b. The **abdominopelvic (peritoneal) cavity** contains the viscera of the abdomen and the pelvic areas.
 - c. Additional small cavities in the head include the **oral cavity**, the **nasal cavity**, the **middle ear cavities**, and the **orbital cavities** for the eyes.

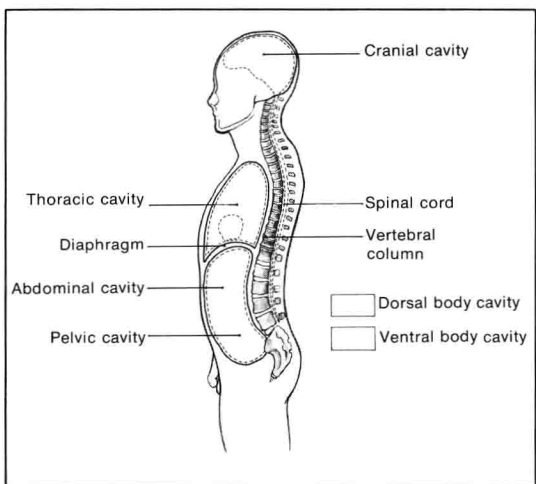
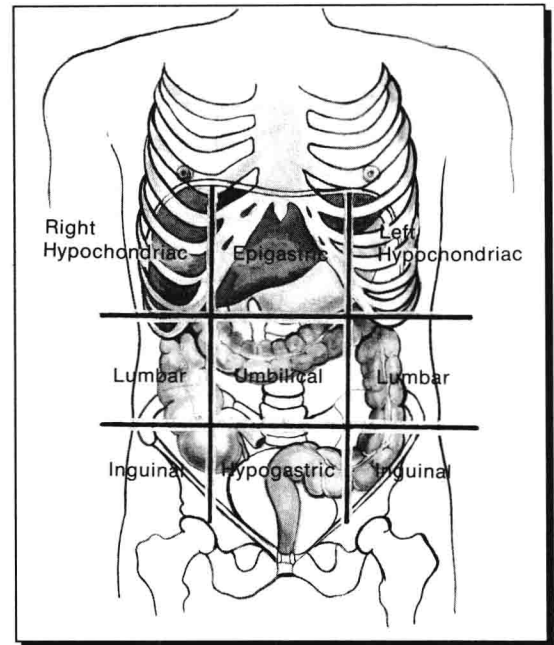


Figure 1–3. Dorsal and ventral body cavities.

Figure 1–4. Anterior view of the abdominopelvic cavity showing superficial organs. Nine regions are delineated by four planes. The superior horizontal plane is just inferior to the ribs, the inferior horizontal plane is just superior to the hip bones, and the vertical planes are just medial to the nipples.



3. **Serous membranes** line the thoracic and abdominopelvic cavities and also cover the organs within these cavities. A **parietal membrane** lines a cavity; a **visceral membrane** covers the organs.
 - a. The **parietal pleura** lines the pleural cavities and the **visceral pleura** covers the lungs.
 - b. The **parietal pericardium** lines the pericardial cavity and the **visceral pericardium** covers the heart.
 - c. The **parietal peritoneum** lines the abdominopelvic cavity; the **visceral peritoneum** covers the abdominal organs and many of the pelvic organs.
- D. **Abdominal-pelvic regions.** Nine designations are used in anatomical studies to facilitate references to body structures and internal organs (Figure 1–4).
 1. The **umbilical region** is in the center of the abdomen.
 2. The **epigastric region** is immediately superior to the umbilical region.
 3. The **hypogastric region** is immediately inferior to the umbilical region.
 4. The **right and left hypochondriac regions** are lateral to the epigastric region.
 5. The **right and left lumbar regions** are lateral to the umbilical region.
 6. The **right and left inguinal (iliac) regions** are lateral to the hypogastric region.
- E. Four **abdominopelvic designations**, generally used clinically, are derived from imaginary horizontal and vertical lines intersecting at the umbilicus. These lines divide the abdomen into the **right and left upper quadrants (RUQ, LUQ)** and the **right and left lower quadrants (RLQ, LLQ)**.

Study Questions

Directions: Each question below contains four suggested answers. Choose the **one best** answer to each question.

- A pathologist who conducts an autopsy to determine the cause of death is most likely to have been trained primarily as a(an)
 - physiologist
 - anatomist
 - biochemist
 - chemist
 - Which of the following contributors to the science of anatomy and physiology is known as "the father of medicine?"
 - Hippocrates
 - Vesalius
 - Aristotle
 - Galen
 - Into which taxonomic group are apes, mice, and humans all classified?
 - Primates
 - Hominidae
 - Rodents
 - Vertebrates
 - All of the following are characteristics of the class Mammalia EXCEPT
 - four-chambered heart
 - bony spinal column
 - warm-blooded
 - feathers
 - The fundamental structural and functional component of a living organism is the
 - atom
 - cell
 - organ
 - organ system
 - The total of the chemical changes or reactions that occur within the body are referred to collectively as
 - organization levels
 - physiology
 - metabolism
 - homeostasis
 - All of the following statements are true concerning homeostasis EXCEPT
 - Homeostasis implies that the internal environment is in a static, unchanging state.
 - Feedback systems are involved in homeostatic mechanisms.
 - Various organ systems participate in homeostasis in an interrelated fashion.
 - Homeostasis is concerned with the control of the composition of the extracellular fluid that constantly bathes the outsides of the cells.
 - The brain is contained within the
 - dorsal body cavity
 - thoracic cavity
 - spinal cavity
 - cranial cavity
 - The serous membrane that covers the heart is the
 - visceral peritoneum
 - visceral pericardium
 - parietal pleura
 - parietal pericardium
 - A transverse line passing medially from the posterior border of the left lumbar region would cross closest to which of the following structures?
 - left nipple
 - right nipple
 - navel
 - heart
- Questions 11–14:** Match the word below with the phrase or word that best describes or is synonymous with it.
- proximal
 - anterior
 - sagittal
 - horizontal
- A plane that divides the body into right and left halves
 - Closest to the midline of the body or origin of the part
 - Ventral
 - A plane that divides the body into cranial and caudal parts