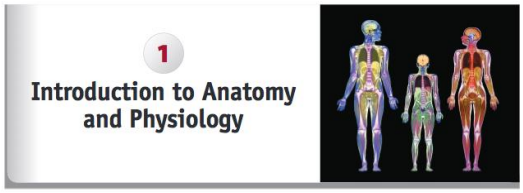

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MODULE 1.1 HOW TO SUCCEED IN YOUR ANATOMY AND PHYSIOLOGY COURSE

HOW TO DEVELOP STUDY SKILLS

Learning styles, different ways of learning, can be categorized into four basic styles:

- **Visual/Verbal** learners fare best when reading *written materials* and viewing *multimedia presentations*
- **Visual/Nonverbal** learners fare best when using *visual media* without *text*

HOW TO DEVELOP STUDY SKILLS

Learning styles (continued)

- **Auditory/Verbal** learners fare best when *listening* to lectures; generally prefer *text-based materials* instead of *visual media*
- **Tactile/Kinesthetic** learners fare best when able to *physically manipulate* a teaching tool; useful in anatomy and physiology lab setting

HOW TO DEVELOP STUDY SKILLS

How to read a textbook – textbook is a *tool* for building a foundation for *understanding* complex subject matter; following approach is called **SQ3R method**:

- **Survey** chapter to get an idea of what *major topics* are discussed
- Form **questions** about chapter's content from your survey that can be answered as you progress through text

HOW TO DEVELOP STUDY SKILLS

How to read a textbook (continued)

- **Read actively** – process that engages some sort of *activity* (note-taking or diagram sketching for example) while reading to enhance *understanding* and *recall*
- **Recite** material *aloud*; another form of active reading that helps *retain information*
- **Review** what has been read; may be accomplished using several *different methods* such as answering end of chapter questions or writing your own summaries of main topics

How to Develop Study Skills

Managing your time (**Figure 1.1**); studying takes time, so develop a *weekly schedule* that includes allotted time dedicated to

- Studying on your own
- Meeting with a study group
- Using other resources your school provides, such as open labs and/or tutoring

How to Develop Study Skills

Figure 1.1 Some ways to maximize your study time.

How to Develop Study Skills

How to study for an exam; following methods have been found to work for many people:

- **Find out as much as you can about exam** (format, fact- or application-based, practice exam availability)
- **Take advantage of available resources** (within text or online)
- **Form a study group early in semester**

How to Develop Study Skills

How to study for an exam (continued):

- **Use whatever study techniques help (**depending on your learning style)
- **Take care of yourself** (nutrition, health, and SLEEP) **and manage your stress**

How to Make the Best Use of Class and Lab Time

- **Come prepared**
  - Coming to lab and lecture with a *familiarity* for what you are expected to know or do is *invaluable*
  - Should not be an issue if you are *managing your time* well and following a *weekly study schedule*

How to Make the Best Use of Class and Lab Time

- **How to take good notes:**
  - Don't rely on instructor's lecture notes alone; printed PowerPoint slides are not a substitute for *class notes*
  - You might benefit from *recording lectures* if that is an option
  - This is an *acquired skill*; might take some time to master; experiment to find out what works best for you

How to Use This Book and Its Associated Materials

Following is a tour of features found in this book; written with busy, modern students in mind (**Figure 1.2**):

- Each chapter is divided into *manageable chunks* called **modules**; block of text with definitive starting and stopping points; covers one *primary concept* and its related principles

How to Use This Book and Its Associated Materials

Tour of features found in book (continued):

- **Learning Outcomes** – found at start of each module; a list containing *essential concepts and related principles* you should be able to understand after reading each module

How to Use This Book and Its Associated Materials

Tour of features found in book (continued):

- **Concept Boosts and Study Boosts** – short sections strategically placed in certain modules intended to "boost" understanding for particularly *difficult concepts*

How to Use This Book and Its Associated Materials

Tour of features found in book (continued):

- Different types of **questions** provide opportunities for *self-assessment*:
  - **Flashback** – beginning of many sections; ask you to recall material from *previous modules or chapters*
  - **Quick Check** – end of each major section in a module; assess how well you *remember basic concepts* about which you have just read

How to Use This Book and Its Associated Materials

Tour of features found in book (continued):

- Different types of **questions** (continued)
  - **Apply What You Learned** – end of each module; critical thinking and problem-solving questions; help you *analyze and apply material* that you just read
  - **Assess What You Learned** – contains *three levels of questions*; each requires increasingly greater critical thinking skills

How to Use This Book and Its Associated Materials

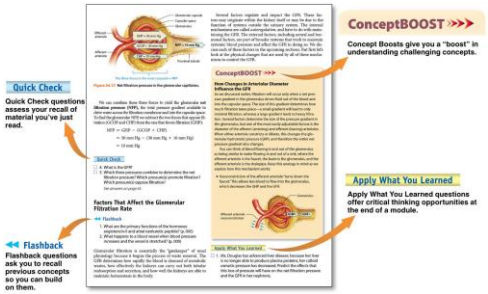


Figure 1.2 Selected features of this textbook.

How to Use This Book and Its Associated Materials

Figures are vital for developing an understanding of *complex anatomical or physiological concepts*; how to get most out of art in textbook **(Figure 1.3)**:

- Examine figures as you complete your initial chapter survey (SQ3R)
- Identify *concept* that figure teaches first

How to Use This Book and Its Associated Materials

How to get most out of art in textbook (continued):

- Break figure into *parts*; understand each part before moving on
- Once you understand each part of figure, examine it as a *whole*
- Combine figure's content with that of other figures for a more *global understanding*

How to Use This Book and Its Associated Materials

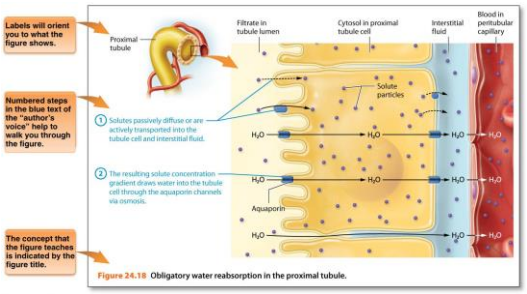


Figure 1.3 How to approach a physiology figure.

How to Use This Book and Its Associated Materials

- **Companion workbook**
  - Active learning tool intended to be used *as you read* textbook (not after you read chapter)
  - Also provides opportunities to *assess understanding*

How to Use This Book and Its Associated Materials

- **Online practice tools** for textbook can be found on **Mastering A&P®** (Chapter practice tests, module quizzes, art-labeling and step-sequencing exercises, downloadable author-narrated podcasts, animations, and more)

Module 1.2 Overview of Anatomy and Physiology

Introduction to Anatomy and Physiology

- **Science** is a method of *observing* and *measuring* natural phenomenon in order to explain them; has provided many answers to the mysteries of humans
- Observation, experimentation, imagination, and time have led to tremendous advances in understanding of human body and how it functions; *form and function are inextricably linked*
  - **Human anatomy** – study of *structure* or *form* of human body
  - **Human physiology** – study of body's *functions*

Characteristics of Living Organisms

Living Organisms share distinct properties:

- **Cellular composition: cells** are *basic units* of life
  - Smallest unit that can carry out functions of life
  - All organisms are *composed of cells*

Characteristics of Living Organisms

Living Organisms share distinct properties (continued):

- **Metabolism:**
  - **Chemicals** – substances with *unique molecular composition*; used in or produced by **chemical reactions**
  - Living organisms carry out a number of chemical reactions collectively known as **metabolism**
  - Metabolic process either *build up* or *break down* substances depending on needs of organism

Characteristics of Living Organisms

Living Organisms share distinct properties (continued):

- **Growth**, where *building* outweighs *breaking down* processes, includes two forms:
  - Increase in *size* of individual cells
  - Increase in *number* of cells

Characteristics of Living Organisms

Living Organisms share distinct properties (continued):

- **Excretion** – process that an organism uses to *eliminate* potentially *harmful* waste products created by metabolic processes
- **Responsiveness** or **irritability** – ability of organisms to *sense* and *react* to changes or stimuli in their environment

Characteristics of Living Organisms

Living Organisms share distinct properties (continued):

- **Movement** – ability of an *entire organism* to move or movement of *individual cells* or of materials within or between cells of an organism

Characteristics of Living Organisms

Living Organisms share distinct properties (continued):

- **Reproduction** takes following *two forms* in multicellular organisms:
  - *Individual cells* reproduce within organism during *growth* and to *replace* damaged or old cells
  - *Organism* itself reproduces to yield *similar offspring*

Levels of Structural Organization and Body Systems

Body is constructed from a series of progressively larger "building blocks;" each type of block is known as a **structural level of organization** (**Figure 1.4**):

- **Chemical level** – *smallest level* is foundation for each successive level, ranges from tiny atoms to complex chemical structures called **molecules**; composed of between two and thousands of atoms

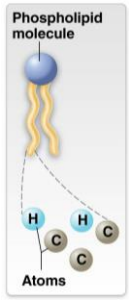


Figure 1.4 Six structural levels of organization of the human body.

Levels of Structural Organization and Body Systems

Structural levels of organization (continued):

- **Cellular level** – formed by groups of many different types of molecules *combined in specific ways* to form cellular structures

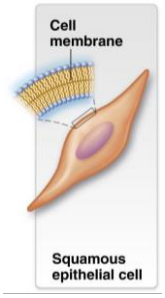


Figure 1.4 Six structural levels of organization of the human body.

Levels of Structural Organization and Body Systems

Structural levels of organization (continued):

- **Tissue level** – *two or more cell types* cooperate to perform a *common function*
  - Consist of two components: **cells** and surrounding **extracellular matrix**
  - Vary from *membrane sheets* that cover body cavities to irregularly shaped *cartilage* found in nose

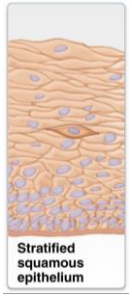


Figure 1.4 Six structural levels of organization of the human body.

Levels of Structural Organization and Body Systems

Structural levels of organization (continued):

- **Organ level** – consists of *two or more tissue types* combined to form a structure or **organ**; has a recognizable *shape* and performs a *specialized task*

Figure 1.4 Six structural levels of organization of the human body.

Levels of Structural Organization and Body Systems

Structural levels of organization (continued):

- **Organ system level** – body's organs are grouped into **organ systems**
  - Consist of two or more organs that together carry out a *broad function* in body
  - For example
    - **Cardiovascular system** (heart and blood vessels) *transports blood* through body
    - **Digestive system** *ingests* food, *absorbs* nutrients, and *eliminates* wastes

Figure 1.4 Six structural levels of organization of the human body.

Levels of Structural Organization and Body Systems

Structural levels of organization (continued):

- **Organism level** – *organ systems function together* to make up working human body, an *organism*

Figure 1.4 Six structural levels of organization of the human body.

Levels of Structural Organization and Body Systems

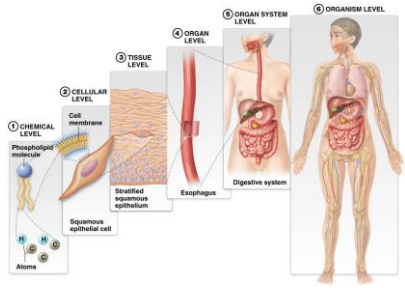


Figure 1.4 Six structural levels of organization of the human body.

Levels of Structural Organization and Body Systems

- Body's organs are grouped into **organ systems**; consist of *two or more organs* that together carry out a *broad function* in body
  - Human body has *11 organ systems* (**Figure 1.5**)
  - Organs and organ systems *work together* to ensure survival of organism as a whole
- Organ systems function together to make up complete **organism** (human body)

Levels of Structural Organization and Body Systems

Figure 1.5 The 11 organ systems of the human body.

Levels of Structural Organization and Body Systems

Figure 1.5 The 11 organ systems of the human body.

Levels of Structural Organization and Body Systems

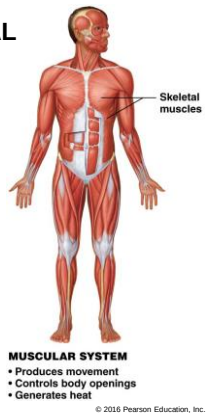


Figure 1.5 The 11 organ systems of the human body.

Levels of Structural Organization and Body Systems

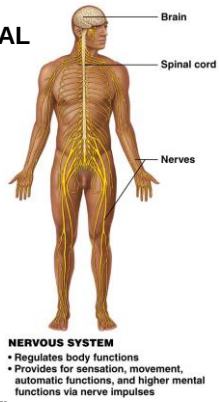


Figure 1.5 The 11 organ systems of the human body.

Levels of Structural Organization and Body Systems

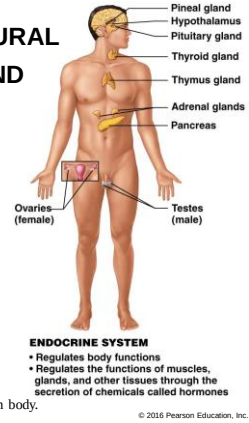
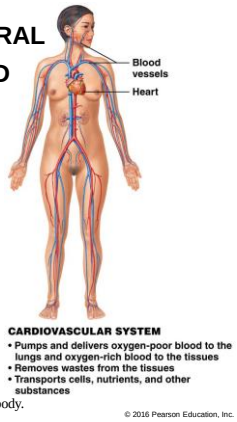


Figure 1.5 The 11 organ systems of the human body.

Levels of Structural Organization and Body Systems



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Levels of Structural Organization and Body Systems

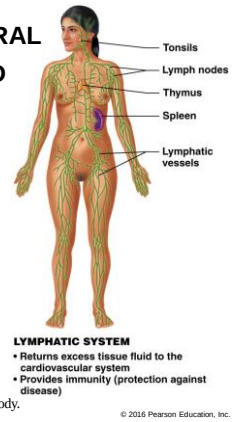

Figure 1.5 The 11 organ systems of the human body.

Levels of Structural Organization and Body Systems

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Levels of Structural Organization and Body Systems

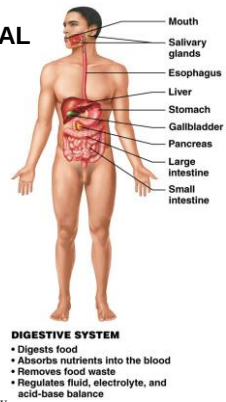


Figure 1.5 The 11 organ systems of the human body.

Levels of Structural Organization and Body Systems

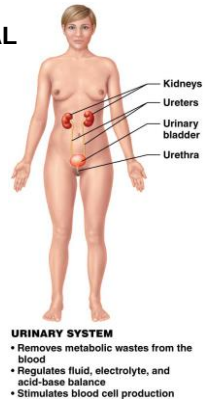


Figure 1.5 The 11 organ systems of the human body.

Levels of Structural Organization and Body Systems

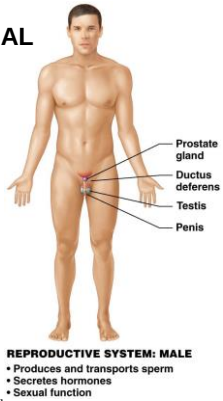


Figure 1.5 The 11 organ systems of the human body.

Levels of Structural Organization and Body Systems

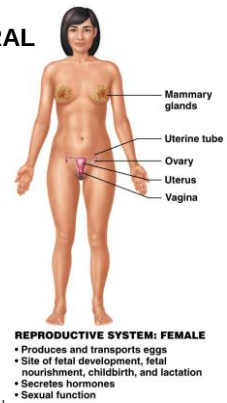


Figure 1.5 The 11 organ systems of the human body.

Types of Anatomy and Physiology

Study of human body can be approached in following ways:

- **Systemic anatomy** – approach used in textbook; examines human body primarily by looking at *individual organ systems*
- **Regional anatomy** – divides body into *regions of study* such as head and neck

Types of Anatomy and Physiology

Study of human body (continued):

- **Surface anatomy** – studies *surface markings* of body
- **Gross anatomy** – examines structures that can be seen with *unaided eye*
- **Microscopic anatomy** – studies structures that can only be seen with aid of a *microscope*; include: **Histology** (study of *tissues*) and **Cytology** (study of *cells*)

Types of Anatomy and Physiology

- **Physiology** has subfields classified by *organ* or *organ system* being studied; examples include:
  - **Neurophysiology** – studies *brain* and *nerves*
  - **Cardiovascular physiology** – studies *heart* and *blood vessels*
- Physiologists may also specialize in levels of organization other than systemic; some study body's *chemical* and *cellular processes*; others study specific *tissues* or *organs*

Module 1.3 The Language of Anatomy and Physiology

The Language of Anatomy and Physiology

Language of science, A&P included, is built on a group of *word roots*, which are core components of words with specific *meanings*:

- Word roots are *combined* with specific *prefixes* and *suffixes* to yield scientific terms
- Building anatomical terms from word roots, prefixes, and suffixes is discussed on *inside back cover* of textbook

Anatomical Position

- **Anatomical position** – common frame of reference from which all body parts and regions are described:
  - Body is standing *upright*; feet are shoulder width apart, with upper limbs at sides of trunk and head and palms facing *forward*
  - Body is always referred to as if it were in anatomical position, even when it's in *another position*
  - "Right" and "left" always refers to right and left sides of body being *described*, not our own

Anatomical Position

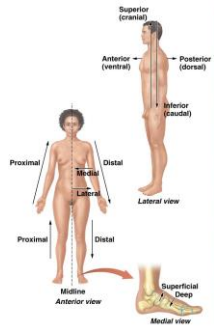
Directional Terms

- **Directional terms**, another means of ensuring accurate communication, describes *relative location* of body parts and markings; some of more common paired terms include (**Figure 1.6**):
  - **Anterior** (**ventral**) refers to *front*, in humans while **posterior** (**dorsal**) refers to *back*; can refer to either body as a whole or to a body part
  - **Superior** (**cranial**) means toward *head* while **inferior** (**caudal**) refers to toward *tail*; terms are used to refer to positions only on *head*, *neck*, and *trunk*

Directional Terms

- **Directional terms** (continued):
  - **Proximal** refers to something being *closer* to point of origin; **distal** refers to being more *distant* or further away from same point of origin
  - The body's midline is an imaginary line that runs down middle of the body; **medial** refers to a position that is *closer* to midline; **lateral** refers to a position that is *further away*
  - **Superficial** refers to structures that are *closer to surface* of the body while **deep** refers to those *further away*

Directional Terms



TERM	DEFINITION	EXAMPLES
Anterior (ventral)	Toward the front	• The palms are on the anterior side of the body. • The esophagus is anterior to the spinal cord
Posterior (dorsal)	Toward the back	• The occipital bone is on the posterior cranium (skull). • The spinal cord is posterior to the esophagus.
Superior (cranial)	Toward the head	• The nose is superior to the mouth. • The neck is superior to the chest.
Inferior (caudal)	Toward the tail	• The nose is inferior to the forehead. • The umbilicus (belly button) is inferior to the chest.
Proximal	Closer to the point of origin (generally the trunk)	• The knee is proximal to the ankle. • The shoulder is proximal to the elbow.
Distal	Farther away from the point of origin (generally the trunk)	• The foot is distal to the hip. • The wrist is distal to the elbow.
Medial	Closer to the midline of the body or a body part; on the inner side of	• The ear is medial to the shoulder. • The index finger is medial to the thumb.
Lateral	Farther away from the midline of the body or a body part; on the outer side of	• The shoulder is lateral to the chest. • The thumb is lateral to the index finger.
Superficial	Closer to the surface	• The skin is superficial to the muscle. • Muscle is superficial to bone.
Deep	Farther below the surface	• Bone is deep to the skin. • Bone is deep to muscle.

Figure 1.6 Directional terms.

Regional Terms

- **Regional Terms** – body can be divided into two regions: **axial region**, which includes head, neck, and trunk and **appendicular region** which includes upper and lower limbs or appendages (**Figure 1.7**)
  - Each broad region can be divided into several *smaller regions*
  - A summary of regional terms can be found in *companion workbook*

Regional Terms

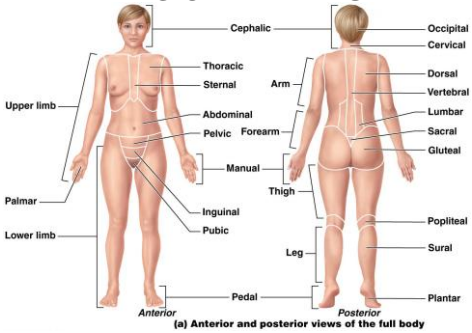


Figure 1.7a Regional terms.

Regional Terms

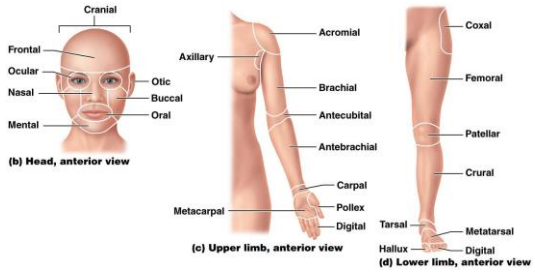
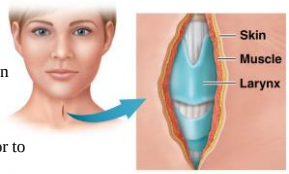


Figure 1.7b, c, d Regional terms.

Concept Boost: Putting Anatomical Terms Together

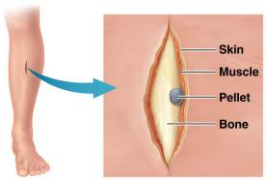
- **Name region** – left cervical
- **Add descriptive directional terms** – where, exactly, incision is located; incision is on anterior side, lateral to midline; begins inferior to mental region and ends superior to thoracic region



- **Describe depth of incision** – deep to skin and muscle but superficial to underlying larynx
- **Put it all together** – incision made on left anterior cervical region 1 centimeter lateral to midline; extended vertically from 1 centimeter inferior to mental region to 2 centimeters superior to thoracic region, and was deep to skin and muscle but superficial to larynx

Concept Boost: Putting Anatomical Terms Together

- **Start with region** – left crural
- **Add descriptive directional terms** (need to use proximal and distal, since describing limbs) – anterior, on medial side, proximal to tarsal region and distal to patellar region



- **Describe depth of incision** – deep to skin and muscle but superficial to bone
- **Put it all together** – wound is on left anteromedial crural region, 6 centimeters proximal to tarsal region and 10 centimeters distal to patellar region; pellet is lodged deep to skin and muscle but superficial to bone

PLANES OF SECTION

Three primary **planes of section** provide a means of studying form and function of a body region by *dividing body or a body part up* for examination:

- **Sagittal plane** divides body or body part into *right and left sections*; includes following two *variations* (**Figure 1.8a**):
  - **Midsagittal plane (median plane)** divides body or body part into equal left and right sections
  - **Parasagittal plane** divides body or body part into unequal right and left sections

PLANES OF SECTION

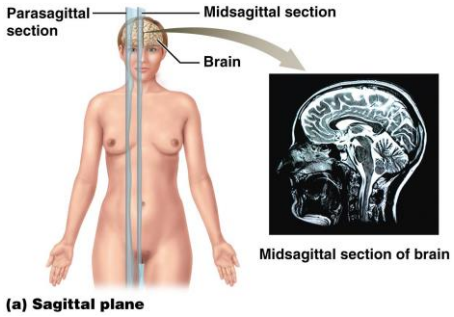


Figure 1.8a Planes of section.

PLANES OF SECTION

- **Frontal plane** (**coronal plane**) divides body or body part into *anterior* and *posterior* sections **(Figure 1.8b**)
- **Transverse plane** (**horizontal plane**) divides body or body part into *superior* and *inferior* sections or *proximal* and *distal* sections when describing structures of appendicular region (**Figure 1.8c**)
- **Oblique plane**, a less standardized plane, is taken at an *angle*; useful for examining structures that are difficult to examine using only three primary planes of section

PLANES OF SECTION

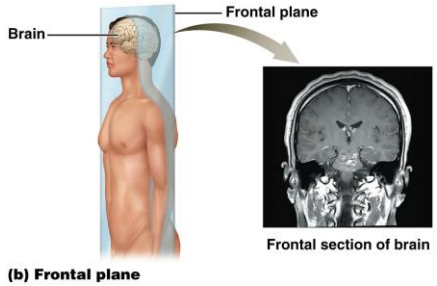


Figure 1.8b Planes of section.

PLANES OF SECTION

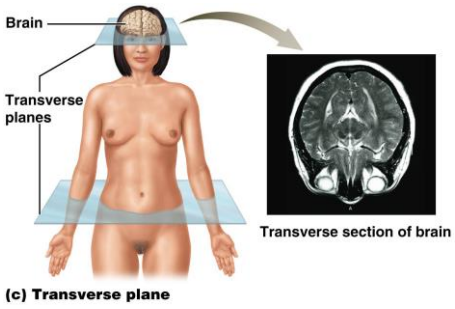


Figure 1.8c Planes of section.

MODULE 1.4 THE ORGANIZATION OF THE HUMAN BODY

BODY CAVITIES

- A **cavity** is any *fluid-filled space* within body; *axial region* of body is divided into several cavities
- Cavities *protect* internal organs and allow them to *move* and *expand* as necessary to perform their functions
- Major cavities include **dorsal** and **ventral** cavities and their subdivisions

BODY CAVITIES

- **Dorsal Body Cavity** – largely located on *posterior* side of body; subdivided into two cavities (**Figure 1.9a**):
  - **Cranial cavity** – within *skull*; protects brain
  - **Vertebral (spinal) cavity** – within *vertebral column*; protects spinal cord
  - Subdivisions are continuous and filled with **cerebrospinal fluid** (**CSF**); bathes and protects both brain and spinal cord

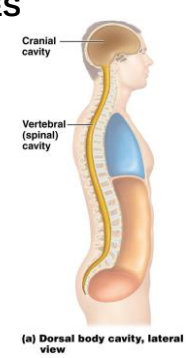


Figure 1.9a The dorsal and ventral body cavities.

BODY CAVITIES

- **Ventral Body Cavity** (**Figures 1.9b**, **1.10**)
  - Separated into *two divisions* by **diaphragm**:
    - **Thoracic cavity** and its subdivisions are *superior* to diaphragm
    - **Abdominopelvic cavity** and its subdivisions are *inferior* to diaphragm

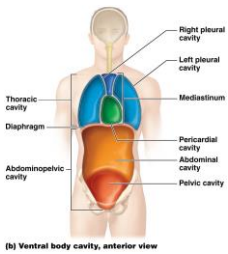


Figure 1.9b The dorsal and ventral body cavities.

BODY CAVITIES

- **Ventral Body Cavity** (continued):
  - **Thoracic cavity** – divided into three smaller cavities:
    - **Pleural cavities –** each surround either left or right *lung*
    - **Mediastinum –** between *pleural cavities*; houses heart, great vessels, trachea (windpipe), and esophagus; not within serous membrane
    - **Pericardial cavity –** within *mediastinum*; within serous membrane that surrounds heart

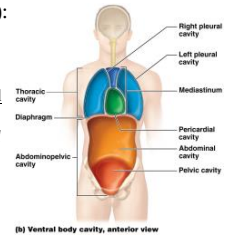


Figure 1.9b The dorsal and ventral body cavities.

BODY CAVITIES

- **Ventral Body Cavity** (continued):
  - **Abdominopelvic cavity** – subdivided into superior **abdominal cavity** (spans from diaphragm to bony pelvis) and **pelvic cavity** (area within bony pelvis)
    - Contains organs from several systems (*digestive, lymphatic, reproductive, and urinary)*
    - **Peritoneal cavity** – *abdominal subcavity* found within serous membrane

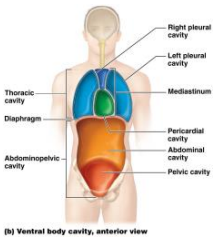


Figure 1.9b The dorsal and ventral body cavities.

BODY CAVITIES

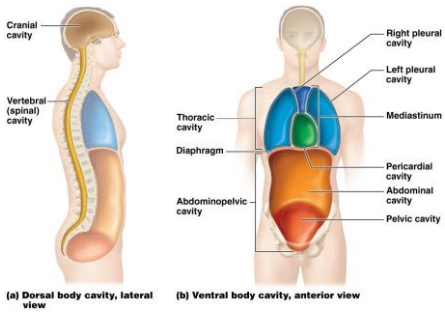


Figure 1.9 The dorsal and ventral body cavities.

Body Cavities

- **Ventral Body Cavity** (continued):
  - Abdominopelvic cavity can be divided up into *segments or quadrants*
  - Imaginary lines that cross at *umbilicus* divide cavity into four **quadrants** (**Figure 1.10a**):
    - **Right upper quadrant** (**RUQ**)
    - **Right lower quadrant** (**RLQ**)
    - **Left upper quadrant** (**LUQ**)
    - **Left lower quadrant** (**LLQ**)

Body Cavities

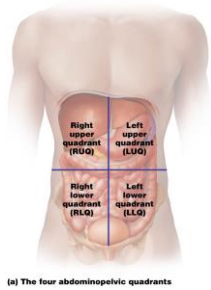


Figure 1.10a The four quadrants and nine regions of the abdominopelvic cavity.

Body Cavities

- **Ventral Body Cavity** (continued):
  - Abdominopelvic cavity can also be divided into nine **segments** using *two parasagittal* and *two transverse* imaginary lines (**Figure 1.10b**):
    - **Right** and **left hypochondriac regions** – *below cartilage* of ribs
    - **Epigastric region** – middle superior region *above stomach* and between right and left hypochondriac regions
    - **Right** and **left lumbar regions** – middle segments at same level as *lumbar vertebrae*

Body Cavities

- **Ventral Body Cavity** (continued):
  - Abdominopelvic cavity (continued):
    - **Umbilical region** – between lumbar regions, *over umbilicus*
    - **Right** and **left iliac** or **inguinal regions** – most inferior segments
    - **Hypogastric region** – between iliac regions, *below stomach*

Body Cavities

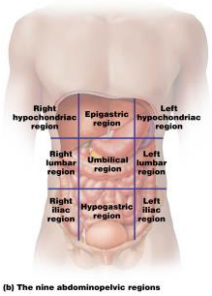


Figure 1.10b The four quadrants and nine regions of the abdominopelvic cavity.

Abdominal Pain

- *Common complaint* of individuals seeking health care
- *Cause* of pain can be difficult to diagnose due to number of structures in abdominopelvic cavity; *four quadrant system* makes this easier
- Organ location in specific quadrants can *narrow potential diagnoses*; helpful first step; examples:
  - **RLQ** – appendix, right ovary (females), first section of large intestine, last part of small intestine
  - **LUQ** – stomach, spleen, pancreas, parts of large intestine

Body Cavities

- **Serous membranes** (**Figure 1.11**):
  - Thin sheets of tissue; form certain cavities found in *ventral cavity*; surround heart, lungs, and many abdominal organs
  - Appear to be *two membranes* when sectioned; actually consists of a *single, continuous layer* of tissue; folds over itself to create a double-layered structure
  - Within cavity *between two layers* is an extremely thin layer of fluid called **serous fluid**

Body Cavities

- **Serous membranes** (continued):
  - **Serous fluid**
    - Watery, slippery **lubricant**
    - Fills space between membrane layers
    - Produced by cells of membrane
    - *Prevents* **friction** caused by movement of organs
  - **Visceral layer** – in contact with *underlying organ*
  - **Parietal layer** – outermost layer attached to *surrounding structures*

Body Cavities

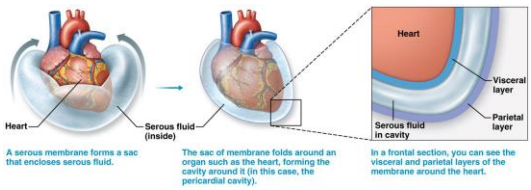


Figure 1.11 How a serous membrane envelops the heart.

Body Cavities

- Body has three **serous body cavities** formed by three main serous membranes:
  - **Pleural membranes** (**Figure 1.12a**)
    - Consist of outer **parietal pleura** (follow contours of thoracic wall) and inner **visceral pleura** (runs along surface of lungs)
    - Thin space enclosed by pleural membranes forms **pleural cavities**

Body Cavities

- Body has three serous body cavities (continued):
  - **Pericardial membranes** (**Figure 1.12a**)
    - Consist of outer **parietal pericardium** (separates heart from mediastinum) and *inner* **visceral pericardium** (lies directly on heart muscle)
    - Space created by pericardial membranes forms **pericardial cavity**

Body Cavities

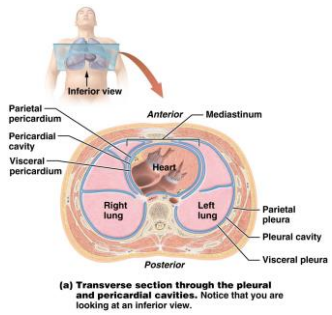


Figure 1.12a The serous membranes of the ventral body cavities.

Body Cavities

- Body has three serous body cavities (continued):
  - **Peritoneal membranes,** surrounds some of abdominal organs (**Figure 1.12b**)
    - Consist of outer **parietal peritoneum** and inner **visceral peritoneum**
    - Space between these layers forms **peritoneal cavity**
    - *Doesn't cover every organ*; kidneys lie outside of and behind parietal peritoneum and are thus called **retroperitoneal** organs

Body Cavities

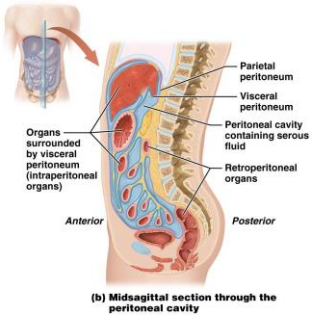
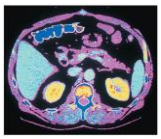


Figure 1.12b The serous membranes of the ventral body cavities.

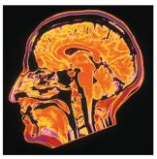
Medical Imaging

- Used to look inside patients without surgery; different forms of radiation form images of internal structures
- Examples of imaging techniques; show sections of body planes:
  - **X-Ray** – uses ionizing radiation; chest image is shown
  - **Computed tomography scan** (**CT**) – also uses ionizing radiation; 3-D image is computer generated from data; transverse section of abdominopelvic and peritoneal cavities is shown



Medical Imaging

- **Magnetic Resonance Imaging** (**MRI**) – body is placed within a *magnetic field*; computer compiles data producing a 3-D image; two scans on right show inside *brain* and *cranial cavity* (top) and inside *vertebral cavity* (bottom), both sectioned midsagittally



Module 1.5 Core Principles in Anatomy and Physiology

Overall Theme

- **Physiological Processes Operate to Maintain Body's Homeostasis** (maintenance of internal environment)
  - **Homeostatic imbalances** – *disturbances* in homeostasis can lead to disease or death if uncorrected
  - Body's internal environment – result of a wide range of *coordinated processes or variables*, including temperature, chemical composition of blood and other body fluids, and many others
  - To prevent imbalance, most variables are **controlled** (**regulated**) **variables**; maintained within a narrow range, close to a normal value

Common Misconceptions about Homeostasis

- **Misconception 1**: Negative feedback is bad for body; positive feedback is good
  - When most of us hear "negative," we think of bad consequences; when we hear "positive," good consequences come to mind
  - Negative and positive feedback refer only to *direction of output* in response to an initial change; normally, both negative and positive feedback *promote homeostasis*

Common Misconceptions about Homeostasis

- **Misconception 2**: Maintaining homeostasis means body's internal environment is static or unchanging
  - Maintenance of "set points" or "normal ranges" does NOT mean body's internal environment is unchanging
  - When you eat, levels of sugar (and other nutrients) and water in blood increase; levels of various other chemicals in blood change; digestive system undergoes multiple physiological processes to digest food
  - These sorts of changes are occurring *constantly*

Common Misconceptions about Homeostasis

- **Misconception 3**: Regulatory mechanisms and feedback loops are either "on" or "off," like a switch
  - Since body's internal environment is a dynamic place, feedback loops are constantly engaged in *some degree of activity*
  - **Example** – *blood sugar regulation*; level of sugar in blood is constantly *changing*; negative feedback loops that regulate blood sugar therefore must always be in operation

Common Misconceptions about Homeostasis

- **Misconception 4**: Any physiological variable can be controlled:
  - Variable can be controlled through feedback loops only if *receptors* exist to *detect changes* in set point
  - Changes in an unregulated *variable* can *disrupt homeostasis* for a regulated variable

Common Misconceptions about Homeostasis

- **Misconception 4** (continued):
  - For example, **vitamin D** (involved in *calcium ion homeostasis*); receptors exist for level of calcium ions, but not for vitamin D
  - So if vitamin D level falls too low, body has no mechanism to return level to normal; a lower vitamin D level, in turn, impacts level of calcium ions

Core Principles in A&P

Core principles – concepts of anatomy and physiology repeated throughout textbook; related to maintenance of homeostasis:

- **Feedback loops**
- **Relationship between structure and function**
- **Gradients**
- **Cell-to-cell communication**

CORE PRINCIPLES IN A&P

Feedback Loops Core Principle – two mechanisms vital to maintenance of homeostasis (**Figures 1.13, 1.14**):

- **Positive feedback loops** – less common than negative feedback loops; effector activity increases and reinforces *initial stimulus*; shuts off when conditions return to the normal range

CORE PRINCIPLES IN A&P

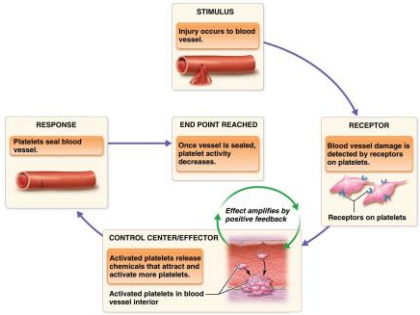


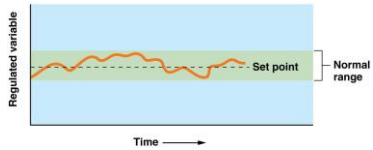
Figure 1.14 Control of blood clotting by a positive feedback mechanism.

CORE PRINCIPLES IN A&P

- **Negative feedback loops** (continued):
  - **Negative feedback loops** – oppose *initial change* in a regulated variable; reduce *output*
  - When a change in status of a regulated variable is detected, a series of events is triggered to *return variable to its normal value*

CORE PRINCIPLES IN A&P

- **Negative feedback loops** (continued):
  - Each regulated variable has a **set point** or an established *normal value*
  - Normal value for a regulated variable's set point is usually a *range of values* called the **normal range**



CORE PRINCIPLES IN A&P

- **Negative feedback loops** (continued):
  - When regulated variable is outside *its normal range*, information called a **stimulus** is detected by specialized cellular structure called **receptor** (**sensor**)
  - Stimulus is sent to a **control center**, usually cells of *nervous* or *endocrine system*; determine that variable is outside of set point

CORE PRINCIPLES IN A&P

- **Negative feedback loops** (continued):
  - Control center then *signals other cells or organs*, called **effectors**; cause physiological **responses** that *return variable* to normal homeostatic range (**Figure 1.13**)
  - Negative feedback loop ends or is closed once variable has *returned to normal*

CORE PRINCIPLES IN A&P

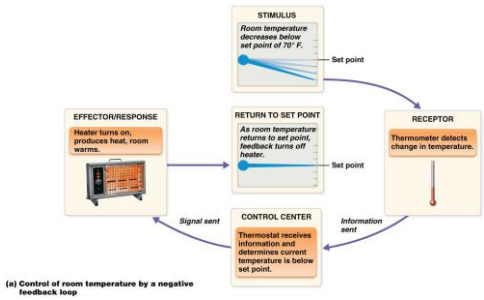


Figure 1.13a Comparison of how negative feedback mechanisms control room and body temperature.

CORE PRINCIPLES IN A&P

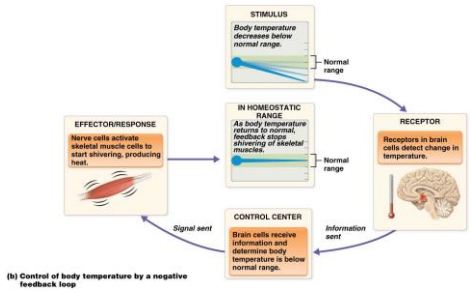


Figure 1.13b Comparison of how negative feedback mechanisms control room and body temperature.

CHILDBIRTH, PITOCIN, AND POSITIVE FEEDBACK LOOPS

- Childbirth begins with **labor**; occurs by *positive feedback*:
  - Baby's head stretches cervix (stimulus); data sent to brain (control center); signals uterus (effector); uterus produces hormone **oxytocin**; oxytocin stimulates uterine contractions (response)
  - Contractions move baby's head, causing more cervical stretching; stimulates release of more hormone; effect continues to be *amplified* until baby is born
- **Pitocin** (*synthetic* oxytocin) – induces labor; stimulates uterine contractions, *initiating* above feedback loop; oxytocin release causes progressively stronger contractions and eventual childbirth

CORE PRINCIPLES IN A&P

- **Structure and Function Core Principle** – One of most basic principles in A&P; known as principle of *complementarity of structure and function*:
  - Form of a structure is always such that it *best suits its function*
  - States simply that *form follows function*; applies to each level of organization even down to chemical level **Figure 1.15)**

CORE PRINCIPLES IN A&P

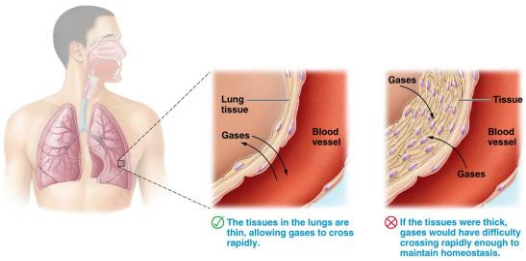


Figure 1.15 The relationship between structure and function. This figure explores structure and function using the example of what would happen if the tissues in the lung were thick instead of thin.

CORE PRINCIPLES IN A&P

- **Gradient Core Principle** – **physiological cornerstone** (**Figure 1.16**):
  - **Gradient** – present any time more of something exists *in one area* than *another*, where two areas are connected
  - Gradients drive many *physiological processes* (respiration, nutrient exchange, formation of urine to name a few)

CORE PRINCIPLES IN A&P

- **Gradient Core Principle** (continued):
  - Examples of three *common gradients* found in human body:
    - **Temperature gradient** – when there is a *temperature difference* between two connected regions (**Figure 1.16a**)
    - **Concentration gradient** – where there is a *concentration difference* between two connected regions (**Figure 1.16b**)
    - **Pressure gradient** – when there is a *pressure difference* between two connected regions (**Figure 1.16c**)

CORE PRINCIPLES IN A&P

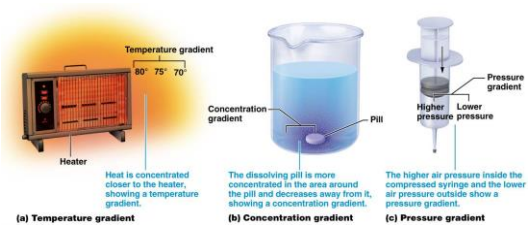


Figure 1.16 Examples of gradients.

CORE PRINCIPLES IN A&P

- **Cell-Cell Communication Core Principle –** cell to cell communication is required to *coordinate body functions*
  - Cells in body have to work in a coordinated fashion to ensure homeostasis of *entire organism* is maintained
  - Usually accomplished with either *chemical messengers* or *electrical signals*; one cell triggers a response from another cell
  - Electrical signals are usually transmitted between *neighboring cells;* chemical messengers can affect neighboring cells or *travel to distant cells* to cause effect (**Figure 1.17**)

CORE PRINCIPLES IN A&P

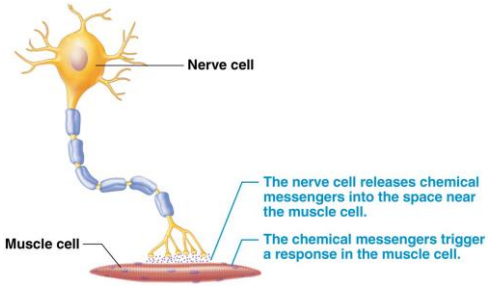


Figure 1.17 Communication between a nerve cell and a muscle cell.