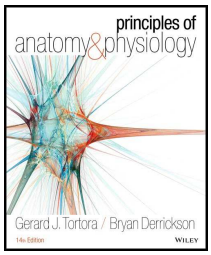


Principles of Anatomy and Physiology

14th Edition

CHAPTER 1

An Introduction to the Human Body

Introduction

The purpose of the chapter is to:

1. Introduce the disciplines of anatomy and physiology
2. Discuss the organization of the human body
3. Reveal shared properties of all living things
4. Discuss the concept of homeostasis

Anatomy vs. Physiology

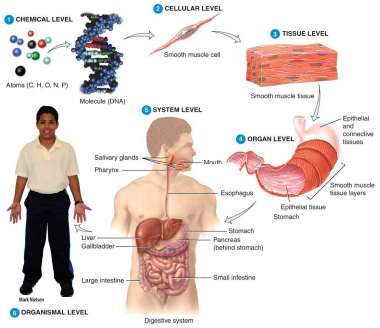
Anatomy is the study of structure whereas physiology is the study of how body structures function

TABLE 1.1

Selected Branches of Anatomy and Physiology

BRANCH OF ANATOMY	STUDY OF	BRANCH OF PHYSIOLOGY	STUDY OF
Embryology (em″-brē-OL-ō-jē; embry- = embryo; -logy = study of)	The first eight weeks of development after fertilization of a human egg.	**Neurophysiology** (NOOR-ō-fiz-ē-ol″-ō-jē; neuro- = nerve)	Functional properties of nerve cells.
Developmental biology	The complete development of an individual from fertilization to death.	**Endocrinology** (en″-dō-krī-NOL-ō-jē; endo- = within; crin- = secretion)	Hormones (chemical regulators in the blood) and how they control body functions.
Cell biology	Cellular structure and functions.	**Cardiovascular physiology** (kar-dē-ō-VAS-kū-lar; cardi- = heart; vascular = blood vessels)	Functions of the heart and blood vessels.
Histology (his-TOL-ō-jē; *histi-* = tissue)	Microscopic structure of tissues.	**Immunology** (im″-ū-NOL-ō-jē; *immun-* = not susceptible)	The body's defenses against disease-causing agents.
Gross anatomy	Structures that can be examined without a microscope.	**Respiratory physiology** (RES-pi-ra-tōr-ē; respira- = to breathe)	Functions of the air passageways and lungs.
Systemic anatomy	Structure of specific systems of the body such as the nervous or respiratory systems.	**Renal physiology** (RE-nal; ren- = kidney)	Functions of the kidneys.
Regional anatomy	Specific regions of the body such as the head or chest.	**Exercise physiology**	Changes in cell and organ functions due to muscular activity.
Surface anatomy	Surface markings of the body to understand internal anatomy through visualization and palpation (gentle touch).	**Pathophysiology** (Path-ō-fiz-ē-ol″-ō-jē)	Functional changes associated with disease and aging.
Imaging anatomy	Body structures that can be visualized with techniques such as x-rays, MRI, and CT scans.		
Pathological anatomy (path″-ō-LOJ-i-kal; *path-* = disease)	Structural changes (gross to microscopic) associated with disease.		

Levels of Structural Organization & Body Systems



Systems of the Human Body

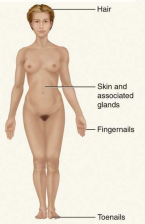
TABLE 1.2

The Eleven Systems of the Human Body

INTEGUMENTARY SYSTEM (CHAPTER 5)

Components: **Skin** and associated structures, such as **hair, fingernails** and **toenails, sweat glands**, and **oil glands**.

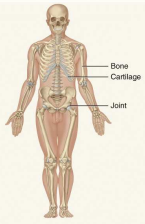
Functions: Protects body; helps regulate body temperature; eliminates some wastes; helps make vitamin D; detects sensations such as touch, pain, warmth, and cold; stores fat and provides insulation.



SKELETAL SYSTEM (CHAPTERS 6–9)

Components: **Bones** and **joints** of the body and their associated **cartilages.**

Functions: Supports and protects body; provides surface area for muscle attachments; aids body movements; houses cells that produce blood cells; stores minerals and lipids (fats).



Systems of the Human Body

TABLE 1.2

The Eleven Systems of the Human Body

MUSCULAR SYSTEM (CHAPTERS 10, 11)

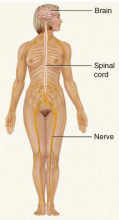
Components: Specifically, **skeletal muscle** tissue—muscle usually attached to bones (other muscle tissues include smooth and cardiac).

Functions: Participates in body movements, such as walking; maintains posture; produces heat.

NERVOUS SYSTEM (CHAPTERS 12–17)

Components: **Brain, spinal cord, nerves**, and special sense organs, such as **eyes** and **ears**.

Functions: Generates action potentials (nerve impulses) to regulate body activities; detects changes in body's internal and external environments, interprets changes, and responds by causing muscular contractions or glandular secretions.



Systems of the Human Body

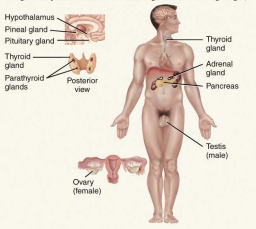
TABLE 1.2 CONTINUED

The Eleven Systems of the Human Body

ENDOCRINE SYSTEM (CHAPTER 18)

Components: Hormone-producing glands (**pineal gland, hypothalamus, pituitary gland, thymus, thyroid gland, parathyroid glands, adrenal glands, pancreas, ovaries**, and **testes**) and hormone-producing cells in several other organs.

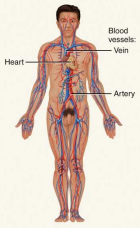
Functions: Regulates body activities by releasing hormones (chemical messengers transported in blood from endocrine gland or tissue to target organ).



CARDIOVASCULAR SYSTEM (CHAPTERS 19–21)

Components: **Blood, heart**, and **blood vessels**.

Functions: Heart pumps blood through blood vessels; blood carries oxygen and nutrients to cells and carbon dioxide and wastes away from cells and helps regulate acid–base balance, temperature, and water content of body fluids; blood components help defend against disease and repair damaged blood vessels.



Systems of the Human Body

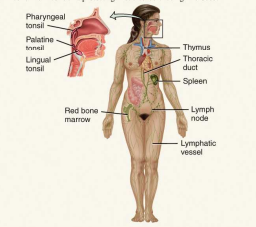
TABLE 1.2 CONTINUED

The Eleven Systems of the Human Body

LYMPHATIC SYSTEM AND IMMUNITY (CHAPTER 22)

Components: **Lymphatic fluid** and **vessels; spleen, thymus, lymph nodes,** and **tonsils**; cells that carry out immune responses (**B cells, T cells**, and others).

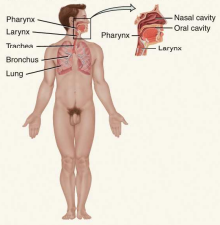
Functions: Returns proteins and fluid to blood; carries lipids from gastrointestinal tract to blood; contains sites of maturation and proliferation of B cells and T cells that protect against disease-causing microbes.



RESPIRATORY SYSTEM (CHAPTER 23)

Components: **Lungs** and air passageways such as the **pharynx** (throat), **larynx** (voice box), **trachea** (windpipe), and **bronchial tubes** leading into and out of lungs.

Functions: Transfers oxygen from inhaled air to blood and carbon dioxide from blood to exhaled air; helps regulate acid–base balance of body fluids; air flowing out of lungs through vocal cords produces sounds.



Systems of the Human Body

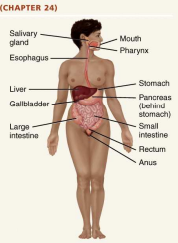
TABLE 1.2 CONTINUED

The Eleven Systems of the Human Body

DIGESTIVE SYSTEM (CHAPTER 24)

Components: Organs of gastrointestinal tract, a long tube that includes the **mouth, pharynx** (throat), **esophagus** (food tube), **stomach, small** and **large intestines**, and **anus**; also includes accessory organs that assist in digestive processes, such as **salivary glands, liver, gallbladder**, and **pancreas**.

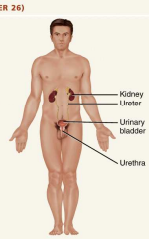
Functions: Achieves physical and chemical breakdown of food; absorbs nutrients; eliminates solid wastes.



URINARY SYSTEM (CHAPTER 26)

Components: **Kidneys, ureters, urinary bladder**, and **urethra**.

Functions: Produces, stores, and eliminates urine; eliminates wastes and regulates volume and chemical composition of blood; helps maintain the acid–base balance of body fluids; maintains body's mineral balance; helps regulate production of red blood cells.



Systems of the Human Body

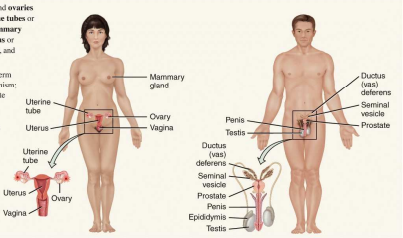
TABLE 1.2 CONTINUED

The Eleven Systems of the Human Body

REPRODUCTIVE SYSTEMS (CHAPTER 28)

Components: **Gonads** (**testes** in males and **ovaries** in females) and associated organs (**uterine tubes** or *fallopian tubes*, **uterus, vagina**, and **mammary glands** in females and **epididymis, ductus** or **vas deferens, seminal vesicles, prostate**, and **penis** in males).

Functions: Gonads produce gametes (sperm or oocytes) that unite to form a new organism; gonads also release hormones that regulate reproduction and other body processes; associated organs transport and store gametes; mammary glands produce milk.



Clinical Connection: Noninvasive Diagnostic Techniques

Palpation, auscultation, and percussion are used to assess certain aspects of body structure and function

Basic Life Processes

- All living things have certain characteristics that distinguish them from nonliving things
- Life processes in humans include metabolism, responsiveness, movement, growth, differentiation, and reproduction

Clinical Connection: Autopsy

- An autopsy is a postmortem examination of the body and dissection of its internal organs to confirm or determine cause of death

Homeostasis

- Homeostasis is a condition of equilibrium, or balance, in the body's internal environment
- Homeostasis is maintained by regulatory processes

Homeostasis & Body Fluids

- The survival of our body cells is dependent on the precise regulation of the chemical composition of their surrounding fluid
- This fluid is known as extracellular fluid

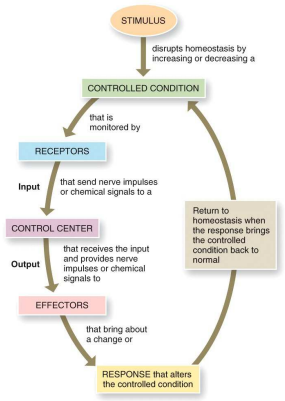
Homeostasis

Interactions Animation:

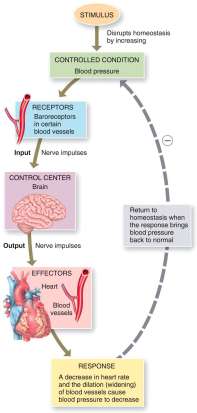
- Communication, Regulation, and Homeostasis

You must be connected to the Internet and in Slideshow Mode to run this animation.

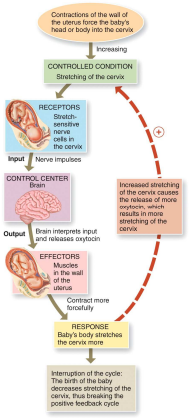
Control of Homeostasis



Control of Homeostasis: Negative Feedback



Control of Homeostasis: Positive Feedback



Homeostatic Imbalances

When homeostasis is disrupted disease, disorder, and even death may result

Basic Anatomical Terminology

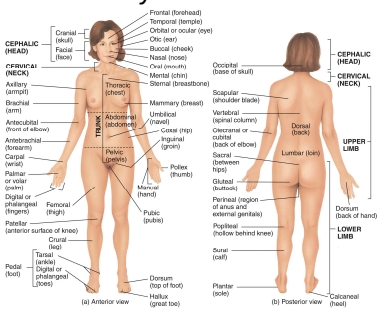
- Body positions
- Regional names
- Directional terms
- Planes and sections
- Body cavities

Body Positions

- Anatomical position is a standardized method of observing or imaging the body that allows precise and consistent anatomical reference
- Person stands erect, facing the observer, the upper extremities are places at the sides, the palms of the hands are turned forward, and the feet are flat on the floor

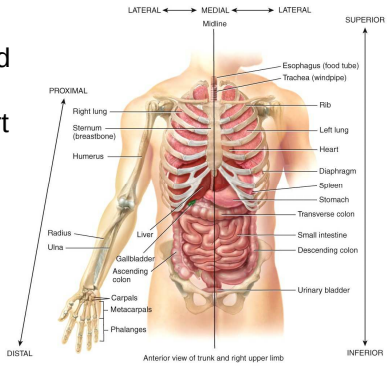
Regional Names

Regional names are names given to specific regions of the body for reference



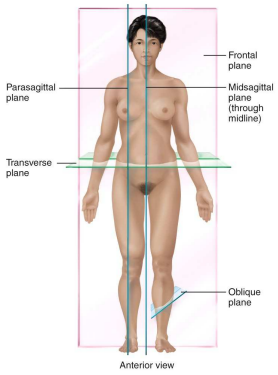
Directional Terms

Directional terms are used to precisely locate one part of the body relative to another

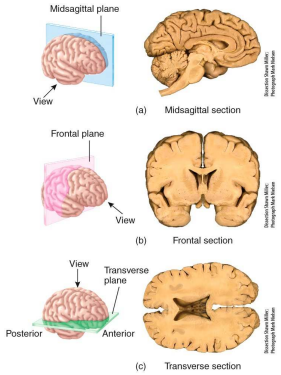


Planes & Sections

Planes are imaginary flat surfaces that are used to divide the body

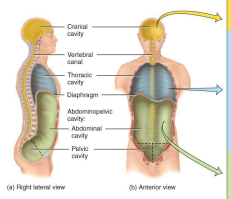


Practicing Planes & Sections



Body Cavities

Body cavities are spaces within the body that help protect, separate, and support internal organs

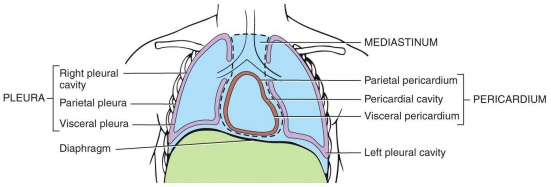


CAVITY	COMMENTS
Cranial cavity	Formed by cranial bones and contains brain.
Vertebral canal	Formed by vertebral column and contains spinal cord and the beginnings of spinal nerves.
Thoracic cavity*	Chest cavity; contains pleural and pericardial cavities and the mediastinum.
Pleural cavity	A potential space between the layers of the pleura that surrounds a lung.
Pericardial cavity	A potential space between the layers of the pericardium that surrounds the heart.
Mediastinum	Central portion of thoracic cavity between the lungs; extends from sternum to vertebral column and from first rib to diaphragm; contains heart, thymus, esophagus, trachea, and several large blood vessels.
Abdominopelvic cavity	Subdivided into abdominal and pelvic cavities.
Abdominal cavity	Contains stomach, spleen, liver, gallbladder, small intestine, and most of large intestine; the serous membrane of the abdominal cavity is the peritoneum.
Pelvic cavity	Contains urinary bladder, portions of large intestine, and internal organs of reproduction.

* See Figure 1.10 for details of the thoracic cavity.

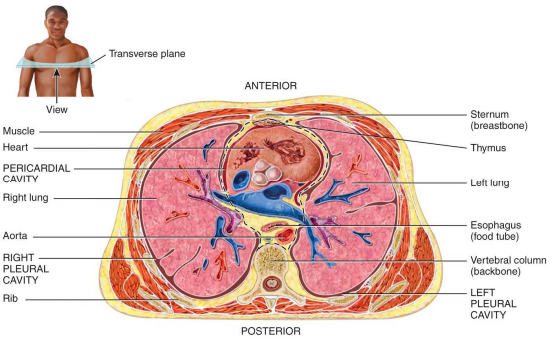
Thoracic Cavity Serous Membranes

The pericardium and pleura cover the heart and lungs, respectively



(a) Anterior view of thoracic cavity

Thoracic Cavity Serous Membranes



(b) Inferior view of transverse section of thoracic cavity

Abdominal Cavity Serous Membrane

- The peritoneum, covers many of the abdominal organs
- The visceral membrane covers the organs
- The parietal layer lines the abdominal wall

Abdominopelvic Regions & Quadrants

- The abdominal cavity can be divided into 9 regions to easily describe the location of organs

Medical Imaging

- Medical imaging involves techniques that allow physicians to view images of the human body
- This allows physicians to diagnose anatomical and physiological abnormalities

Medical Imaging Procedures

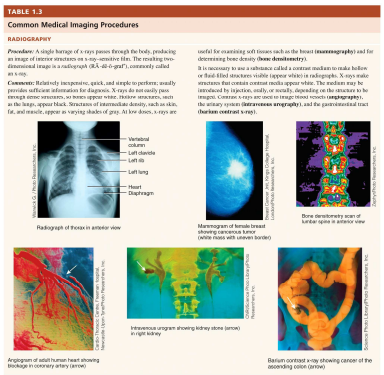


TABLE 1.3

Common Medical Imaging Procedures

RADIOGRAPHY

Procedure: A single barrage of x-rays passes through the body, producing an image of interior structures on a x-ray–sensitive film. The resulting two-dimensional image is a radiograph (RA-dē-ō-graf'), commonly called an x-ray.

Common: Relatively inexpensive, quick, and simple to perform; usually provides sufficient information for diagnosis. X-rays do not easily pass through dense structures, so bones appear white. Hollow structures, such as the lungs, appear black. Structures of intermediate density, such as skin, fat, and muscle, appear as varying shades of gray. At low doses, x-rays are useful for examining soft tissues such as the breast (**mammography**) and for determining bone density (**bone densitometry**).

It is necessary to use a substance called a contrast medium to make hollow or fluid-filled structures visible (appear white) in radiographs. X-rays make structures that contain contrast media appear white. The medium may be introduced by injection, orally, or rectally, depending on the structure to be imaged. Common x-rays are used to image blood vessels (**angiography**), the urinary system (**intravenous urography**), and the gastrointestinal tract (**barium contrast x-ray**).

Vertebral column
Left clavicle
Left rib
Left lung
Heart
Diaphragm

Radiograph of thorax in anterior view

Mammogram of female breast showing cancerous tumor (white mass with uneven border)

Bone densitometry scan of lumbar spine in anterior view

Angiogram of adult human heart showing blockage in coronary artery (arrow)

Intravenous urogram showing kidney stone (arrow) in right kidney

Barium contrast x-ray showing cancer of the ascending colon (arrow)

Medical Imaging Procedures

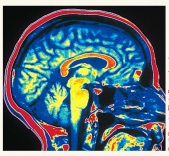
TABLE 1.3 CONTINUED

Common Medical Imaging Procedures

MAGNETIC RESONANCE IMAGING (MRI)

Procedure: The body is exposed to a high-energy magnetic field, which causes protons (small positive particles within atoms, such as hydrogen) in body fluids and tissues to arrange themselves in relation to the field. Then a pulse of radio waves "reads" these ion patterns, and a color-coded image is assembled on a video monitor. The result is a two- or three-dimensional blueprint of cellular chemistry.

Comments: Relatively safe but cannot be used on patients with metal in their bodies. Shows fine details for soft tissues but not for bones. Most useful for differentiating between normal and abnormal tissues. Used to detect tumors and artery-clogging fatty plaques; reveal brain abnormalities; measure blood flow; and detect a variety of musculoskeletal, liver, and kidney disorders.



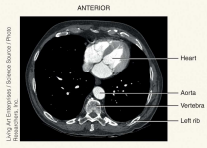
Magnetic resonance image of brain in sagittal section

COMPUTED TOMOGRAPHY (CT)

[formerly called computerized axial tomography (CAT) scanning]

Procedure: In this form of computer-assisted radiography, an x-ray beam traces an arc at multiple angles around a section of the body. The resulting transverse section of the body, called a *CT scan*, is shown on a video monitor.

Comments: Visualizes soft tissues and organs with much more detail than conventional radiographs. Differing tissue densities show up as various shades of gray. Multiple scans can be assembled to build three-dimensional views of structures (described next). Whole-body CT scanning typically targets the torso and appears to provide the most benefit in screening for lung cancers, coronary artery disease, and kidney cancers.



Computed tomography scan of thorax in inferior view

Medical Imaging Procedures

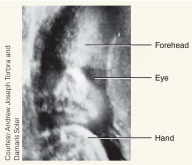
TABLE 1.3 CONTINUED

Common Medical Imaging Procedures

ULTRASOUND SCANNING

Procedure: High-frequency sound waves produced by a handheld wand reflect off body tissues and are detected by the same instrument. The image, which may be still or moving, is called a *sonogram* (SON-ō-gram) and is shown on a video monitor.

Comments: Safe, noninvasive, painless, and uses no dyes. Most commonly used to visualize the fetus during pregnancy. Also used to observe the size, location, and actions of organs and blood flow through blood vessels (**Doppler ultrasound**).



Sonogram of fetus (Courtesy of Andrew Joseph Tortora and Damaris Soler)

Medical Imaging Procedures

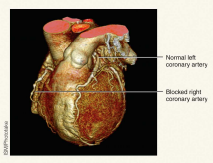
TABLE 1.3

Common Medical Imaging Procedures

CORONARY (CARDIAC) COMPUTED TOMOGRAPHY ANGIOGRAPHY (CCTA) SCAN

Procedure: In this form of computer-assisted radiography, an iodine-containing contrast medium is injected into a vein and a beta-blocker is given to decrease heart rate. Then, numerous x-ray beams trace an arc around the heart and a scanner detects the x-ray beams and transmits them to a computer, which transforms the information into a three-dimensional image of the coronary blood vessels on a monitor. The image produced is called a *CCTA scan* and can be generated in less than 20 seconds.

Comments: Used primarily to determine if there are any coronary artery blockages (for example, atherosclerotic plaque or calcium) that may require an intervention such as angioplasty or stent. The CCTA scan can be stored, enlarged, and moved at any angle. The procedure can take thousands of images of the heart within the time of a single heartbeat, so it provides a great amount of detail about the heart's structure and function.

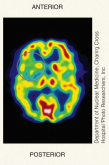


CCTA scan of coronary arteries

POSITRON EMISSION TOMOGRAPHY (PET)

Procedure: A substance that emits positrons (positively charged particles) is injected into the body, where it is taken up by tissues. The collision of positrons with negatively charged electrons in body tissues produces gamma rays (similar to x-rays) that are detected by gamma cameras positioned around the subject. A computer receives signals from the gamma cameras and constructs a *PET scan* image, displayed in color on a video monitor. The PET scan shows where the injected substance is being used in the body. In the PET scan image shown here, the black and blue colors indicate minimal activity; the red, orange, yellow, and white colors indicate areas of increasingly greater activity.

Comments: Used to study the physiology of body structures, such as metabolism in the brain or heart.



Positron emission tomography scan of transverse section of brain (circled area at upper left indicates where a stroke has occurred)

Medical Imaging Procedures

TABLE 1.3

Common Medical Imaging Procedures

ENDOSCOPY

Procedure: Endoscopy involves the visual examination of the inside of body organs or cavities using a lighted instrument with lenses called an *endoscope*. The image is viewed through an eyepiece on the endoscope or projected onto a monitor.

Comments: Examples include *colonoscopy* (used to examine the interior of the colon, which is part of the large intestine), *laparoscopy* (used to examine the organs within the abdominopelvic cavity), and *arthroscopy* (used to examine the interior of a joint, usually the knee).

©Carnaval/Photofalko

Interior view of colon as shown by colonoscopy

Medical Imaging Procedures

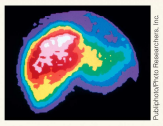
TABLE 1.3 CONTINUED

Common Medical Imaging Procedures

RADIONUCLIDE SCANNING

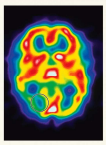
Procedure: A *radionuclide* (radioactive substance) is introduced intravenously into the body and carried by the blood to the tissue to be imaged. Gamma rays emitted by the radionuclide are detected by a gamma camera outside the subject, and the data are fed into a computer. The computer constructs a *radionuclide image* and displays it in color on a video monitor. Areas of intense color take up a lot of the radionuclide and represent high tissue activity; areas of less intense color take up smaller amounts of the radionuclide and represent low tissue activity. **Single-photon-emission computed tomography (SPECT) scanning** is a specialized type of radionuclide scanning that is especially useful for studying the brain, heart, lungs, and liver.

Comments: Used to study activity of a tissue or organ, such as searching for malignant tumors in body tissue or scars that may interfere with heart muscle activity.



PubLipotat/Photo Researchers, Inc.

Radionuclide (nuclear) scan of normal human liver



Dept. of Nuclear Medicine, Charing Cross Hospital/Photo Researchers, Inc.

Single-photon-emission computed tomography (SPECT) scan of transverse section of the brain (the almost all green area at lower left indicates migraine attack)

End of Chapter 1