Introduction to anatomy and physiology

The Human Body Plan

General Anatomical Terminology

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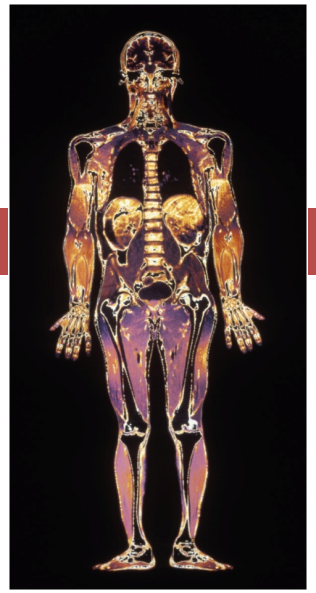


LEARNING OUTCOMES

As a result of the lesson you will be able to:

- *Define anatomy, physiology relate them to each other.*
- *Define homeostasis, explain its significance, and discuss how it is maintained by negative feedback;*
- *Discuss positive feedback and its effects on the body;*
- *Define or demonstrate the anatomical position and explain its importance in descriptive anatomy;*
- *Define the three major anatomical planes of the body;*
- *Identify the major anatomical regions of the body;*
- *Describe the body's cavities and the membranes that line them;*
- *Name the 11 organ systems, their principal organs, and their functions.*

Anatomy - The Study of Form

- **Examining structure of the Human Body**
  - inspection
  - palpation
  - auscultation
  - percussion
- **Cadaver dissection**
  - cutting and separation of tissues to reveal their relationships
- **Comparative anatomy**
  - study of more than one species in order to examine structural similarities and differences, and analyze evolutionary trends

Anatomy - The Study of Form

- **Exploratory Surgery**
  - open body and take a look inside
- **Medical imaging**
  - viewing the inside of the body without surgery
  - **Radiology –** branch of medicine concerned with imaging
- **Gross Anatomy**
  - study of structures that can be seen with the naked eye
- **Cytology**
  - study of structure and function of cells
- **Histology (microscopic anatomy)**
  - examination of cells with microscope
- **Ultrastructure**
  - the molecular detail seen in electron microscope
- **Histopathology**
  - microscopic examination of tissues for signs of disease

Physiology - The Study of Function

- **Subdisciplines**
  - neurophysiology (physiology of nervous system)
  - endocrinology (physiology of hormones)
  - pathophysiology (mechanisms of disease)
- **Comparative Physiology**
  - limitations on human experimentation
  - study of different species to learn about bodily function
    - animal surgery
    - animal drug tests
  - basis for the development of new drugs and medical procedures

Hierarchy of Complexity

- **Organism** – a single, complete individual
- **Organ System** – human body made of 11 organ systems
- **Organ** – structure composed of two or more tissue types that work together to carry out a particular function
- **Tissue** – a mass of similar cells and cell products that form discrete region of an organ and performs a specific function
- **Cells** – the smallest units of an organism that carry out all the basic functions of life
  - **Cytology** – the study of cells and organelles
- **Organelles –** microscopic structures in a cell that carry out its individual functions
- **Molecules** – make up organelles and other cellular components
  - **macromolecules** – proteins, carbohydrates, fats, DNA
- **Atoms** – the smallest particles with unique chemical identities

Anatomical Variation

- **No two humans are exactly alike**
  - 70% most common structure
  - 30% anatomically variant
  - variable number of organs
    - missing muscles, extra vertebrae, renal arteries
  - **variation in organ locations (situs solitus, situs inversus, dextrocardia, situs perversus)**

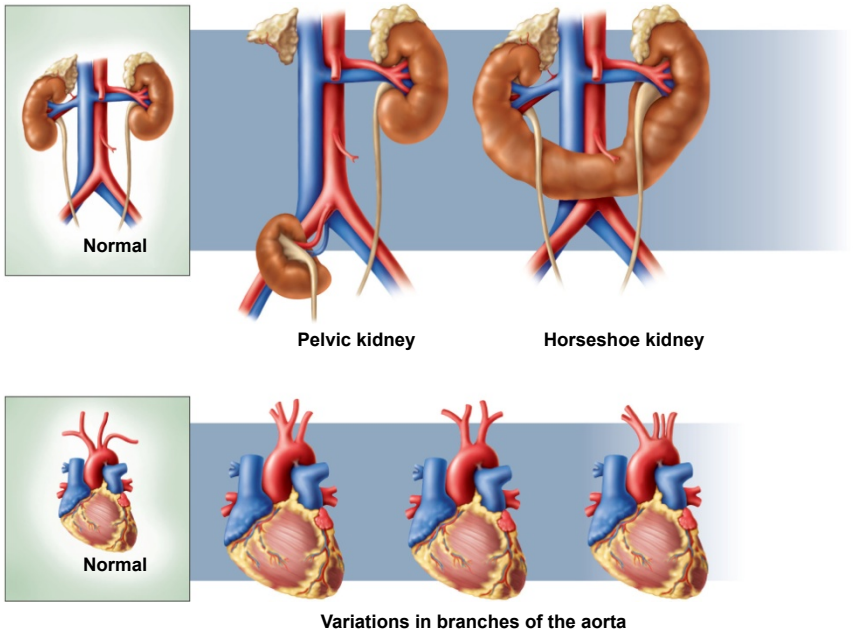


Figure 1.8

Physiological Variation

- **Sex, age, diet, weight, physical activity**
- **Typical physiological values**
  - **reference man**
    - 22 years old, 154 lbs, light physical activity
    - consumes 2800 kcal/day
  - **reference woman**
    - same as man except 128 lbs and 2000 kcal/day
- **Overmedication of elderly**

Homeostasis

- **Homeostasis** – the body's ability to detect change, activate mechanisms that oppose it, and thereby maintain relatively stable internal conditions
- **Claude Bernard (1813-78)**
  - constant internal conditions regardless of external conditions
    - internal body temperature ranges from 97 to 99 degrees despite variations in external temperature
- **Walter Cannon (1871-1945)**
  - coined the term '**Homeostasis**'
  - state of the body fluctuates (**dynamic equilibrium**) within limited range around a **set point**
  - **Negative feedback** keeps variable close to the set point
- **Loss of homeostatic control causes illness or death**

Negative Feedback Loop

- Body senses a change and activates mechanisms to reverse it - dynamic equilibrium

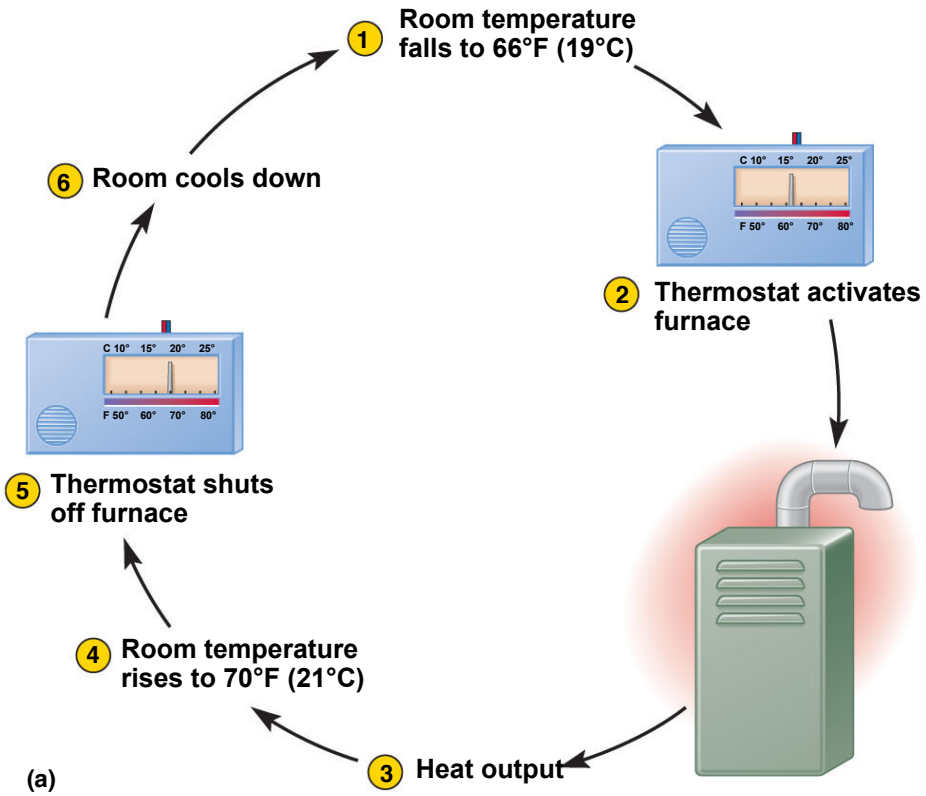
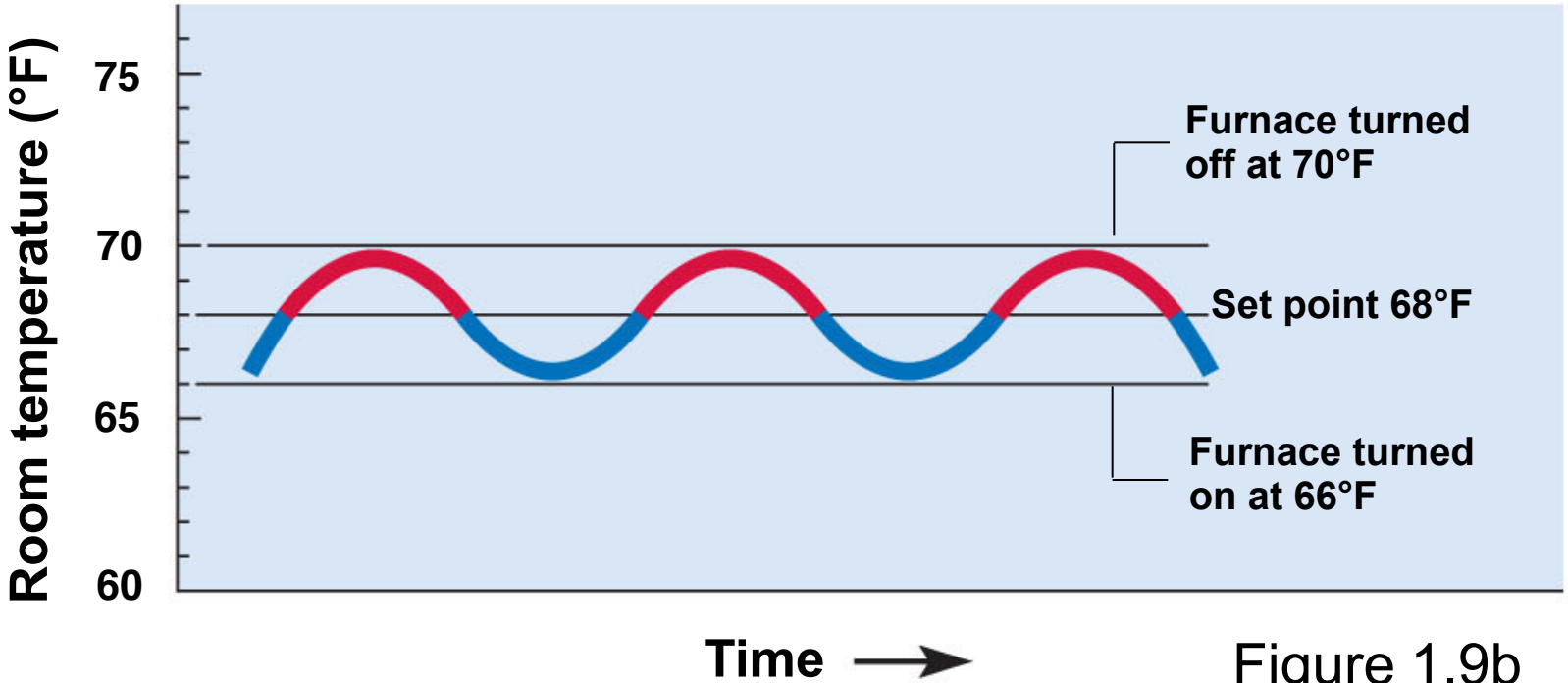


Figure 1.9a

Negative Feedback, Set Point



(b)

Figure 1.9b

- Room temperature does not stay at set point of 68 degrees -- it only averages 68 degrees

Negative Feedback in Human Thermoregulation

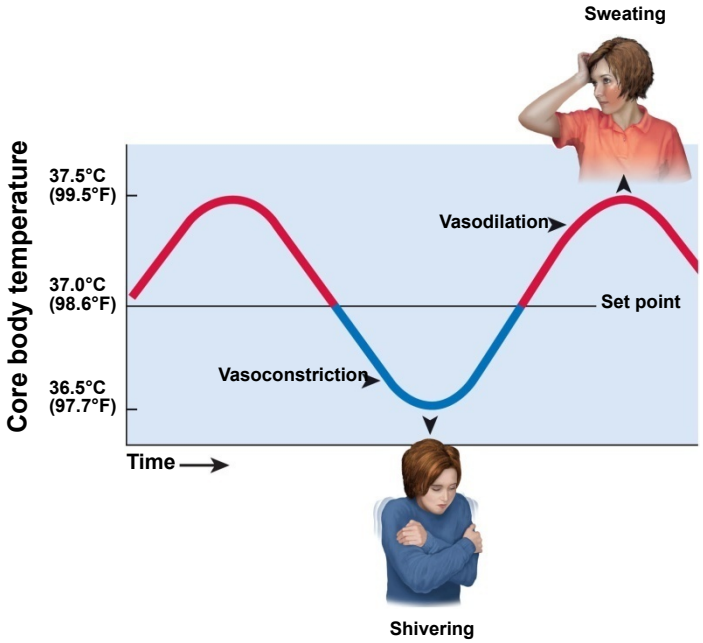


Figure 1.10

- **Brain senses change in blood temperature**
  - if to warm, vessels dilate (**vasodilation**) in the skin and sweating begins (heat losing mechanisms)
  - if too cold, vessels in the skin constrict (**vasoconstriction**) and shivering begins (heat gaining mechanism)

Negative Feedback Control of Blood Pressure

- Sitting up in bed causes a drop in blood pressure in the head and upper thorax
- **Baroreceptors** in the arteries near the heart alert the cardiac center in the brainstem
- **Cardiac center** sends nerve signals that increase the heart rate and return the blood pressure to normal
- Failure of this to feedback loop may produce dizziness in the elderly

Control of Blood Pressure

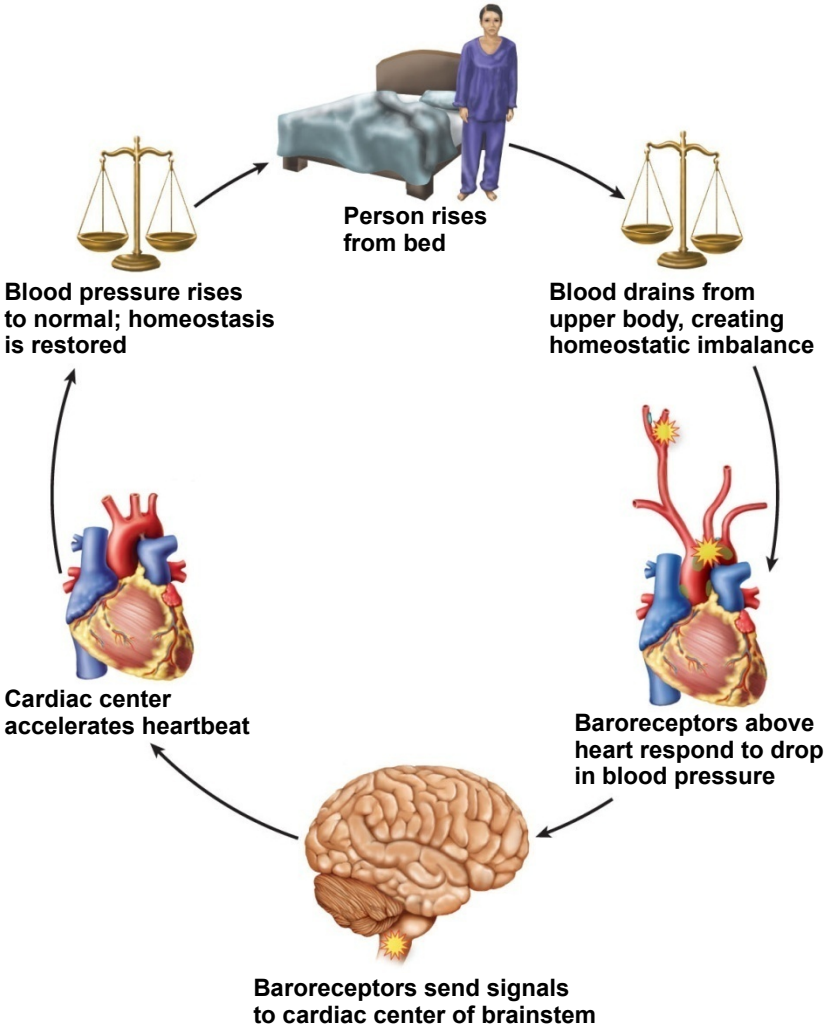


Figure 1.11

3 Components of a Feedback Loop

- **Receptor** - senses change in the body
- **Integrating (Control) Center -** control center that processes the sensory information, ‘makes a decision’, and directs the response
- **Effector –** carries out the final corrective action to restore homeostasis

Positive Feedback Loops

- **Self-amplifying cycle**
  - leads to greater change in the same direction
  - feedback loop is repeated – change produces more change
- **Normal way of producing rapid changes**
  - occurs with childbirth, blood clotting, protein digestion, fever, and generation of nerve signals

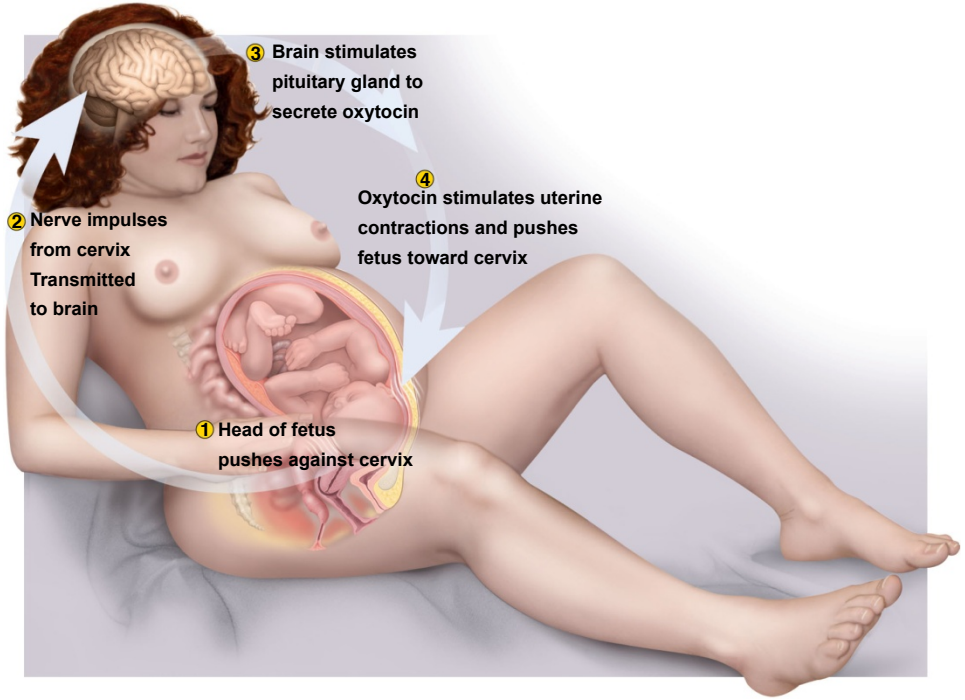


Figure 1.12

Harmful Positive Feedback Loop

- **Fever > 104 degrees F**
  - metabolic rate increases
  - body produces heat even faster
  - body temperature continues to rise
  - further increasing metabolic rate
- Cycle continues to reinforce itself
- Becomes fatal at 113 degrees F

Anatomical Terminology

- **Standard International Anatomical Terminology**
  - ***Terminologia Anatomica*** was codified in 1998 by professional associations of anatomists
- About 90% of medical terms from 1,200 **Greek and Latin** roots
- **Naming confusion during the Renaissance**
  - same structures with different names in different countries
  - structures named after people (eponyms)
- **1895 *Nomina Anatomica* (NA)**
  - rejected all eponyms
  - each structure given a unique Latin name to be used worldwide

Analyzing Medical Terms

- **Terminology based on word elements**
  - lexicon of 400 word elements on the inside the back cover of textbook
- **Scientific terms**
  - one **root** (stem) with core meaning
  - **combining vowels** join roots into a word
  - **prefix** modifies core meaning of root word
  - **suffix** modifies core meaning of root word
- **Acronyms** formed from first letter, or first few letters of series of words
  - Calmodulin comes from the phrase - calcium modulating protein

Useful Tables in Textbook

TABLE 1.2 Singular and Plural Forms of Some Noun Terminals

Singular Ending	Plural Ending	Examples
-a	-ae	axilla, axillae
-ax	-aces	thorax, thoraces
-en	-ina	lumen, lumina
-ex	-ices	cortex, cortices
-is	-es	diagnosis, diagnoses
-is	-ides	epididymis, epididymides
-ix	-ices	appendix, appendices
-ma	-mata	carcinoma, carcinomata
-on	-a	ganglion, ganglia
-um	-a	septum, septa
-us	-era	viscus, viscera
-us	-i	villus, villi
-us	-ora	corpus, corpora
-x	-ges	phalanx, phalanges
-y	-ies	ovary, ovaries
-yx	-yces	calyx, calyces

Plural, Adjectival, and Possessive Forms

- **Plural forms not always easy**
  - ovary – ovaries, cortex – cortices, corpus – corpora, epididymis – epididymides
- **Adjectival form of same word**
  - brachium denotes ‘arm’
  - brachii denotes ‘of the arm’

    or toes

  - digits – fingers and toes
  - digiti – of a single finger or toe
  - digitorum – of multiple fingers
- **3 examples of positive, comparative, and superlative degrees of comparison**
  - **English – large, larger, and largest**
  - **Latin - magnus** means large**, major** means larger of 2**,** while **maximus** is largest of 3 being compared
- **Adjectives often follow the noun in a name**
  - foramen magnum or pectoralis major

Atlas A (Orientation to Anatomy)

- Anatomical position
- Anatomical planes
- Directional terms
- Body regions
- Body cavities and membranes
- Organ systems
- Visual survey of the body

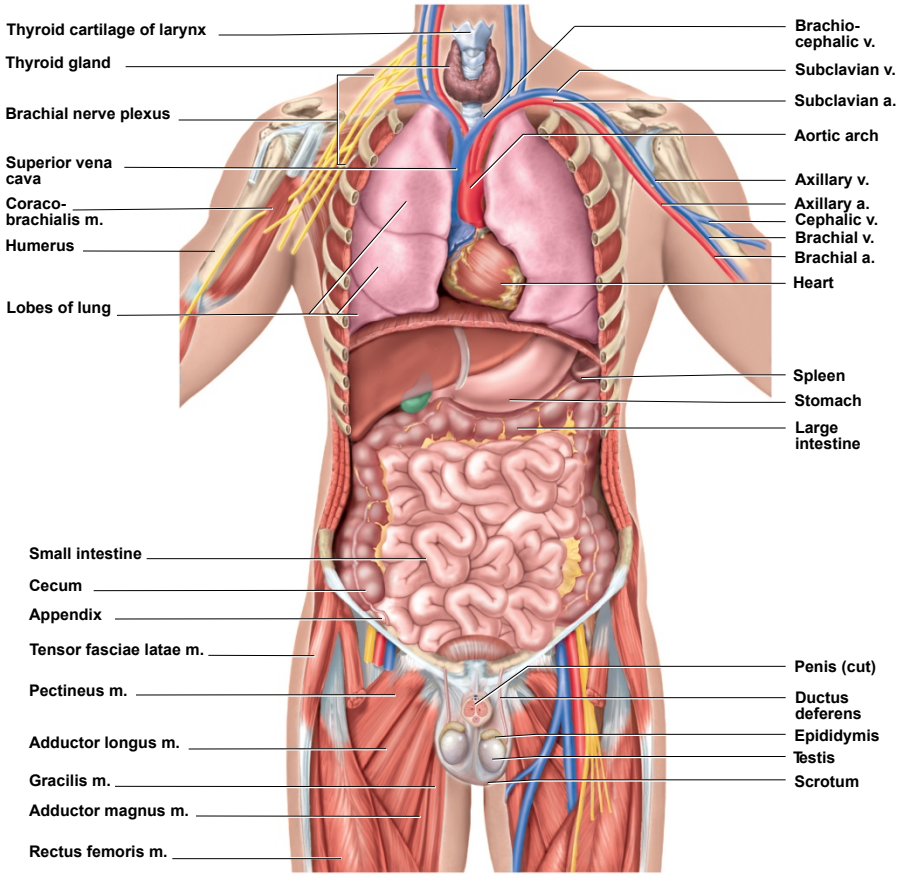
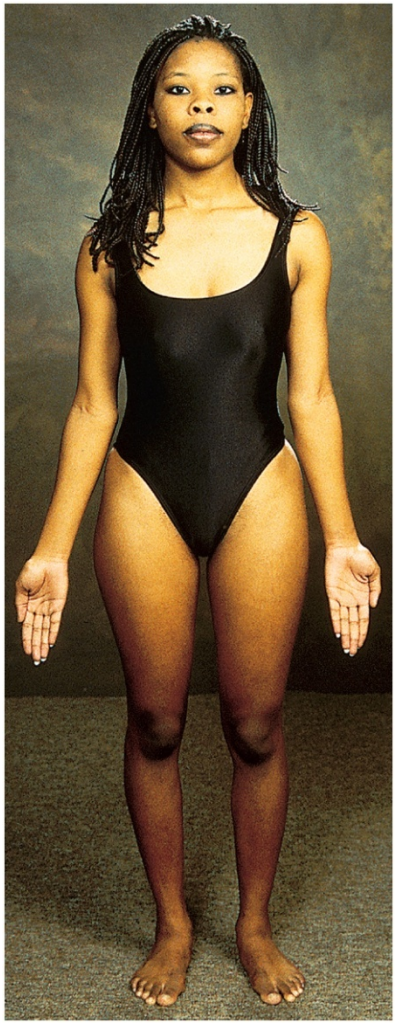


Figure A.14

Anatomical Position



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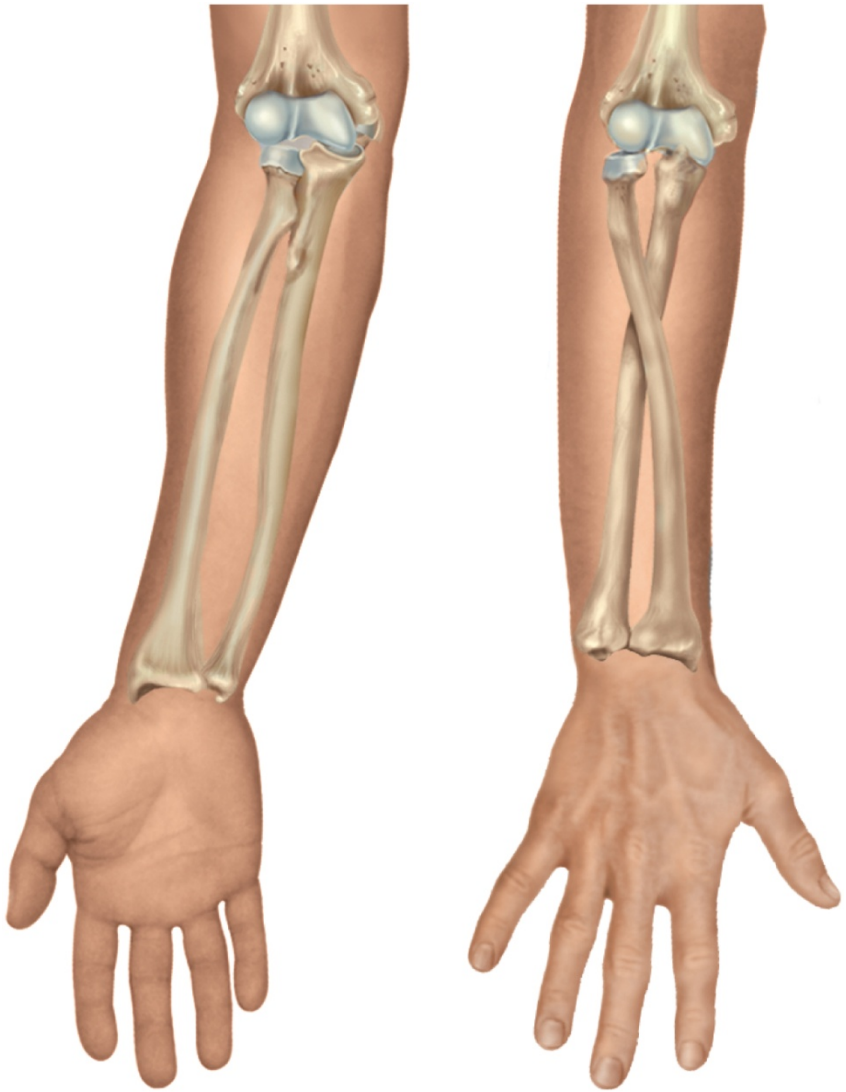
- **Person stands erect**
- **Feet flat on floor**
- **Arms at sides**
- **Palms, face & eyes facing forward**

- Standard frame of reference for anatomical descriptions & dissection

Figure A.1

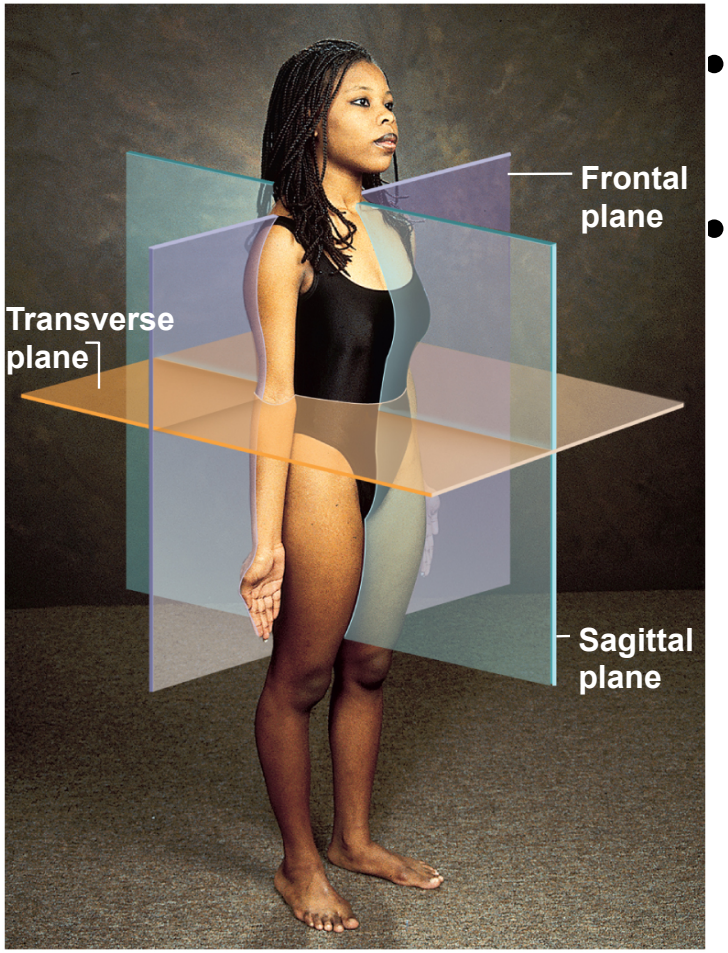
Forearm Positions



- When **supinated**
  - palms face forward or upward
  - radius & ulna are parallel
- When **pronated**
  - palms face rearward or downward
  - radius & ulna are crossed

Figure A.2

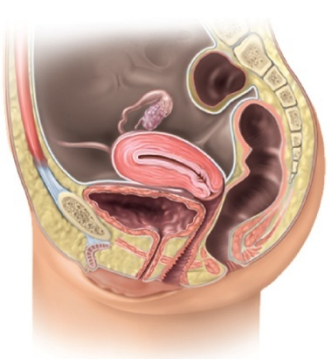
Anatomical Planes and Sections



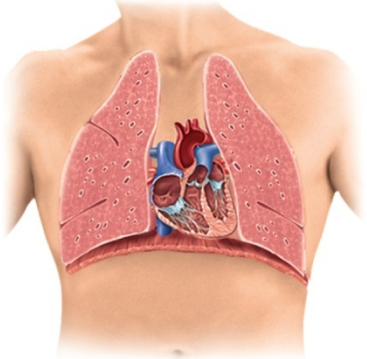
- **Section** implies actual cut or slice to reveal internal anatomy
- **Plane** implies an imaginary flat surface passing through the body
  - **Sagittal plane** divides body into right and left regions
    - **median (midsagittal) plane** divides body or organ into equal halves
  - **Frontal (coronal) plane** divides body into anterior (front) & posterior (back) portions
  - **Transverse (horizontal) plane** divides the body into superior (upper) & inferior (lower) portions

Figure A.3

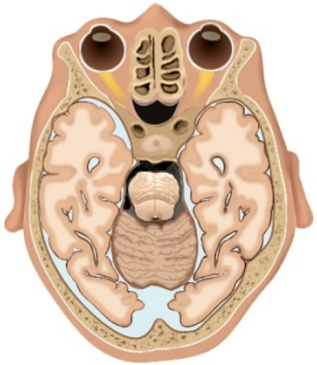
Anatomical Sections



(a) Sagittal section



(b) Frontal section



(c) Transverse section

Sagittal **Frontal** **Transverse**

Figure A.4

Directional Terms

Ventral / Dorsal **Anterior /Posterior**

Superior / Inferior **Proximal / Distal**

Medial / Lateral **Superficial / Deep**

Cephalic **Rostral** **Caudal**

- **Intermediate directions -** often given as combinations of these terms (ex. dorsolateral)
- **Different meanings for humans and four-legged animals**
  - **anterior = ventral surface of human –** front of chest & abdomen
  - anterior (cranial) in a four-legged animal is head end
  - **posterior = dorsal surface of human –** last in locomotion – back side
  - posterior (caudal) in a four-legged animal is tail end

Body Regions

- **Axial region =** head, neck, & trunk
  - **thoracic region =** trunk above diaphragm
  - **abdominal region =** trunk below diaphragm
    - **divided into quadrants**
    - **divided into nine regions by tic-tac-toe grid**
- **Appendicular region =** upper & lower limbs
  - **upper limb**
    - **arm (brachial region), forearm (antebrachial region), wrist (carpal region), hand (manual region), fingers (digits)**
  - **lower limb**
    - **thigh (femoral region), leg (crural region), ankle (tarsal region), foot (pedal region), toes (digits)**

Abdominal Quadrants and Regions

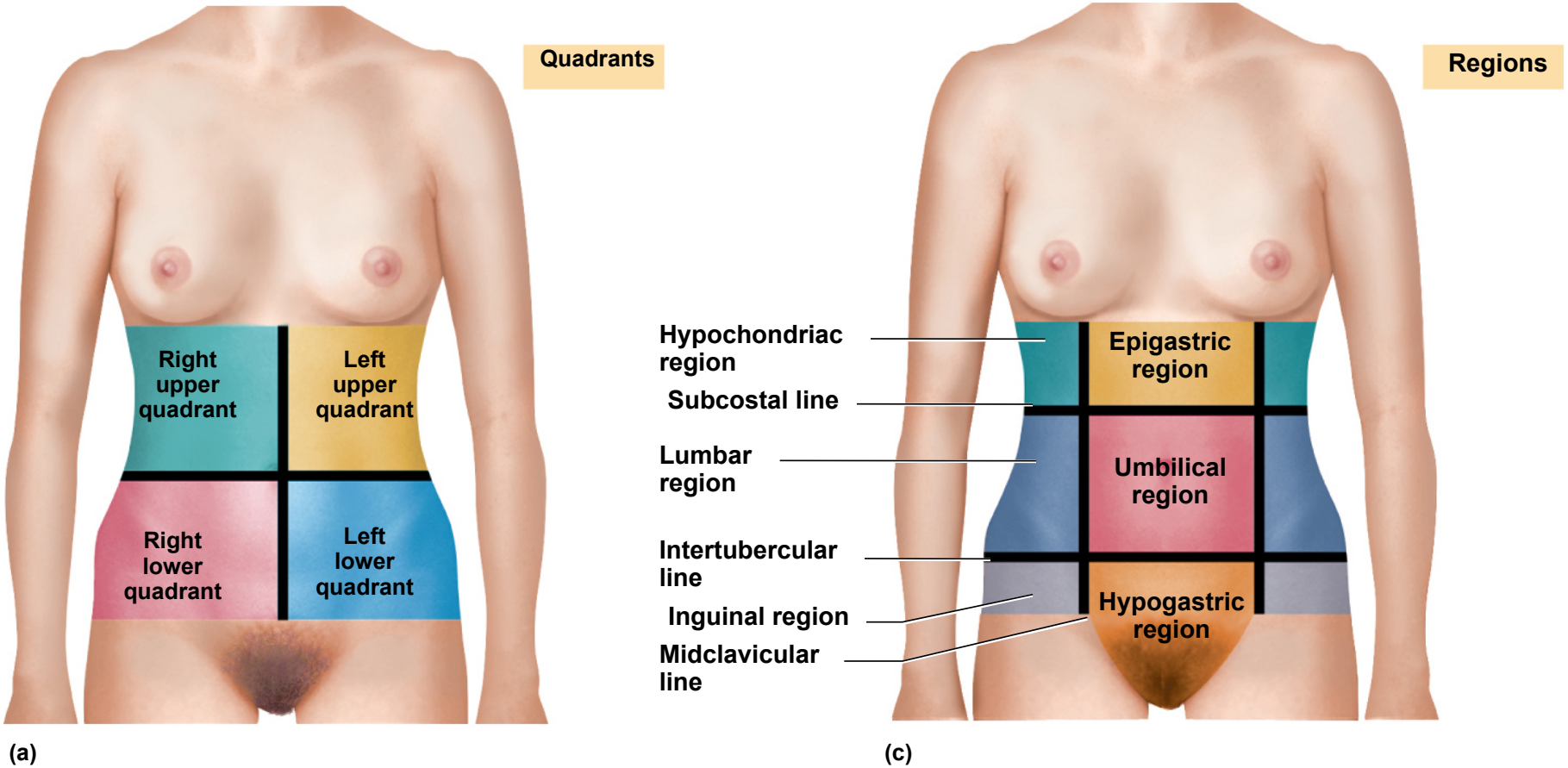


Figure A.6

Anatomical Terminology (ventral)

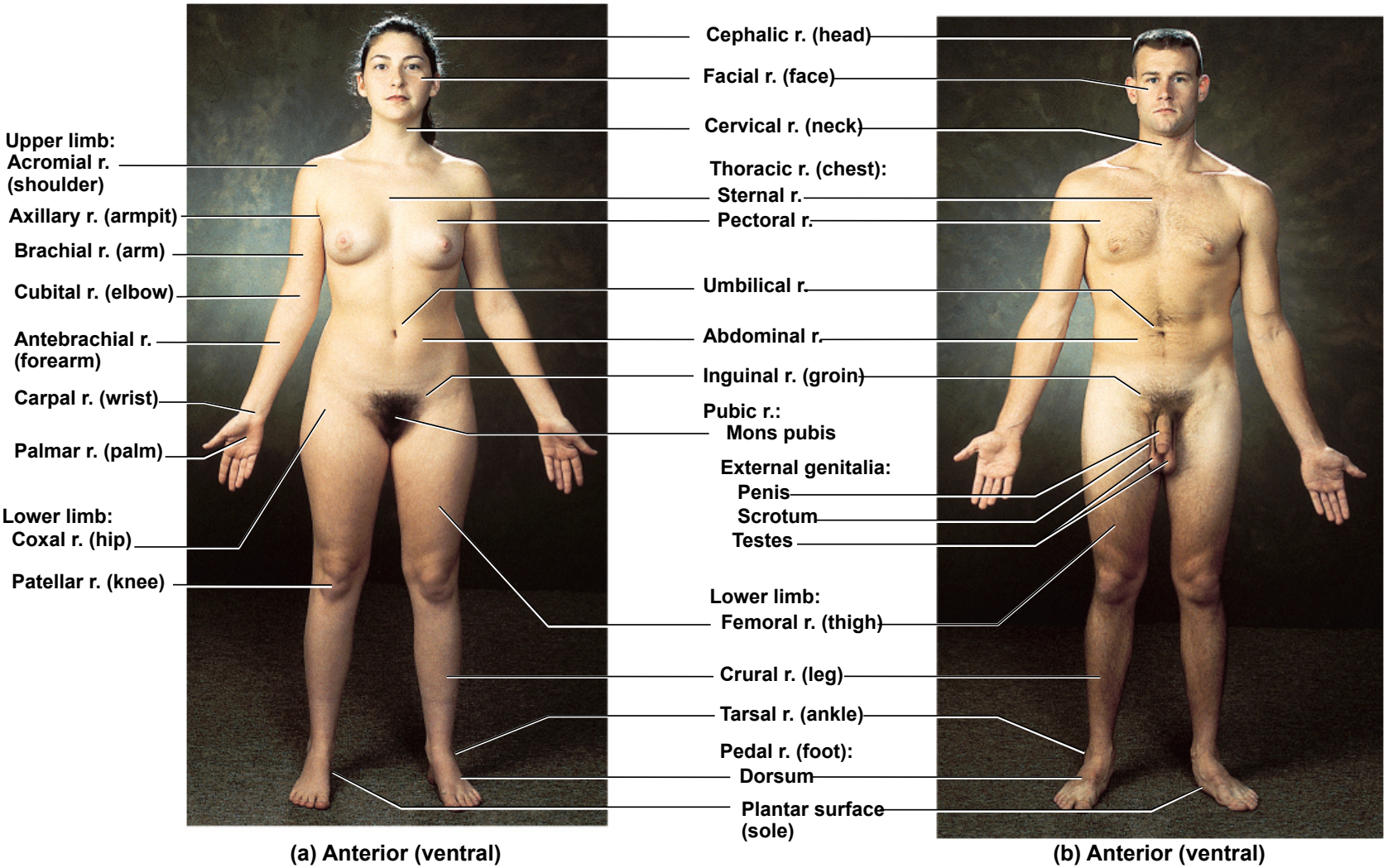
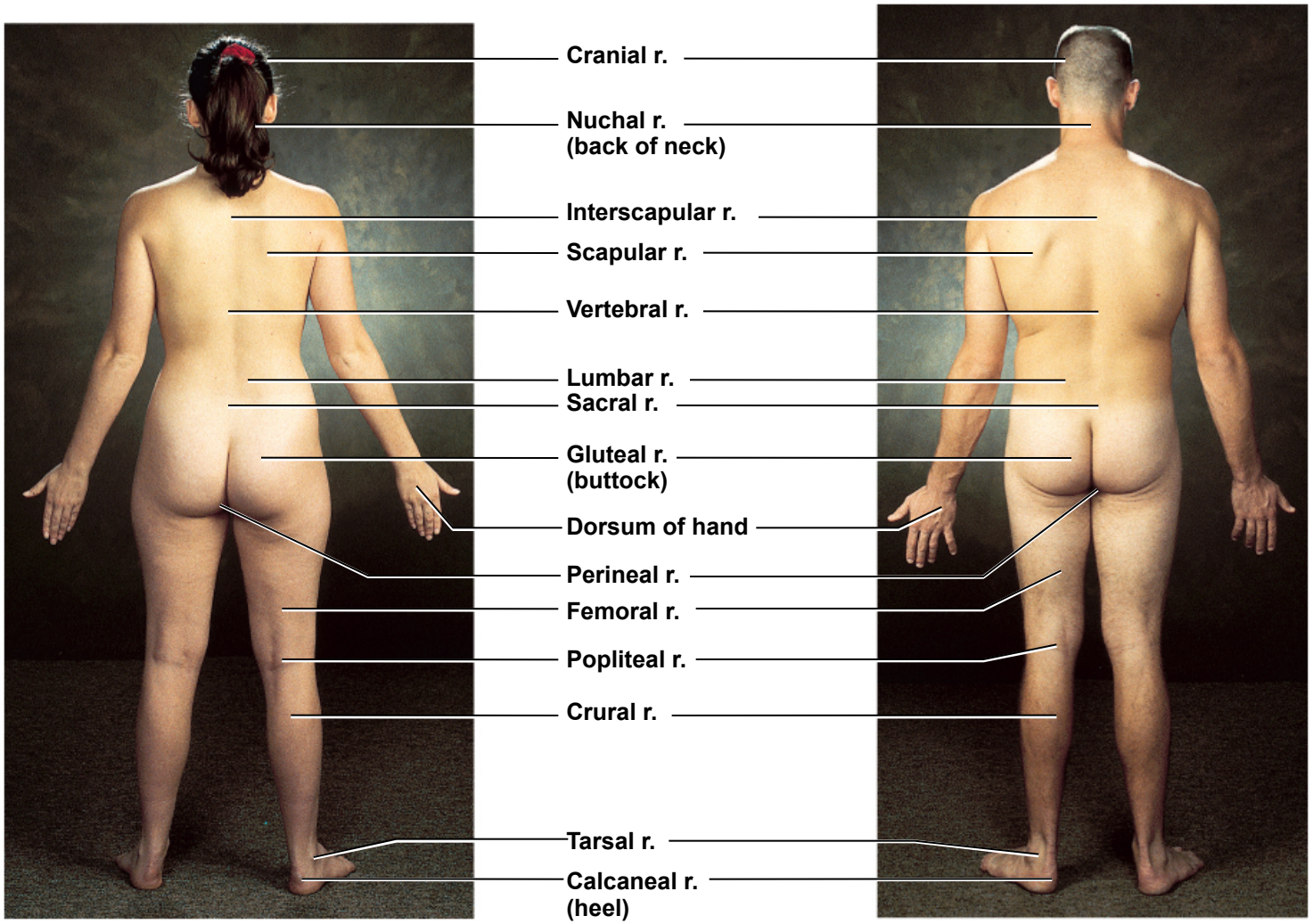


Figure A.5

Anatomical Terminology (dorsal)

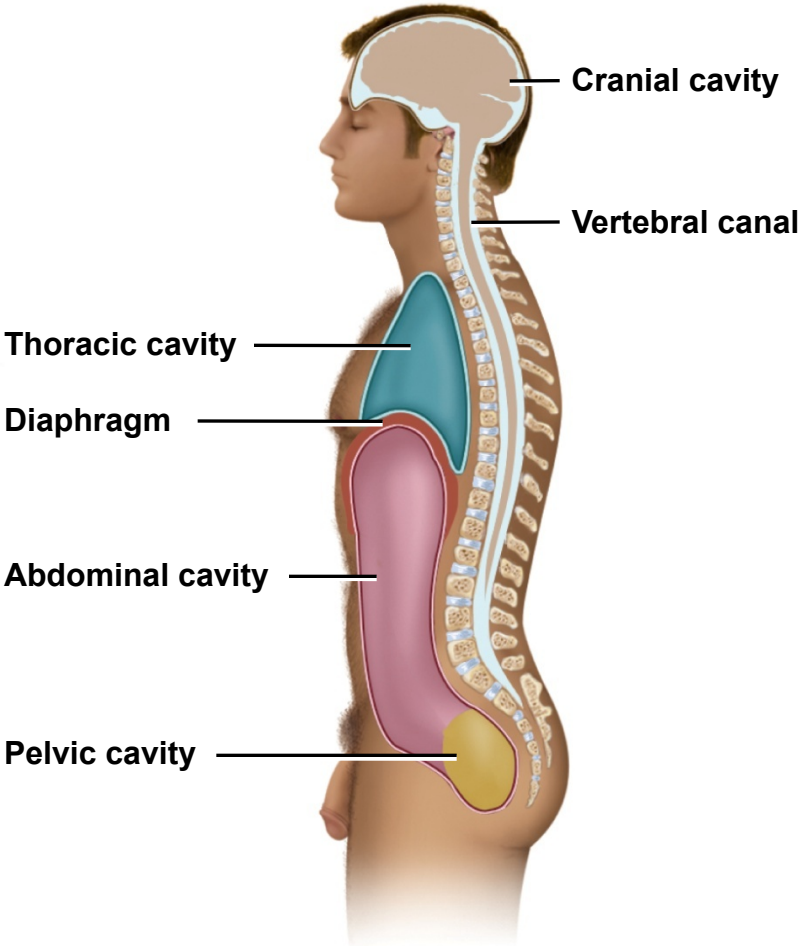


(c) Posterior (dorsal)

(d) Posterior (dorsal)

Figure A.5

Body Cavities and Membranes



(a) Left lateral view

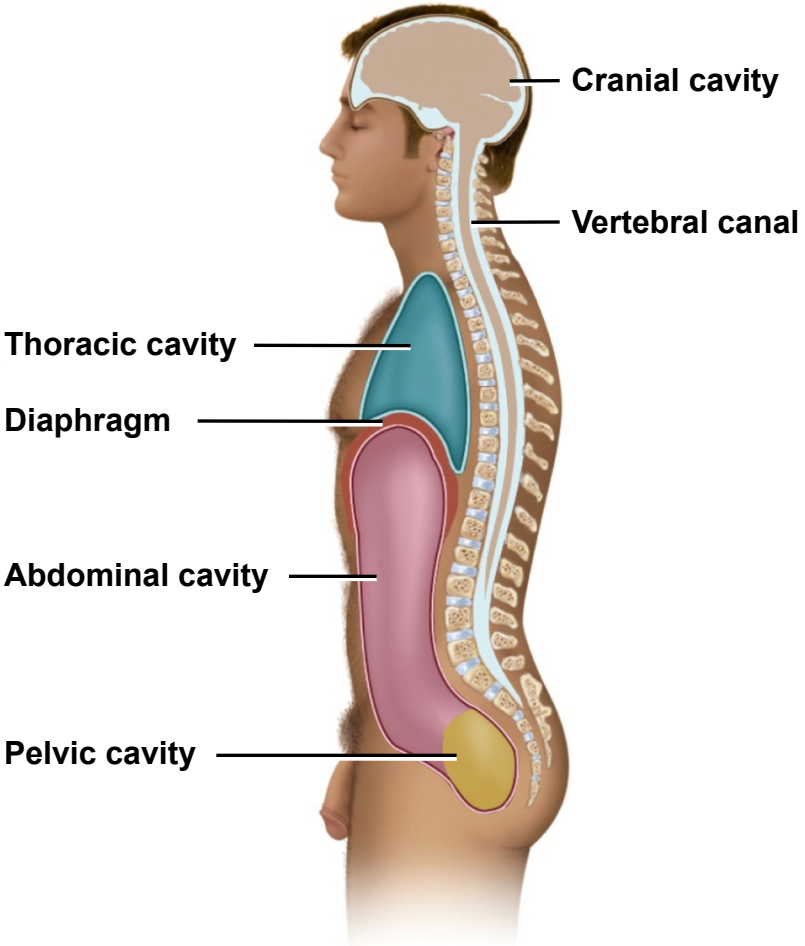
Figure A.7

Major body cavities

- cranial cavity
- vertebral canal
  - meninges
- thoracic cavity
- abdominopelvic cavity
  - abdominal cavity
  - pelvic cavity

- Lined by **serous membranes**
- Filled with **viscera**

Cranial Cavity & Vertebral Canal



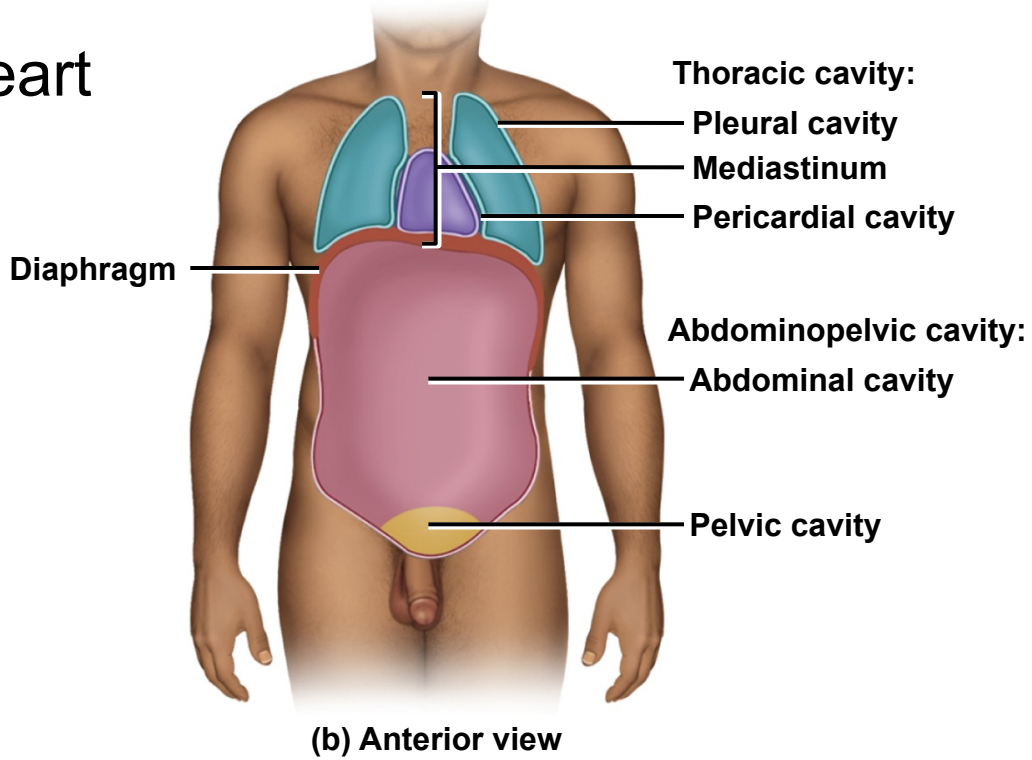
(a) Left lateral view

Figure A.7

- **cranial cavity**
  - contains brain
  - lined with meninges
- **vertebral canal**
  - contains the spinal cord
  - lined with meninges

Thoracic Cavity

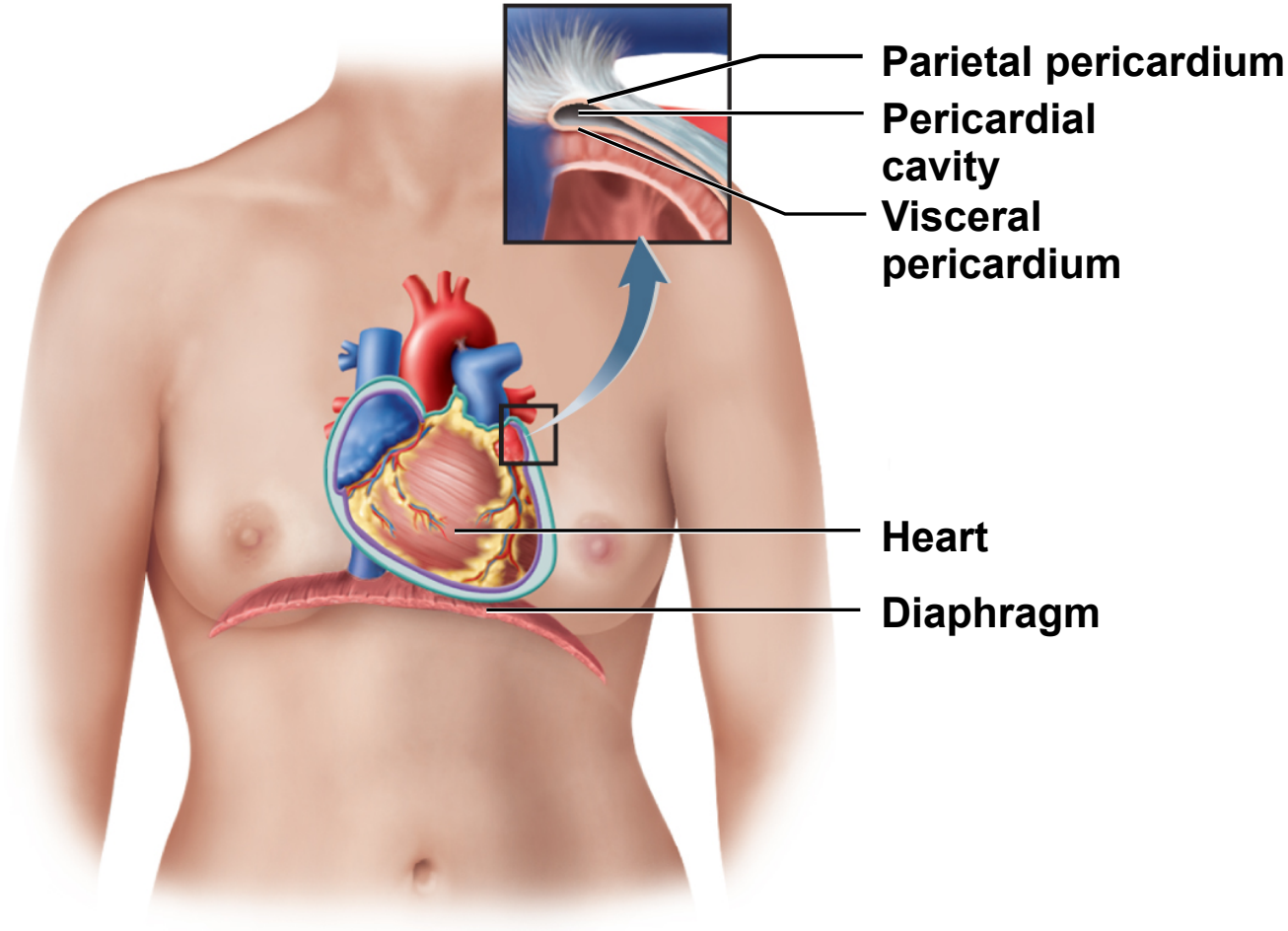
- **Mediastinum -** region between lungs
  - **heart, major blood vessels, esophagus, trachea, & thymus**
- **Pericardium –** around heart
  - **visceral pericardium**
  - **parietal pericardium**
  - **pericardial cavity**
  - **pericardial fluid**
- **Pleura –** around lungs
  - **visceral pleura**
  - **parietal pleura**
  - **pericardial cavity**
  - **pericardial fluid**



(b) Anterior view

Figure A.7

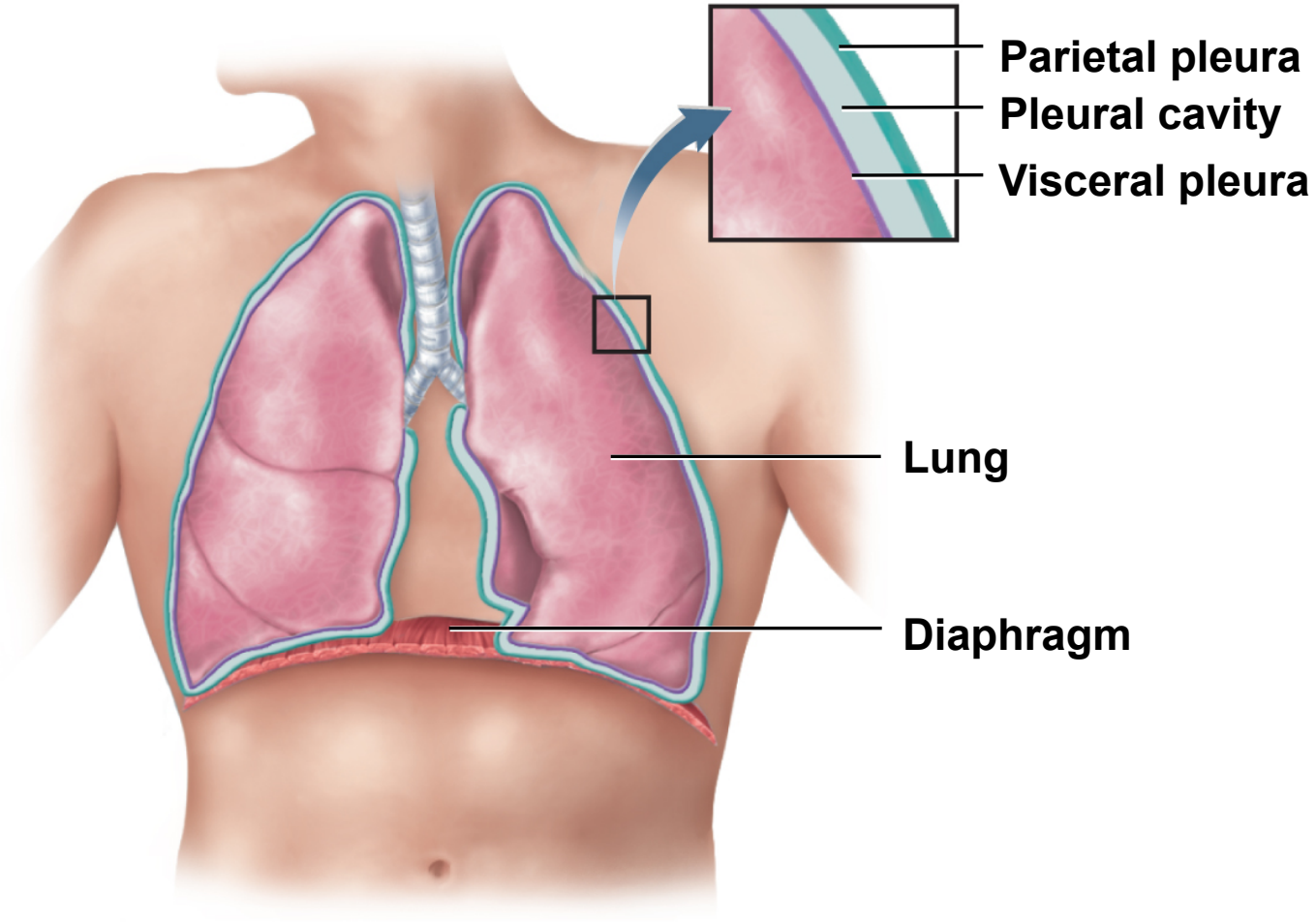
Pericardial Membranes



(a) Pericardium

Figure A.8a

Pleural Membranes



(b) Pleurae

Figure A.8b

Abdominopelvic Cavity

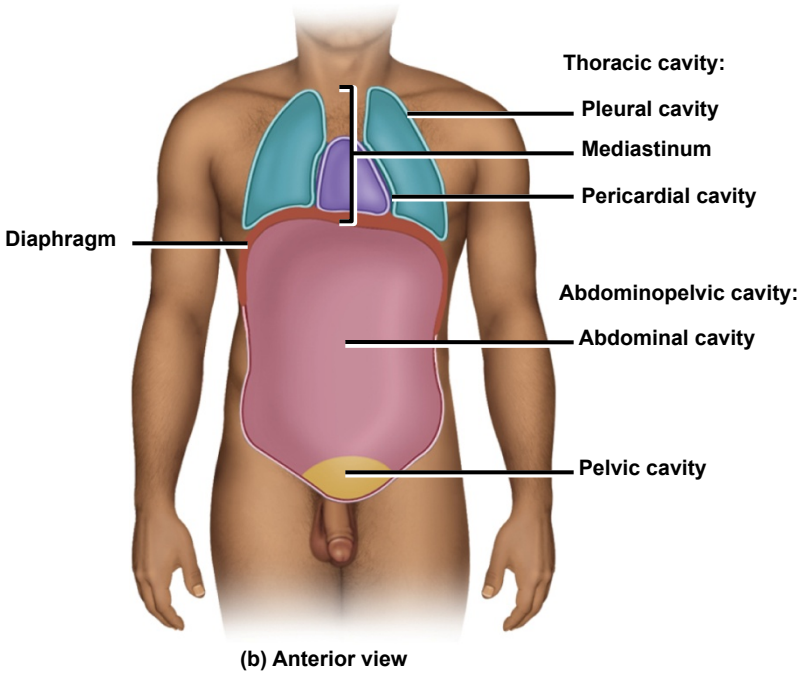
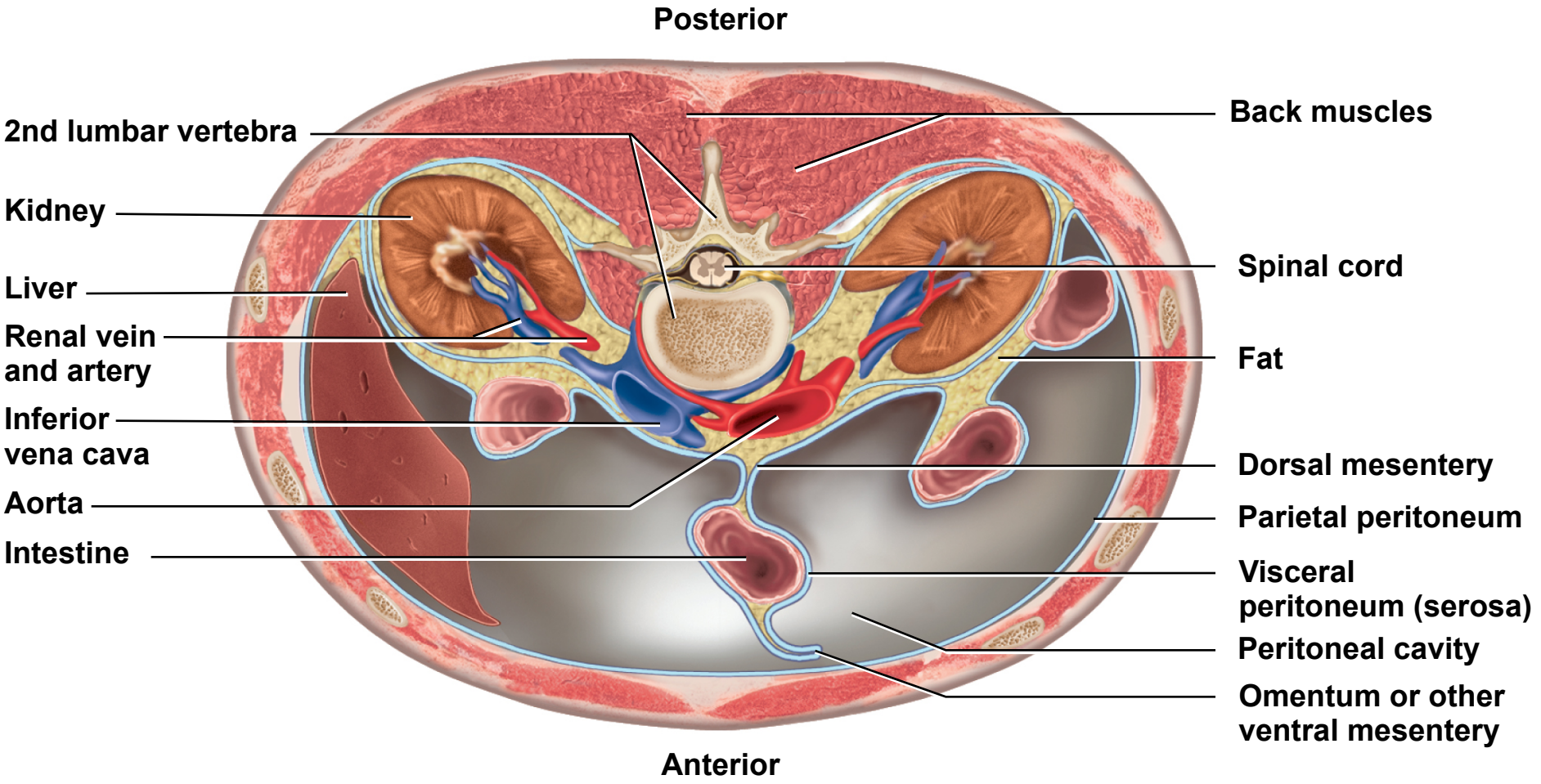


Figure A.7

- **Pelvic brim** separates abdominal & pelvic cavities
  - **abdominal cavity** contains most digestive organs, kidneys & ureters
  - **pelvic cavity** contains rectum, urinary bladder, urethra & reproductive organs

- **Peritoneum -** Serous Membranes of Abdominopelvic cavity
  - **visceral peritoneum** **- peritoneal cavity**
  - **parietal peritoneum** **- peritoneal fluid**

Retroperitoneal Organs



Kidneys, Ureters, **Adrenal Glands,** most of **Pancreas**, Abdominal portions of **Aorta** and **Inferior Vena Cava**

Figure A.9

Intraperitoneal Organs

organs encircled by peritoneum and connected to posterior body wall by peritoneal sheets

- **dorsal mesentery** – suspends intestines from posterior abdominal wall
  - **mesocolon** – dorsal mesentery of large intestine
- **ventral mesentery** – suspends viscera from anterior abdominal wall
  - **greater omentum** – inferolateral border of stomach – overlies intestines - 'fatty apron'
  - **lesser omentum** – superomedial border of stomach to liver
- **serosa** – outer layer of an organ formed when the visceral peritoneum divides and wraps around the organ

Membranes of Abdominal Cavity

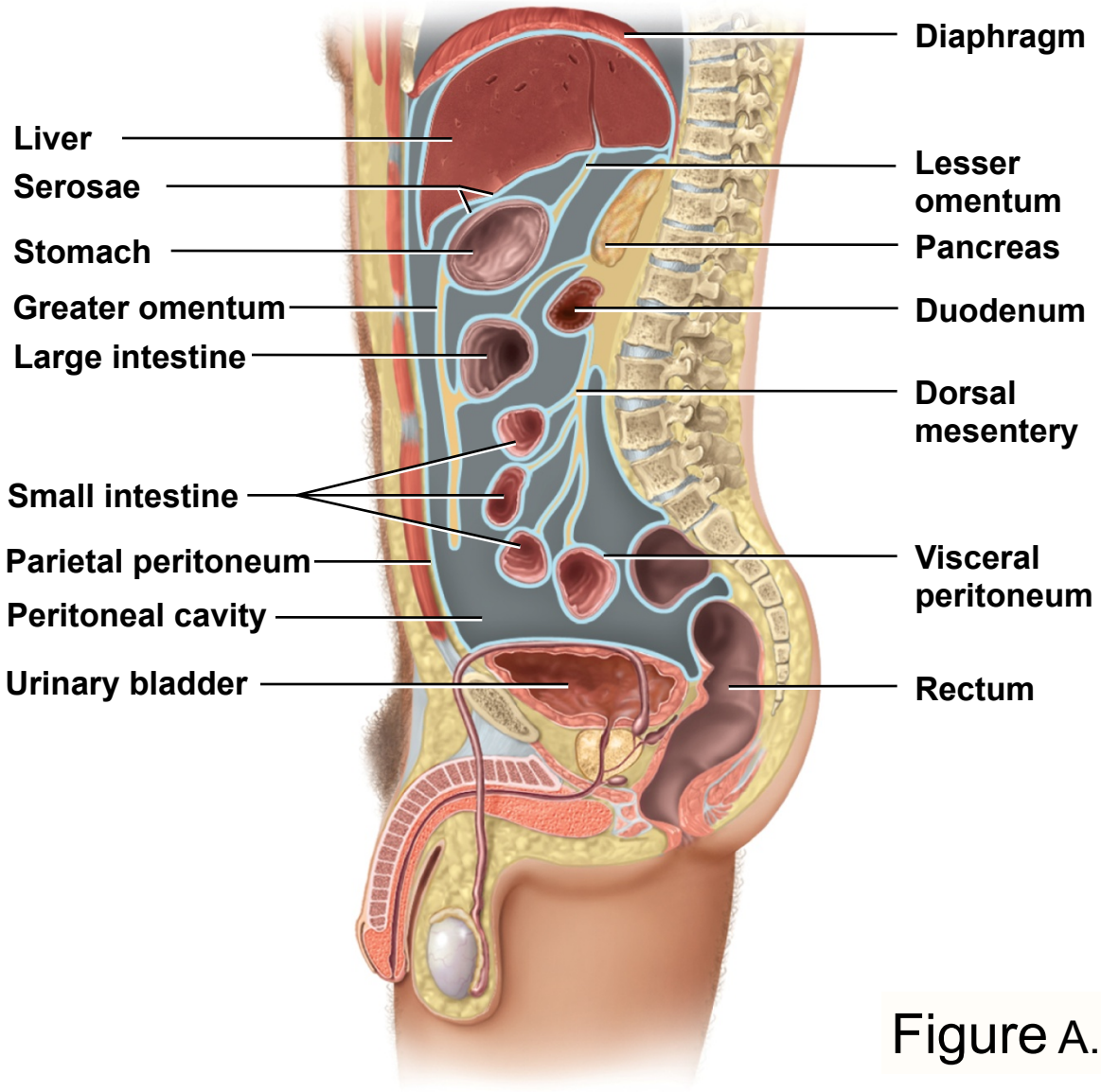


Figure A.10

Potential Spaces

- **Found between two membranes normally pressed firmly together**
  - not physically attached, may separate, and fill with fluid in unusual situations
- **Examples**
  - **pleural cavity**
    - air or fluid can accumulate between parietal and visceral pleura forming a space
  - **uterus**
    - in a nonpregnant uterus, mucous membranes of walls are in contact

11 Organ Systems

- Protection, Support, and Movement
  - **Integumentary System**
  - **Skeletal System**
  - **Muscular System**
- Internal Communications & Integration
  - **Nervous System**
  - **Endocrine System**
- Fluid Transport
  - **Circulatory System**
  - **Lymphatic System**
- Defense
  - **Immune (Lymphatic System)**
- Input and Output
  - **Respiratory System**
  - **Urinary System**
  - **Digestive System**
- Reproduction
  - **Reproductive System**

Organ Systems (1)

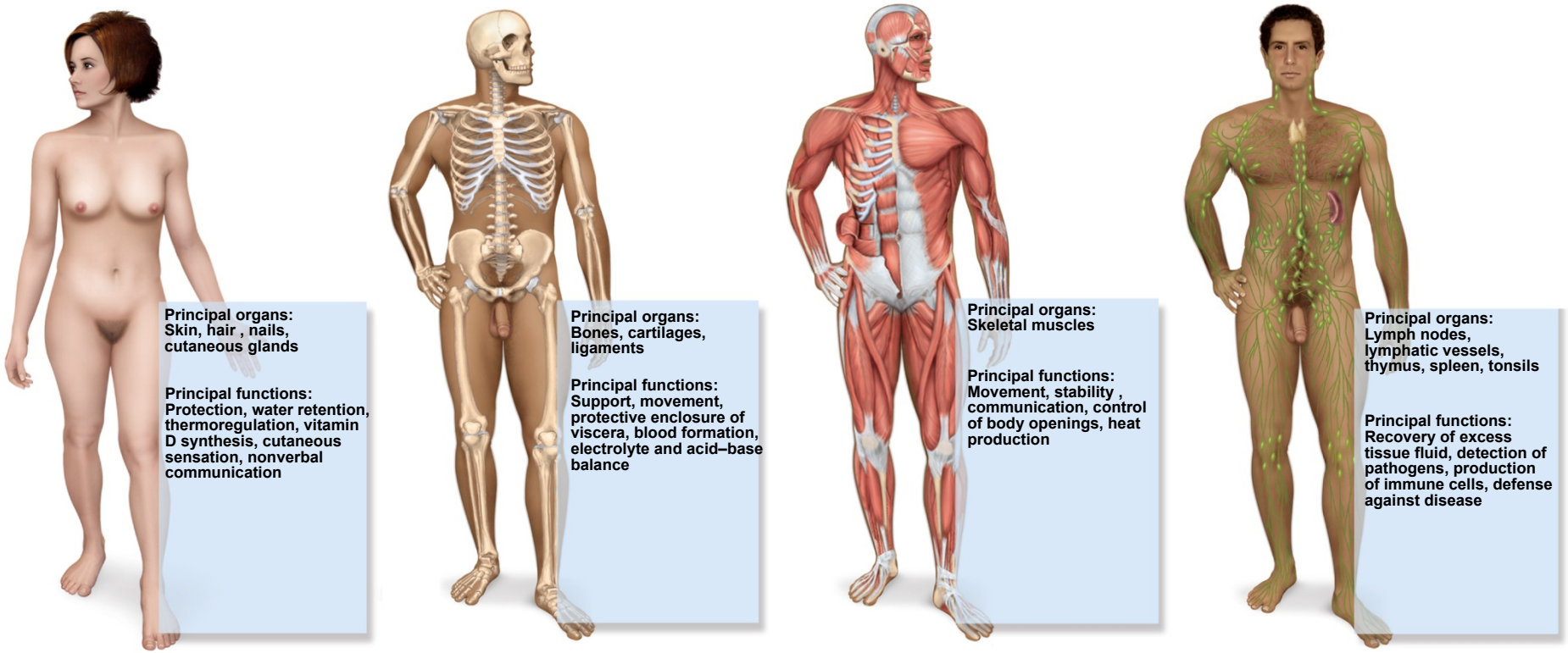


Figure A.11

Organ Systems (2)

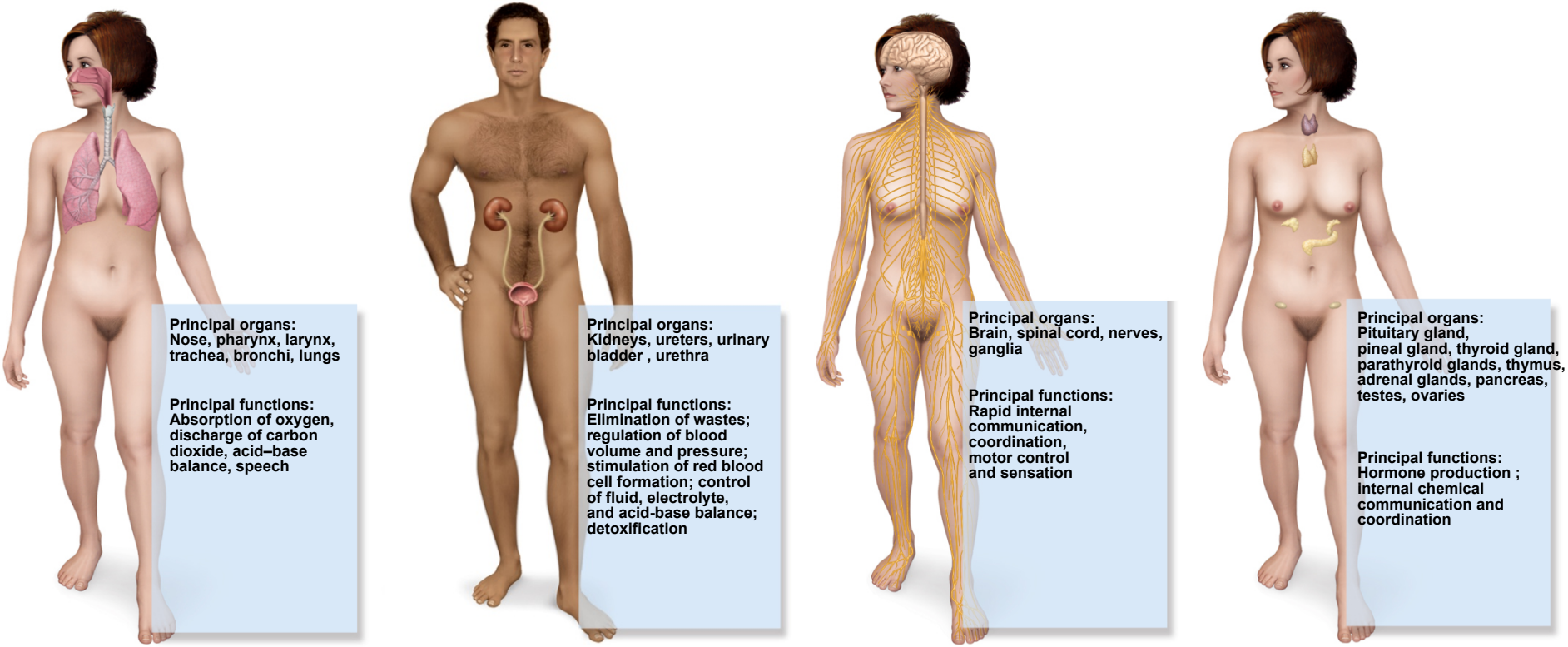
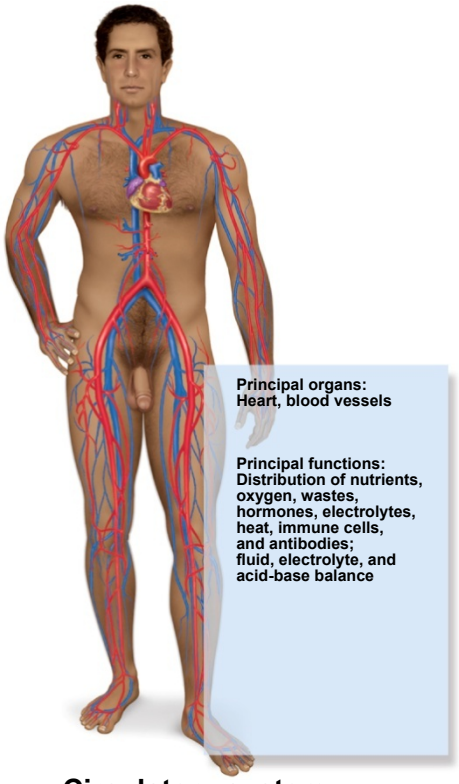


Figure A.11

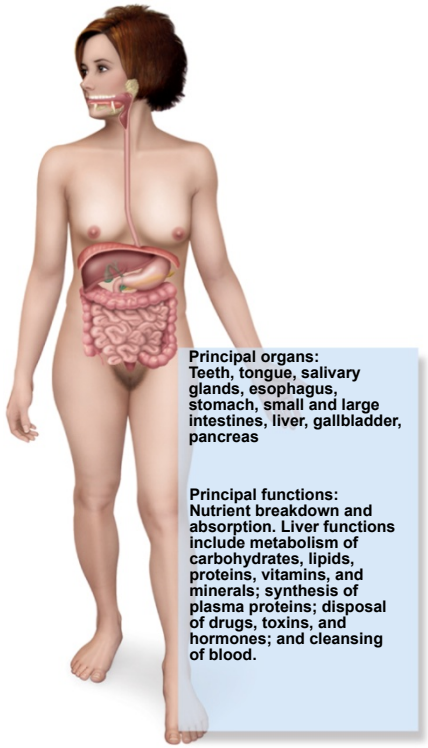
Organ Systems (3)



Principal organs:
Heart, blood vessels

Principal functions:
Distribution of nutrients, oxygen, wastes, hormones, electrolytes, heat, immune cells, and antibodies; fluid, electrolyte, and acid-base balance

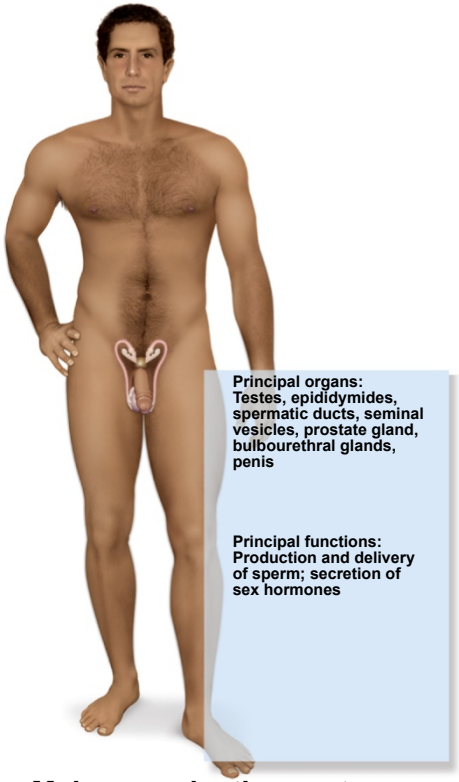
Circulatory system



Principal organs:
Teeth, tongue, salivary glands, esophagus, stomach, small and large intestines, liver, gallbladder, pancreas

Principal functions:
Nutrient breakdown and absorption. Liver functions include metabolism of carbohydrates, lipids, proteins, vitamins, and minerals; synthesis of plasma proteins; disposal of drugs, toxins, and hormones; and cleansing of blood.

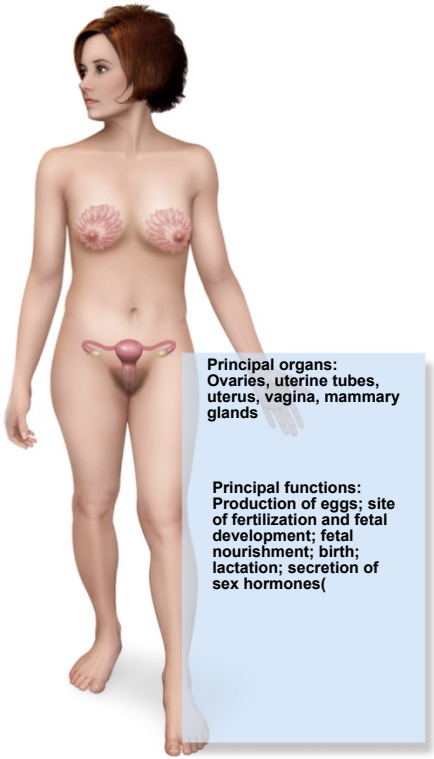
Digestive system



Principal organs:
Testes, epididymides, spermatic ducts, seminal vesicles, prostate gland, bulbourethral glands, penis

Principal functions:
Production and delivery of sperm; secretion of sex hormones

Male reproductive system



Principal organs:
Ovaries, uterine tubes, uterus, vagina, mammary glands

Principal functions:
Production of eggs; site of fertilization and fetal development; fetal nourishment; birth; lactation; secretion of sex hormones(

Female reproductive system

Figure A.11

Superficial Anatomy (female)

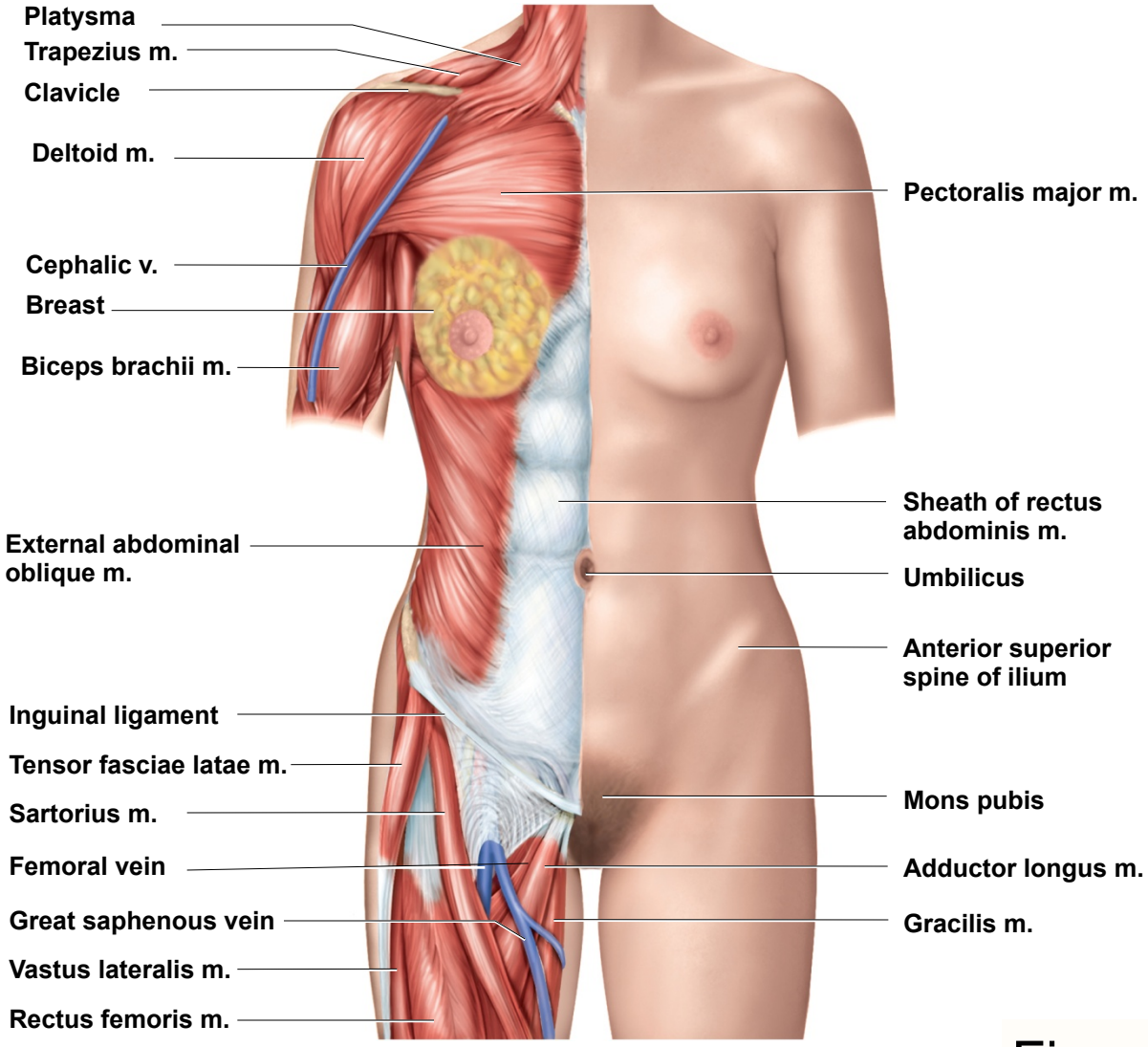


Figure A.12

Visceral Anatomy (male) 1

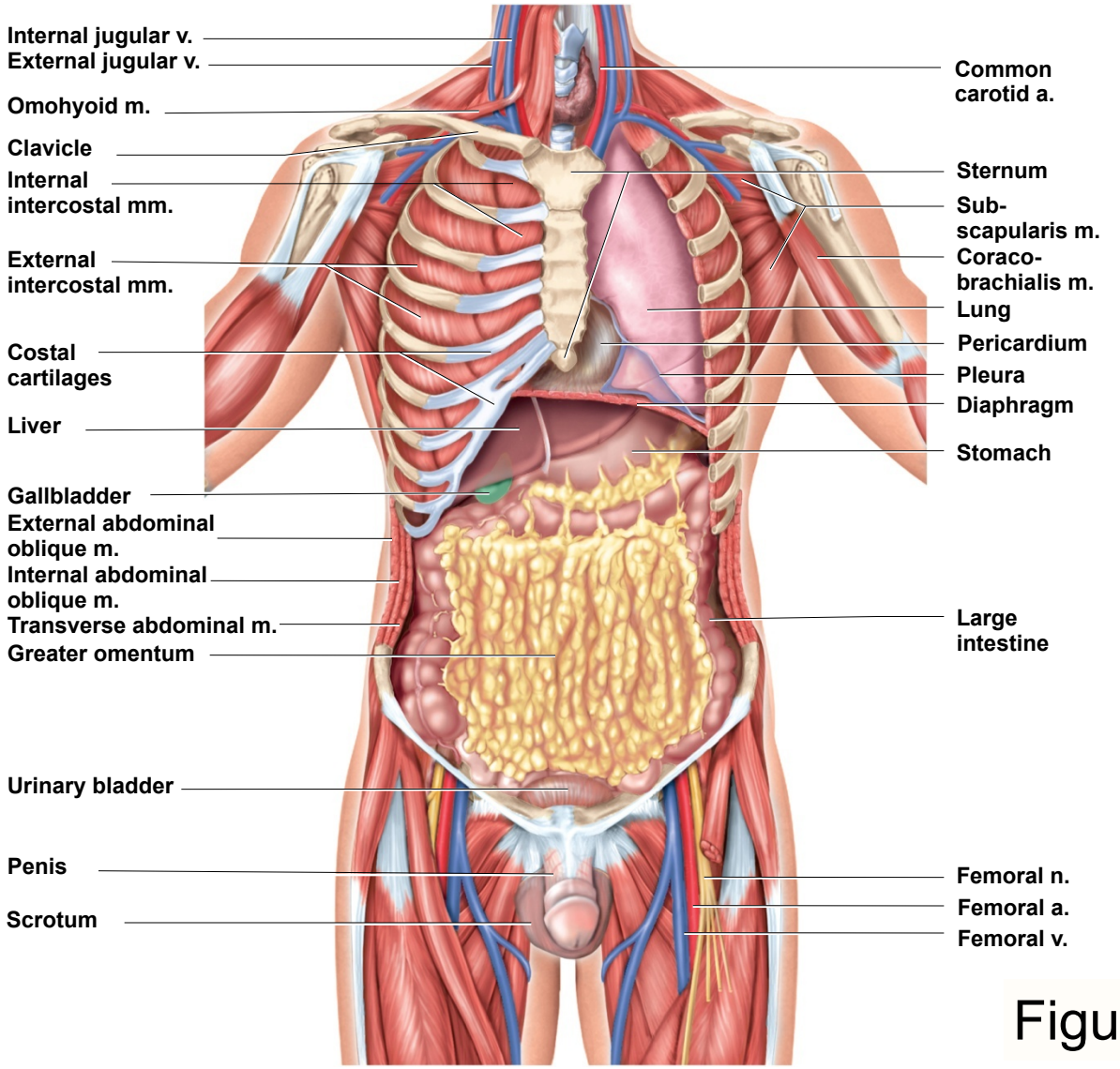


Figure A.13

Visceral Anatomy (male) 2

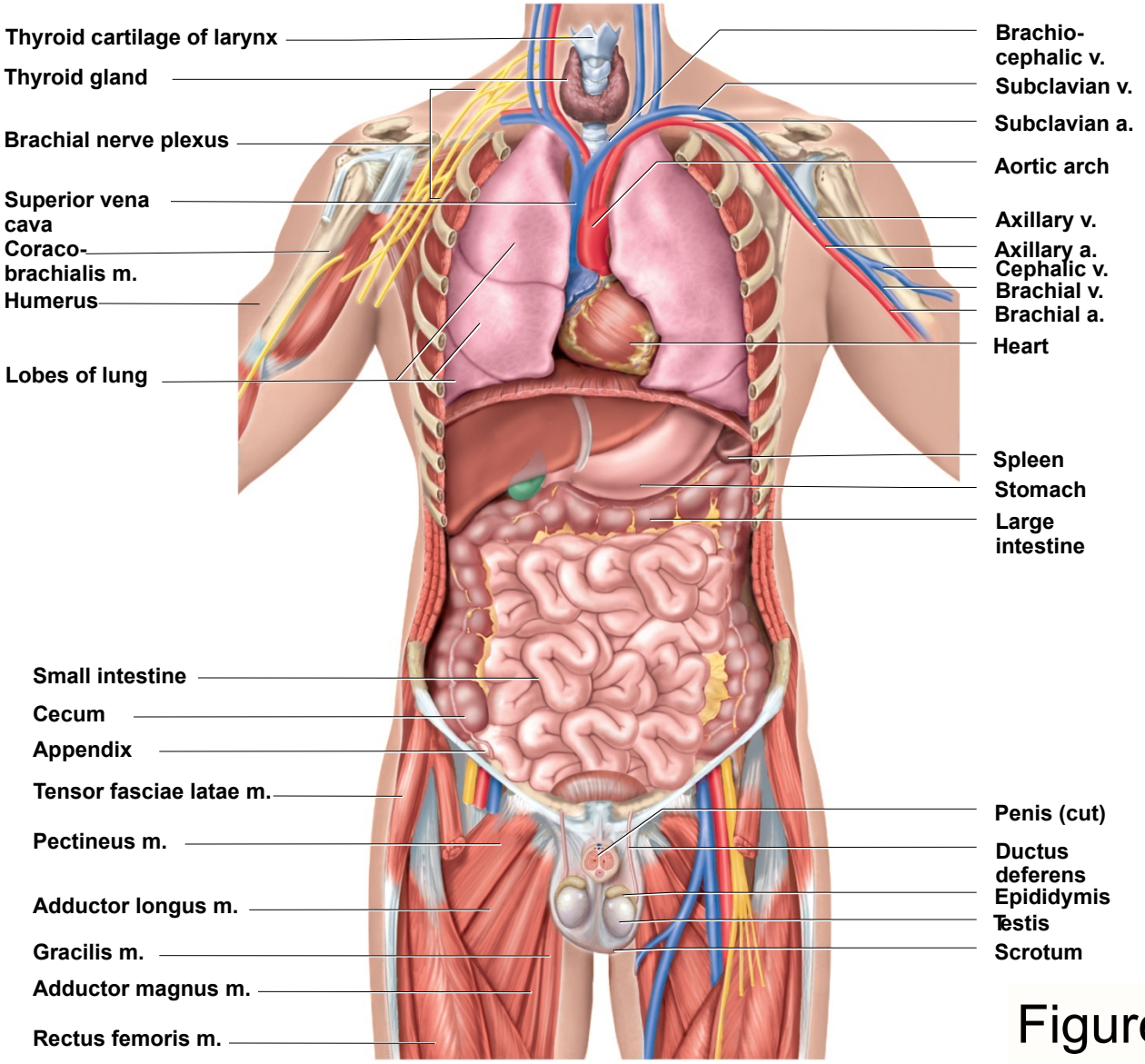


Figure A.14

Retroperitoneal Anatomy (female)

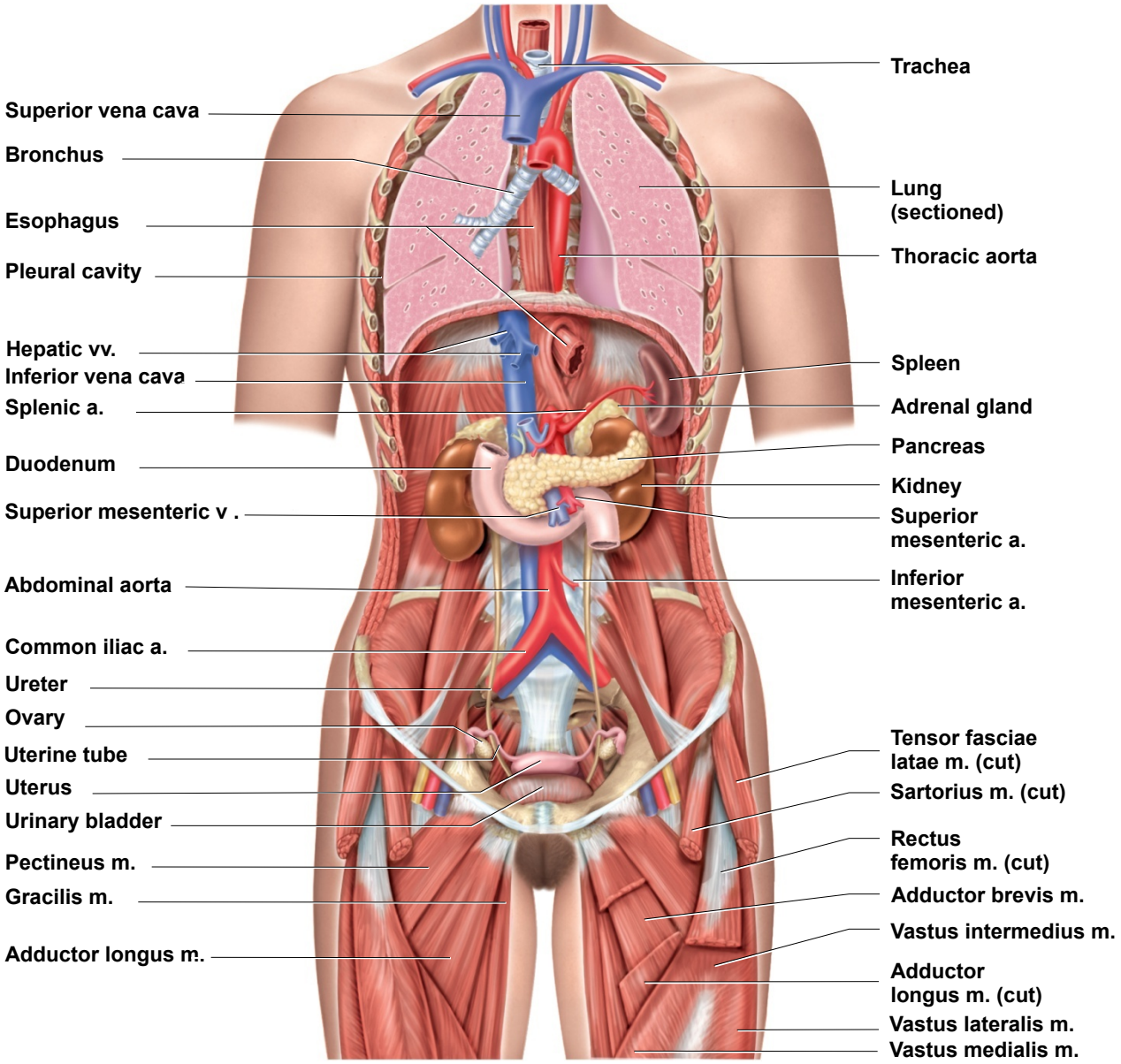


Figure A.15

Dorsal Body Wall (female)

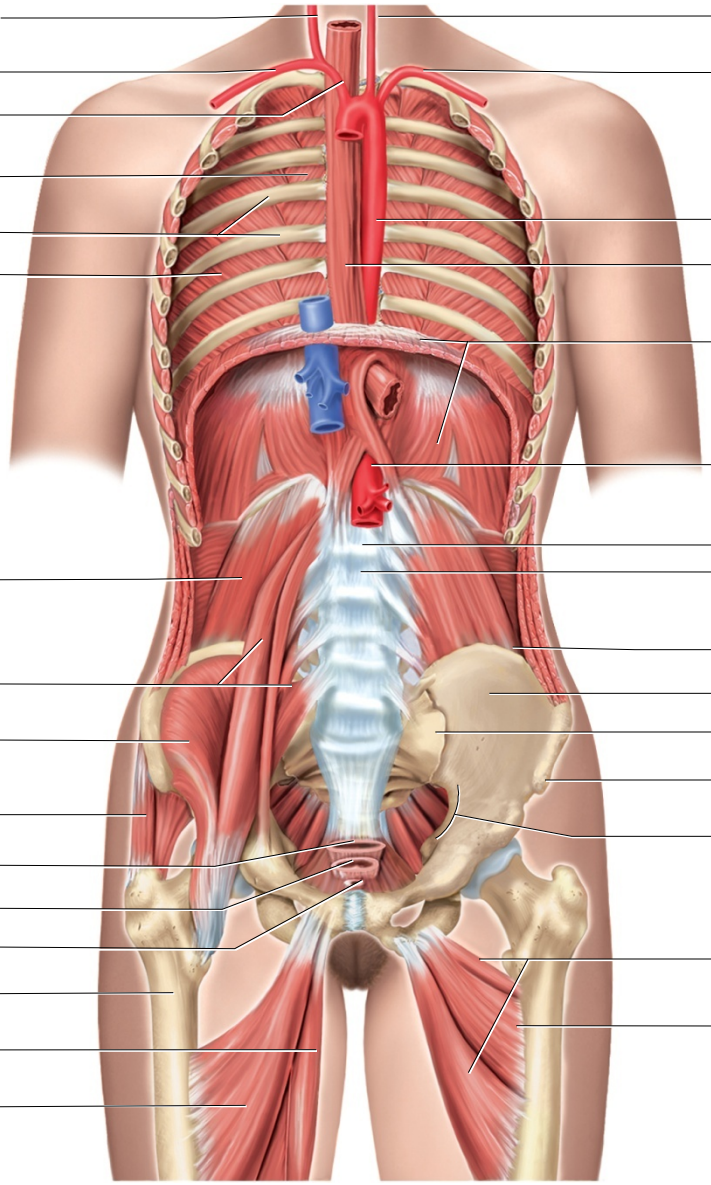


Figure A.16

Median Section of the Head

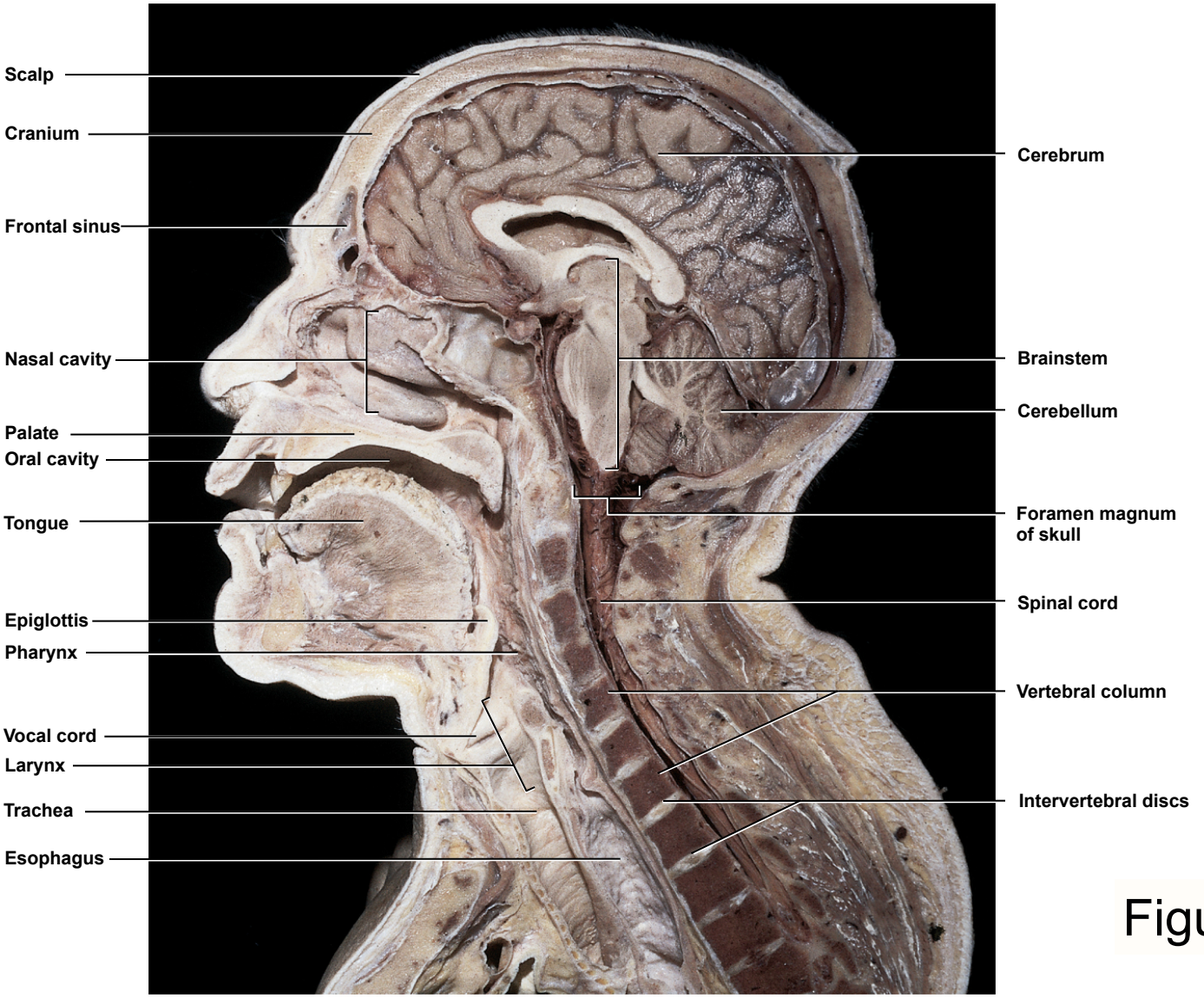


Figure A.17

Dissection of Thoracic Cavity

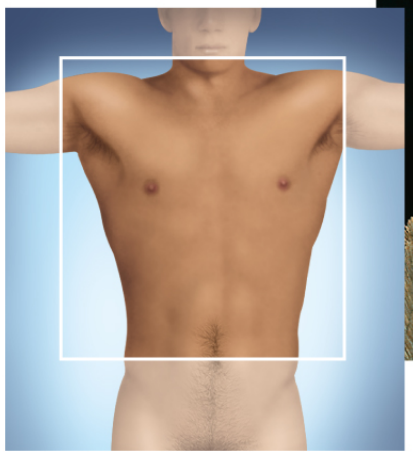
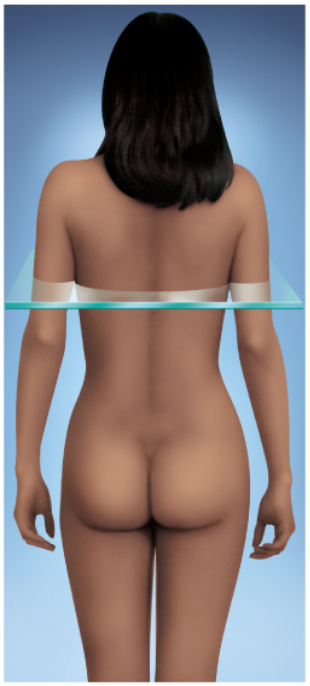


Figure A.18

Transverse Section of Thorax



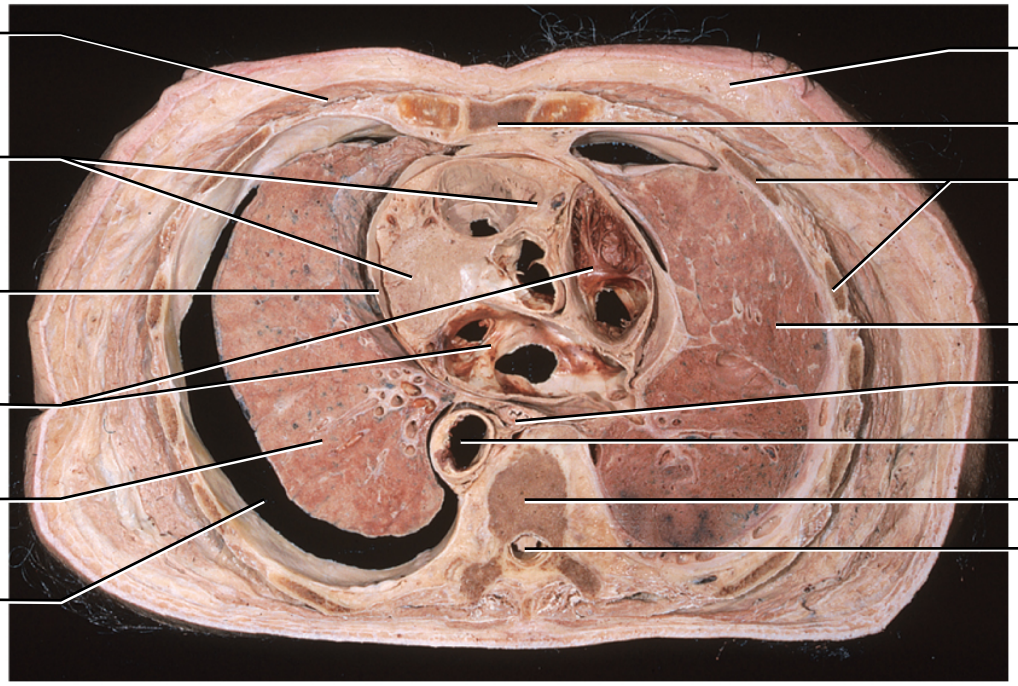
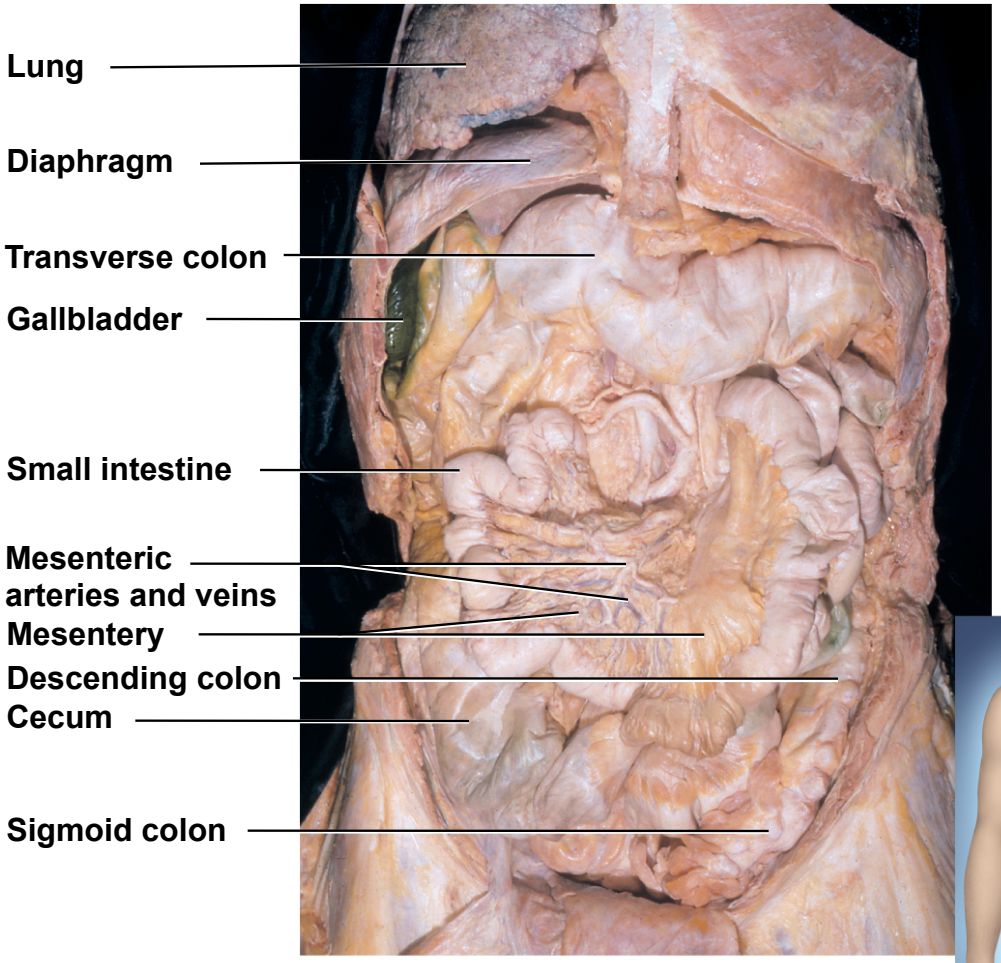


Figure A.19

Dissection of Abdomen



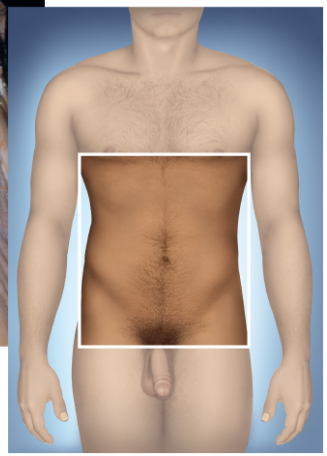


Figure A.20

Transverse Section of Abdomen

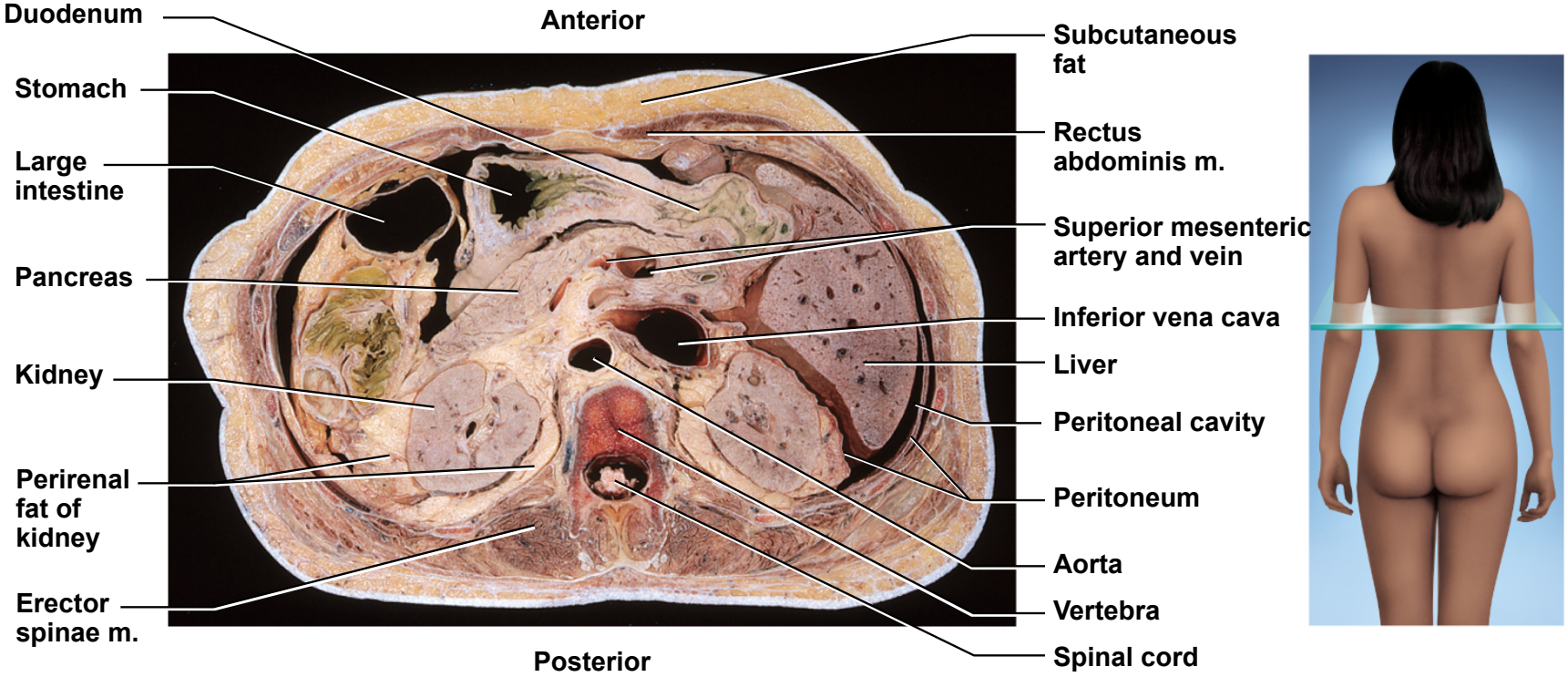


Figure A.21

Median Section of Male Pelvic Region

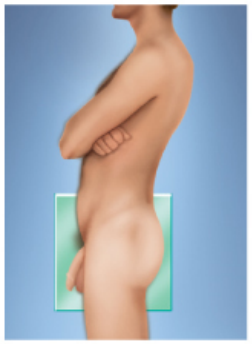
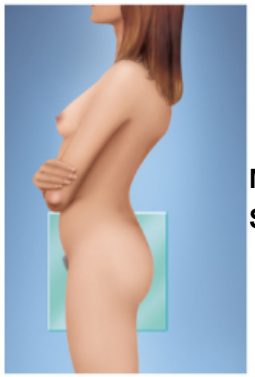


Figure A.22

(a) Male

Median Section of Female Pelvic Region



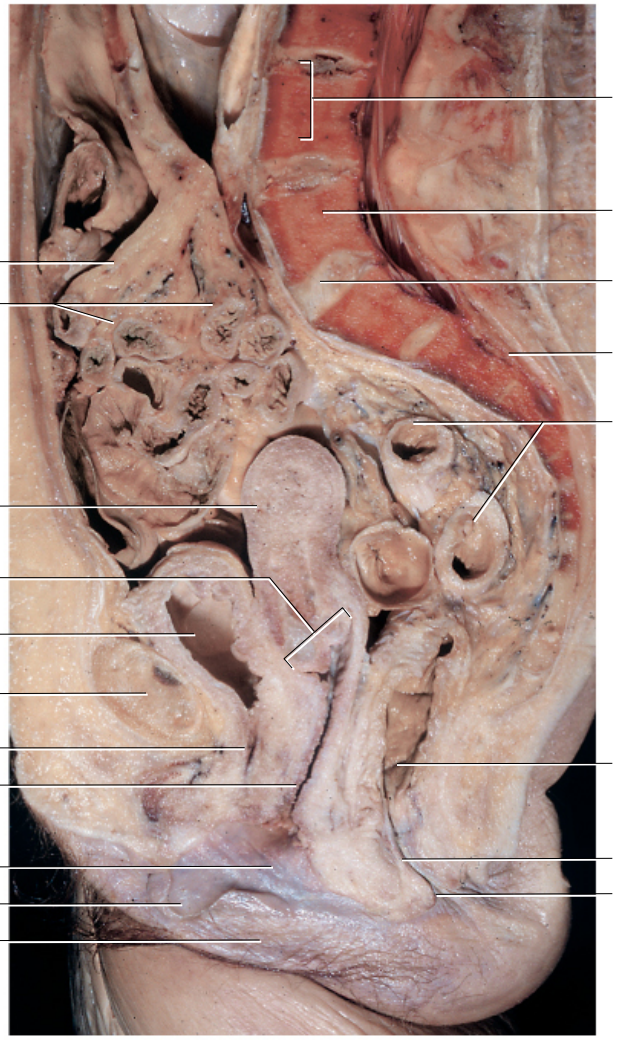


Figure A.22

(b) Female