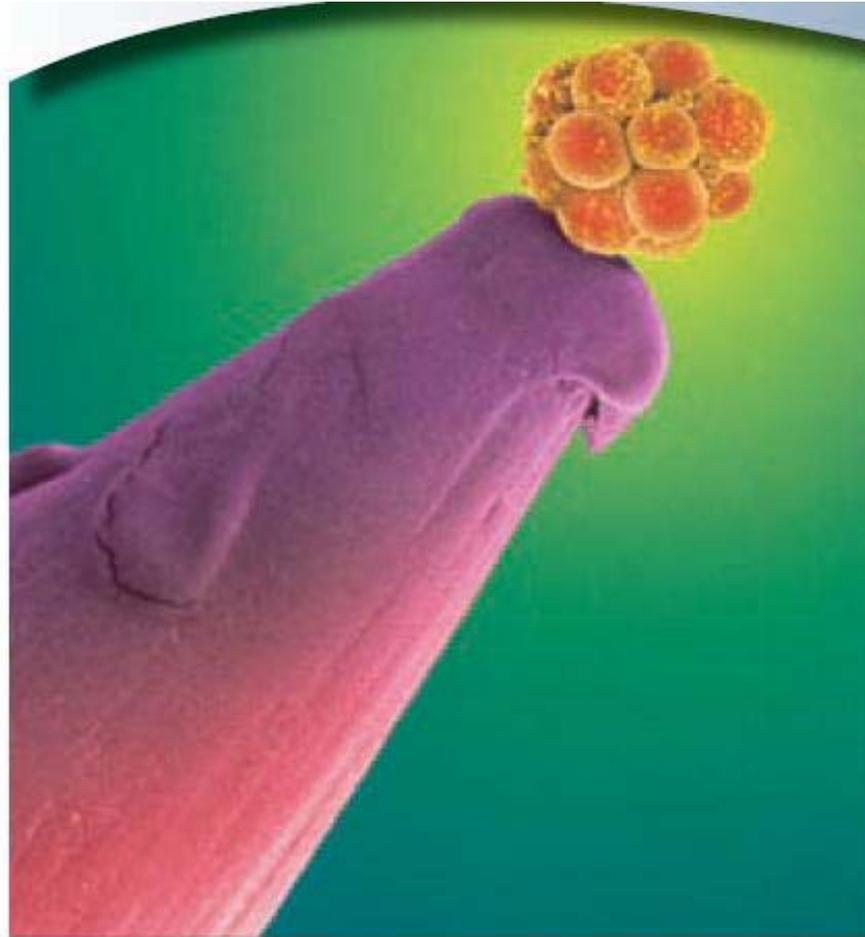


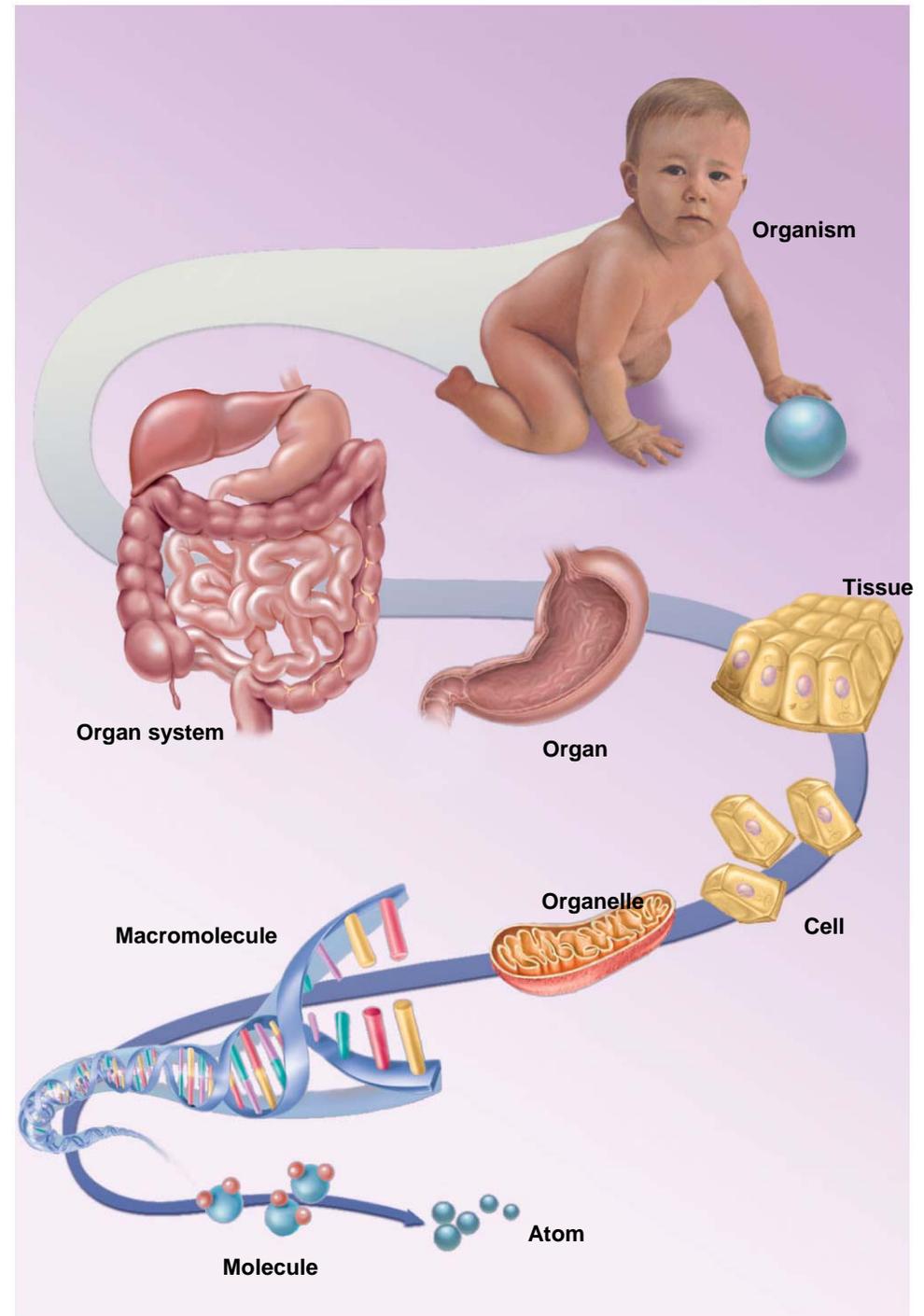
Chapter 1

Major Themes in A/P



Major Themes of Anatomy and Physiology

- Form and Function
- The Scientific Method
- Hierarchy of Complexity
- Homeostasis
- Regulation of Homeostasis
- Components of a Feedback Loop



Anatomy - The Study of Form (Structure)

- **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
 - analyze evolutionary trends

Anatomy - The Study of Form

- **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

Scientific Method

- **Francis Bacon**, in England, and **Rene Descartes**, in France
 - philosophers who invented **new habits of scientific thought** in 1600s
 - sought systematic way of seeking similarities, differences, and trends in nature
 - drawing useful generalizations from observable facts
 - How we solve problems.
 - How we find truth.

The Scientific Method

- **A Proof in Science Requires**
 - reliable observations
 - tested and confirmation // repeatedly
 - not falsified by any credible observation
- **In science, all truth is tentative // “proof beyond a reasonable doubt”**
- **Falsifiability // if we claim something is scientifically true, then we must be able to specify what evidence it would take to prove it wrong**
- **Scientific Method’s Goal // set standards for truth**
- **Two Different Approaches to the Scientific Method (See Next Slide Two Slides)**

Inductive Method

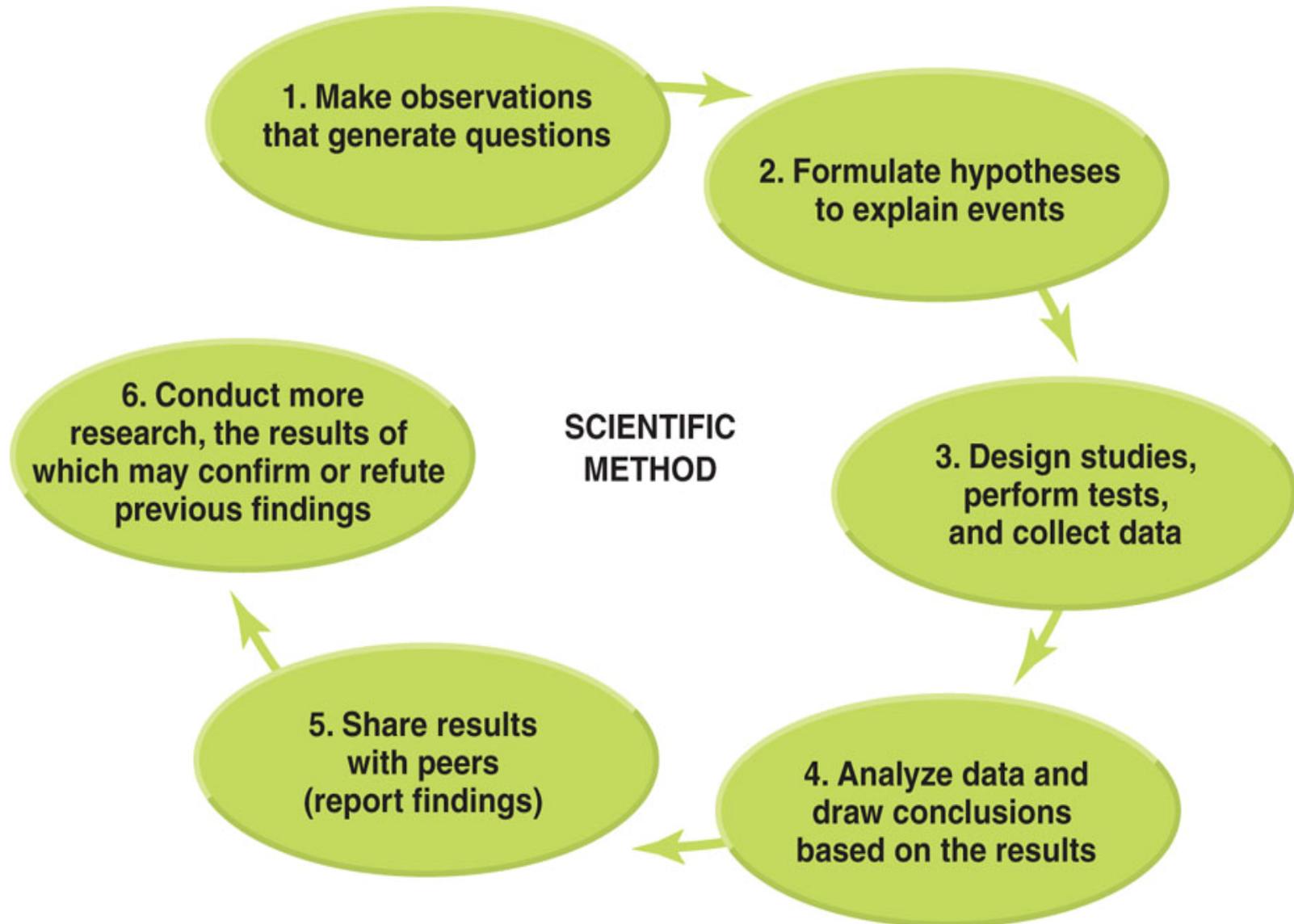
- Described by **Francis Bacon**
 - making numerous observations until one becomes confident in drawing generalizations and predictions from them
 - knowledge of anatomy obtained by this method

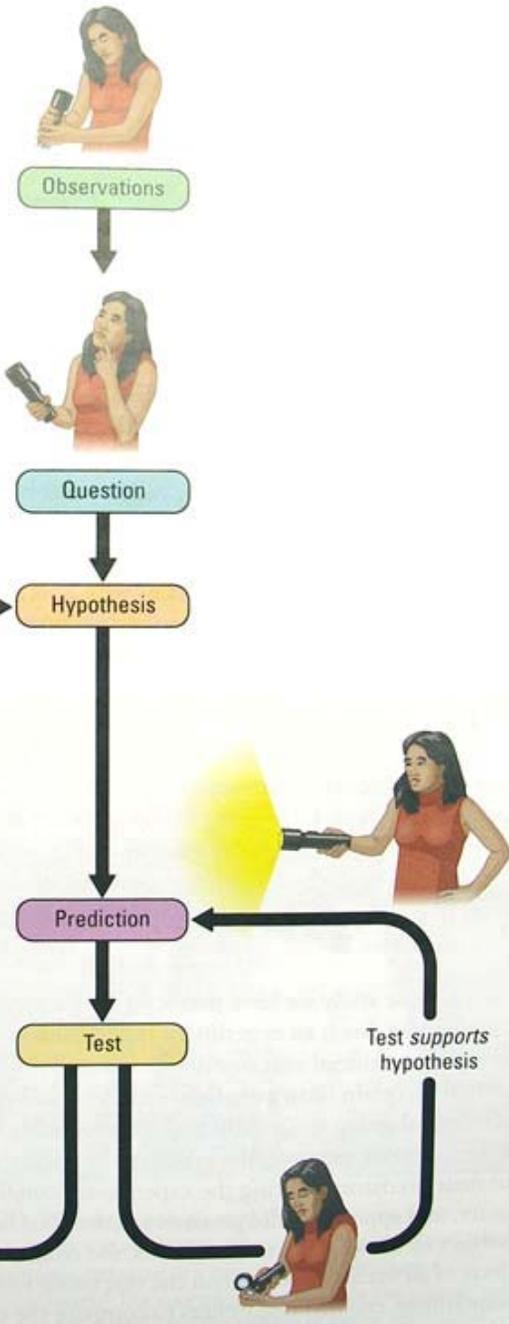
Hypothetico-Deductive Method

- **Physiological knowledge** gained by this method
- Quest for truth is guided by investigator's observation which leads to a **question**
- Investigator formulates a **hypothesis- an educated guess** // speculation or possible answer to the question
 - **characteristics of a good hypothesis**
 - consistent with what is already known
 - testable and possibly falsifiable with evidence
- **Hypothesis** - to suggest a method for answering questions /// written as 'If-Then' statements

Scientific Method / Deductive Method

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- Observation: My flashlight doesn't work.
- Question: What's wrong with my flashlight?
- Hypothesis: The flashlight's batteries are dead.
- Prediction: If I replace the batteries, the flashlight will work
- Experiment: I replace the batteries with new ones.
- Predicted Effect: The flashlight should work.

Facts, Laws and Theories

- **Scientific fact** // information that can be independently verified by a trained person
- **Law of nature**
 - generalization about the predictable way matter and energy behave (e.g. gravity)
 - results from inductive reasoning and repeated observations
 - written as verbal statements or mathematical formulae
- **Theory** // an explanatory statement or set of statements derived from facts, laws, and confirmed hypotheses (e.g. evolution)
 - summarizes what we know
 - suggests direction for further study

People who do not study science often misuse common scientific terms. This includes our policy-makers. This ignorance often makes communication between scientist and policy makers confusing and all too often results unfortunately in bad public policy.

Case Study

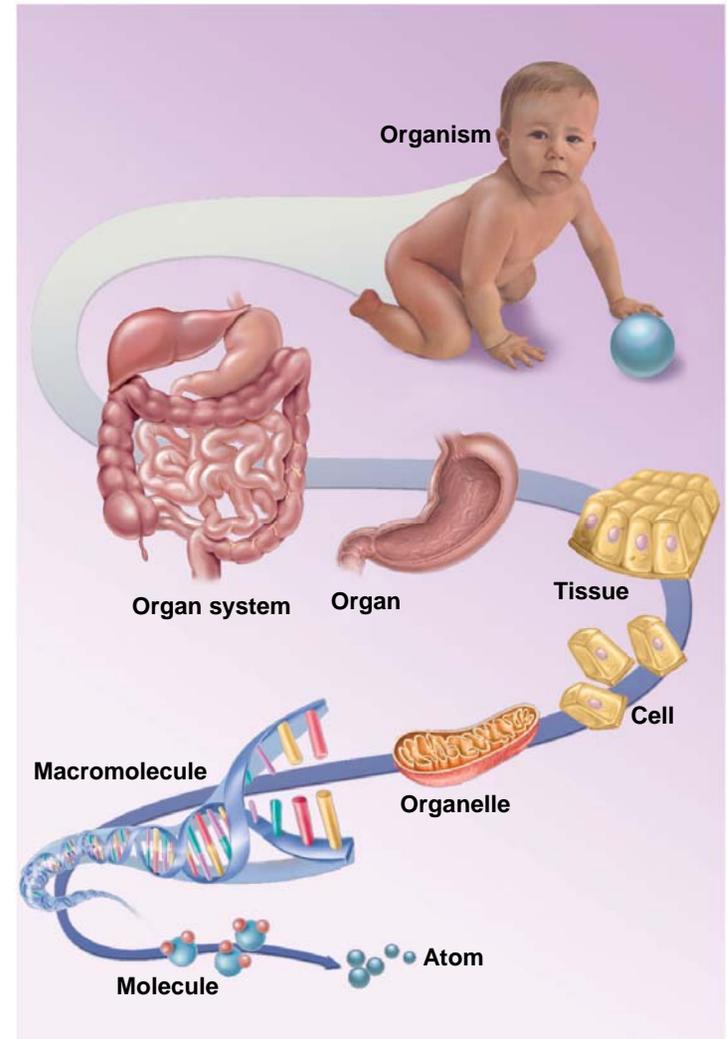
What is Evolution?

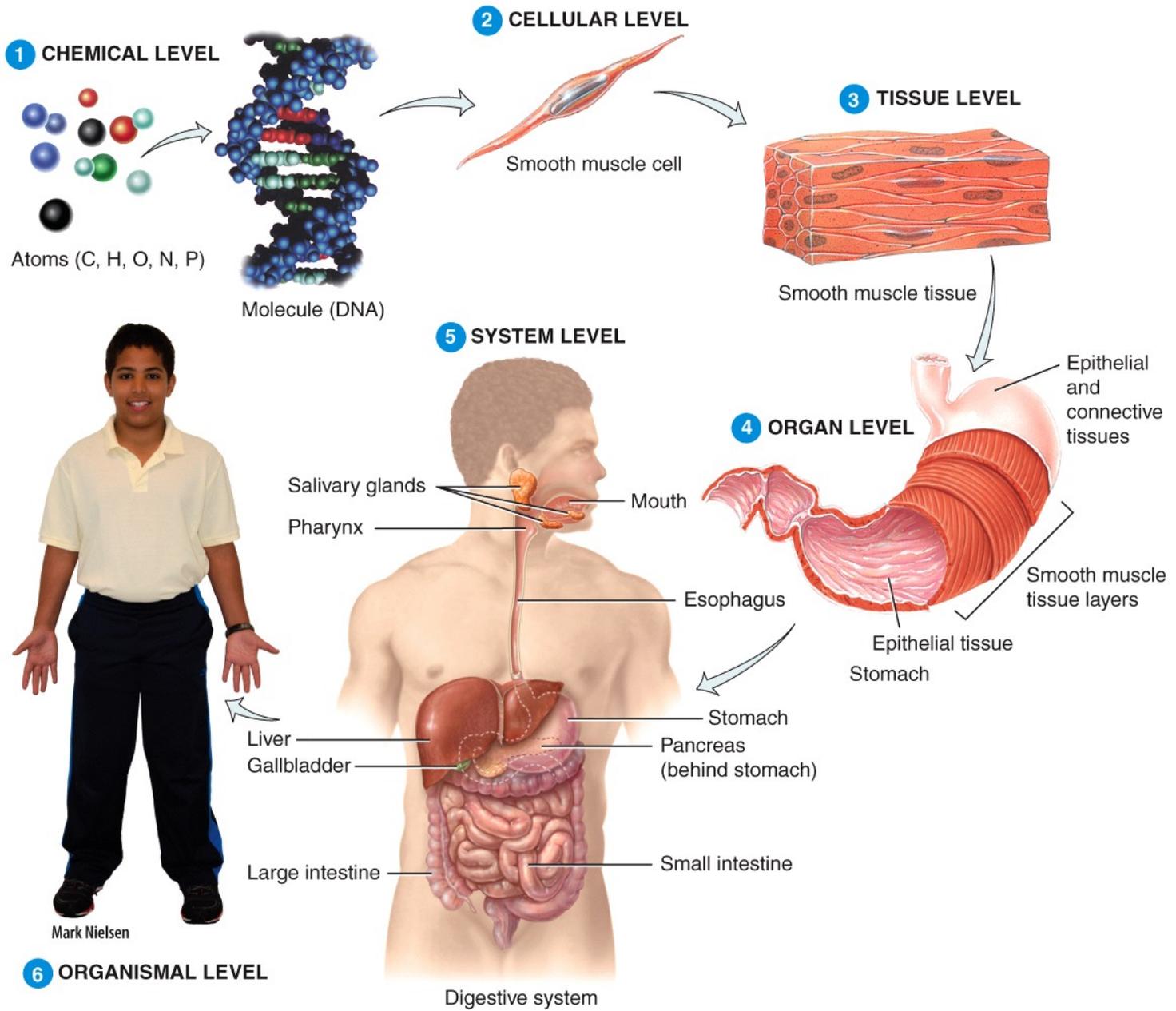
Is it a hypothesis or a theory?

What is Creationism? (a theory or a belief system)

Hierarchy of Complexity

- **Organism** is composed of **organ systems**
- **Organ Systems** composed of **organs**
- **Organs** composed of **tissues**
- **Tissues** composed of **cells**
- **Cells** composed of **organelles**
- **Organelles** composed of **macromolecules**
- **Macromolecules** composed of **molecules**
- **Molecules** composed of **atoms**

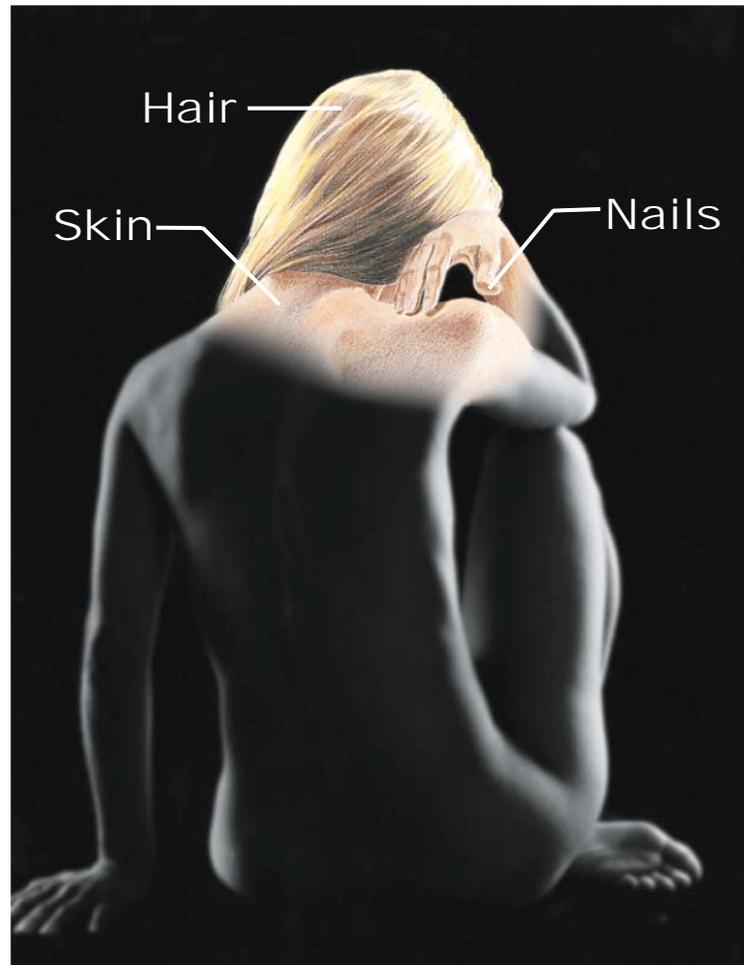




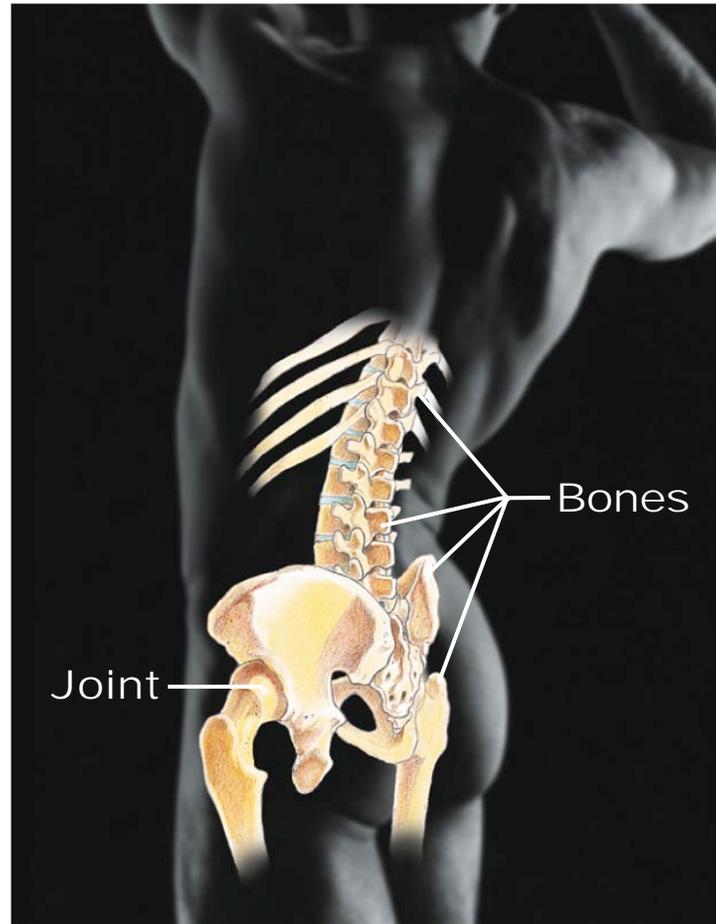
Hierarchy of Complexity

- **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 of matter with unique chemical identities

The body's organ systems and their major functions.

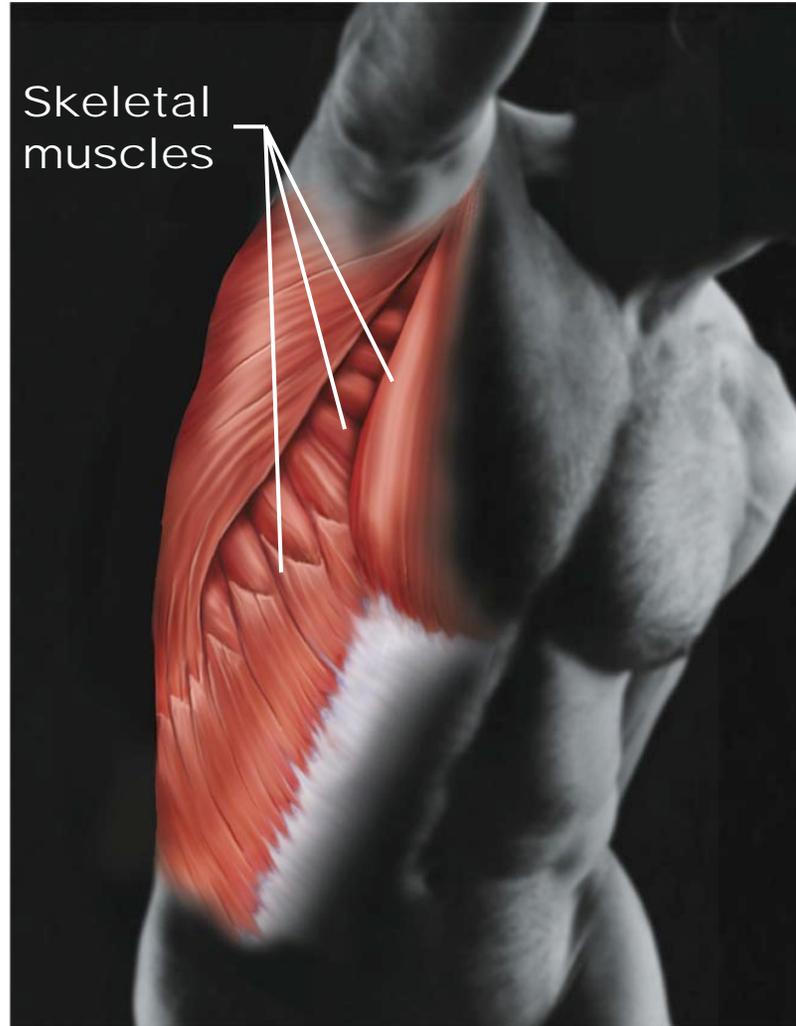


(a) Integumentary System
Forms the external body covering, and protects deeper tissues from injury. Synthesizes vitamin D, and houses cutaneous (pain, pressure, etc.) receptors and sweat and oil glands.

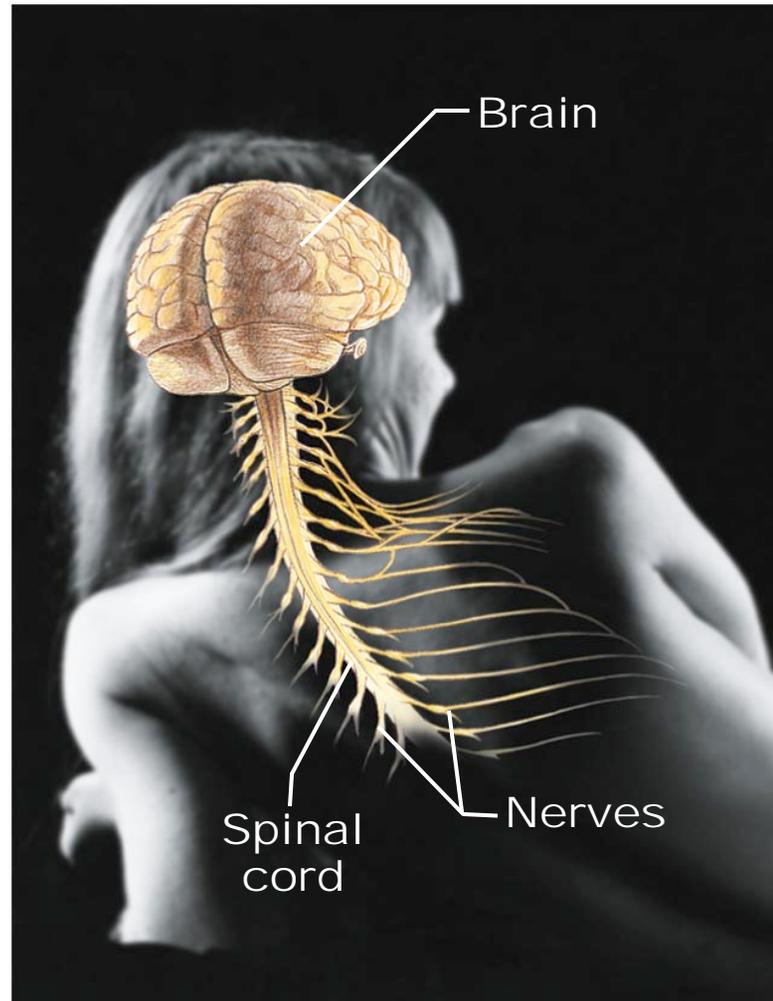


(b) Skeletal System

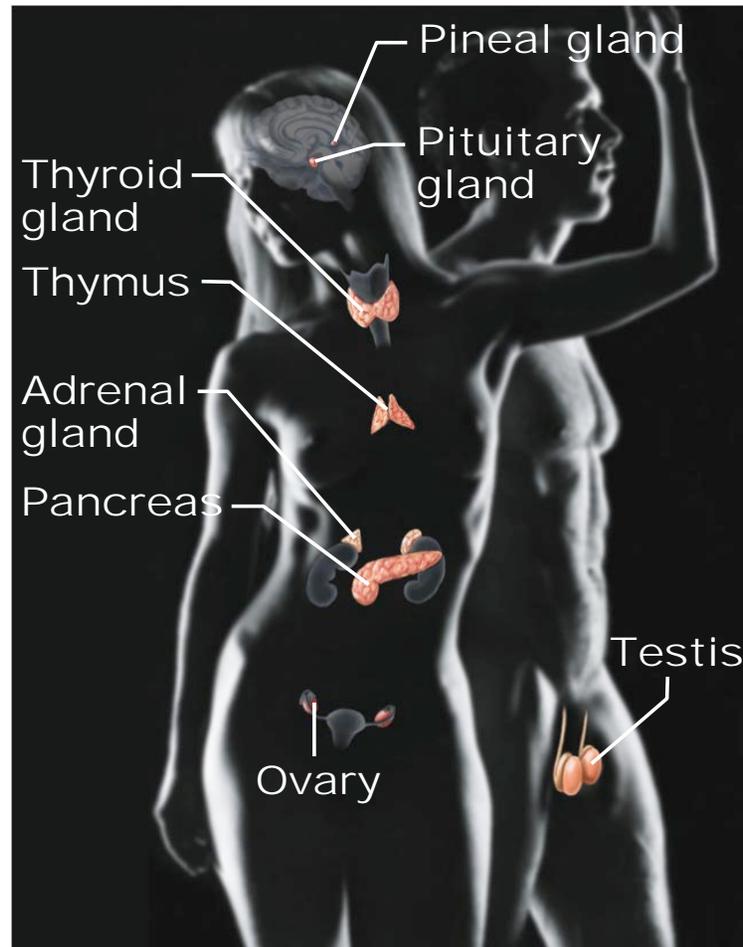
Protects and supports body organs, and provides a framework the muscles use to cause movement. Blood cells are formed within bones. Bones store minerals.



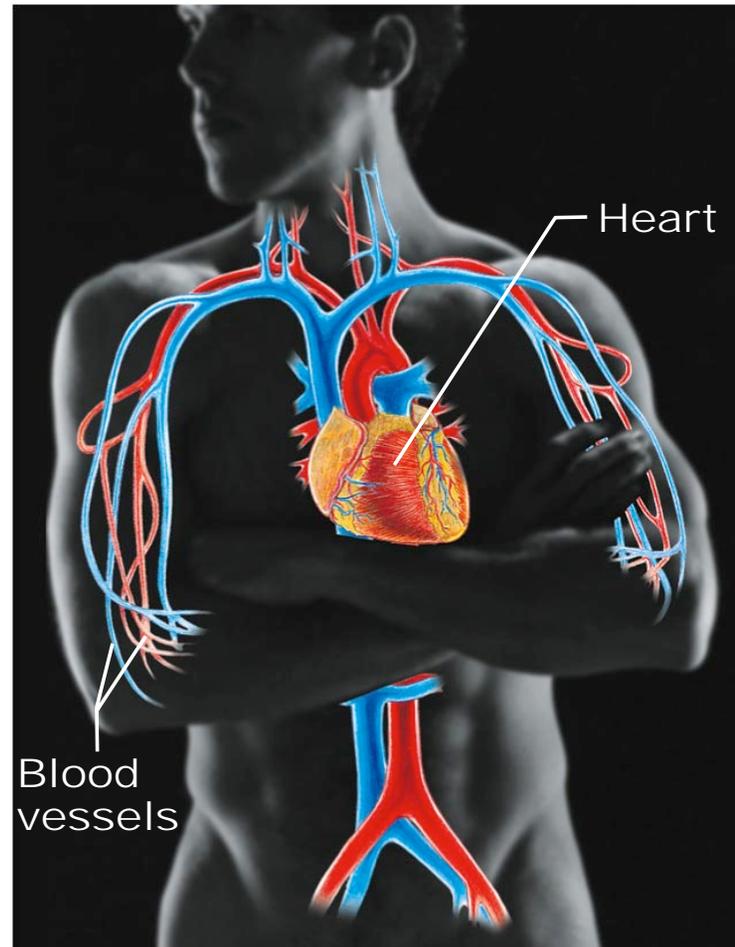
(c) Muscular System
**Allows manipulation of the environment,
locomotion, and facial expression.
Maintains posture, and produces heat.**



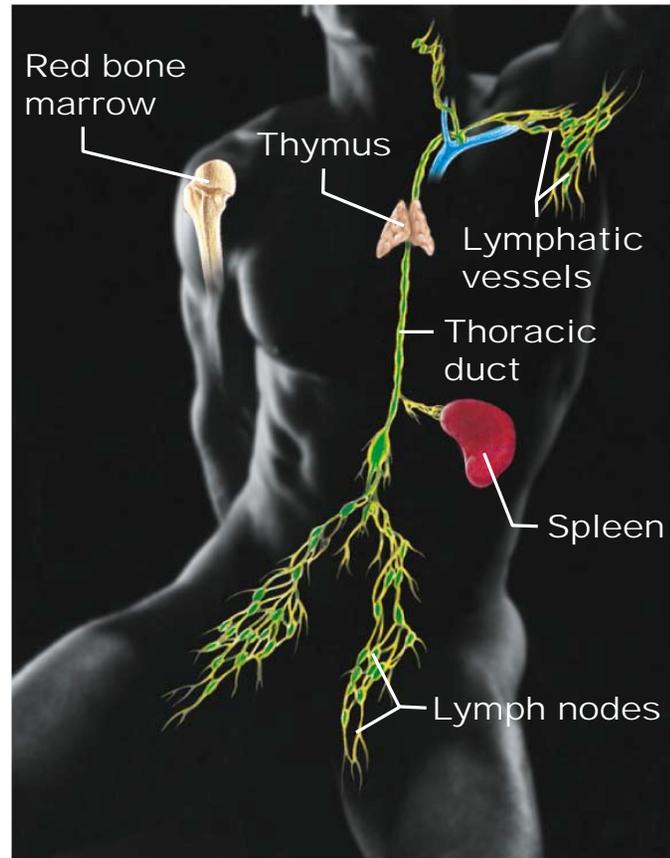
- (d) Nervous System**
As the fast-acting control system of the body, it responds to internal and external changes by activating appropriate muscles and glands.



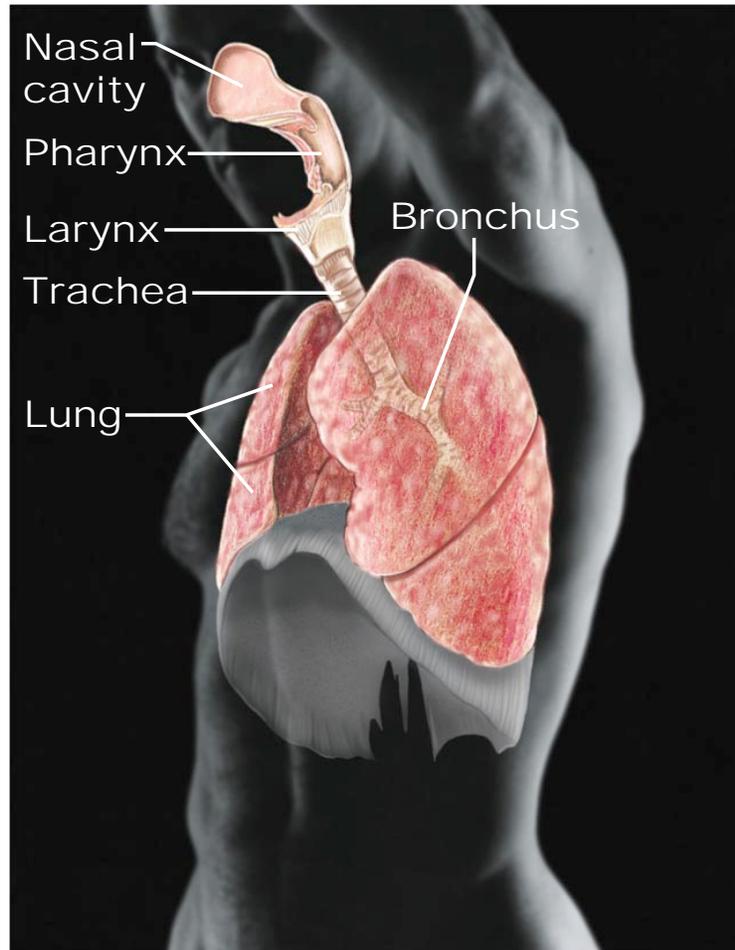
(e) Endocrine System
Glands secrete hormones that regulate processes such as growth, reproduction, and nutrient use (metabolism) by body cells.



- (f)** Cardiovascular System
Blood vessels transport blood, which carries oxygen, carbon dioxide, nutrients, wastes, etc. The heart pumps blood.

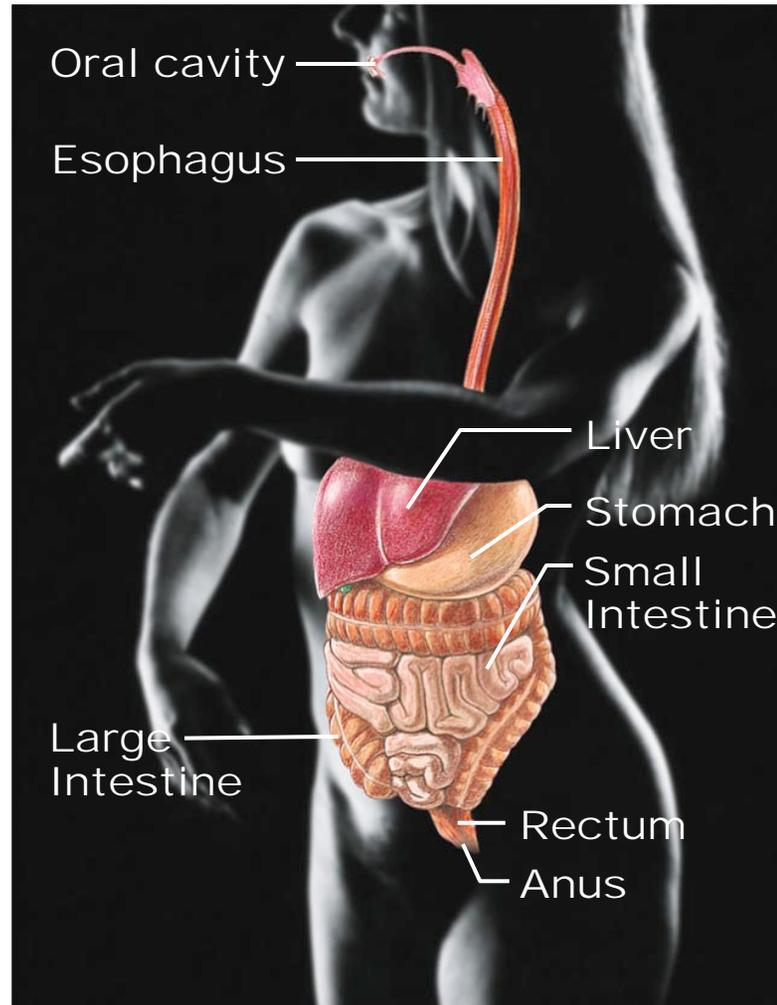


(g) Lymphatic System/Immunity
Picks up fluid leaked from blood vessels and returns it to blood. Disposes of debris in the lymphatic stream. Houses white blood cells (lymphocytes) involved in immunity. The immune response mounts the attack against foreign substances within the body.

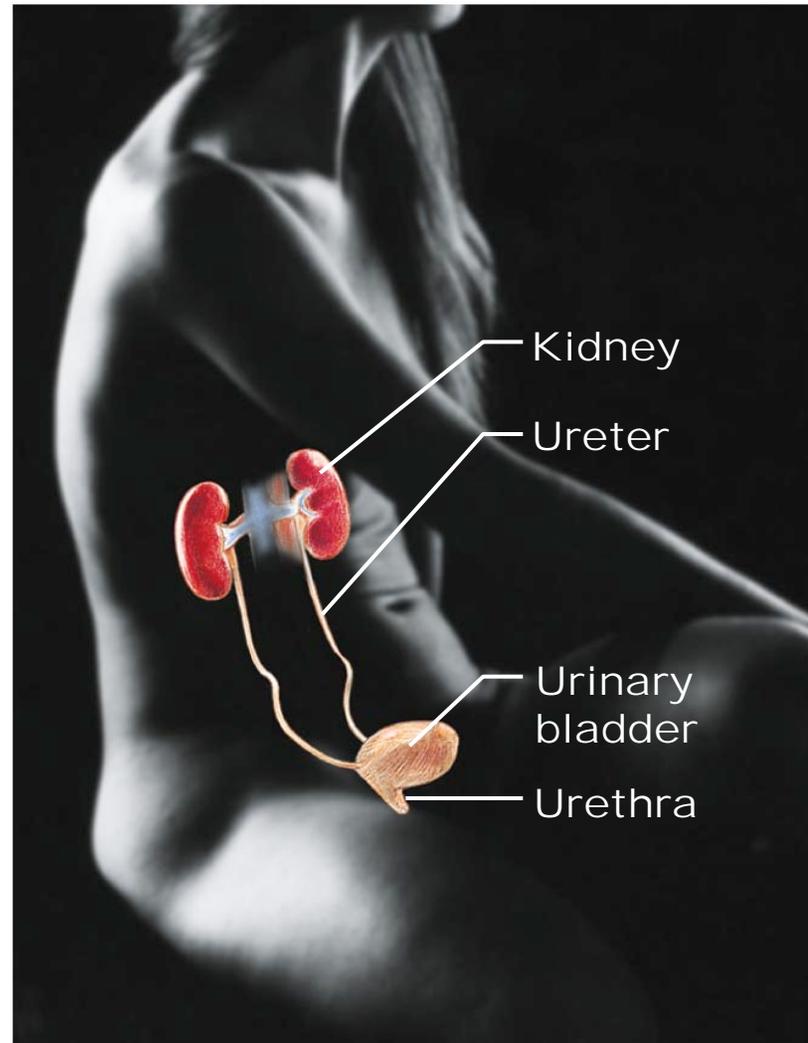


(h) Respiratory System

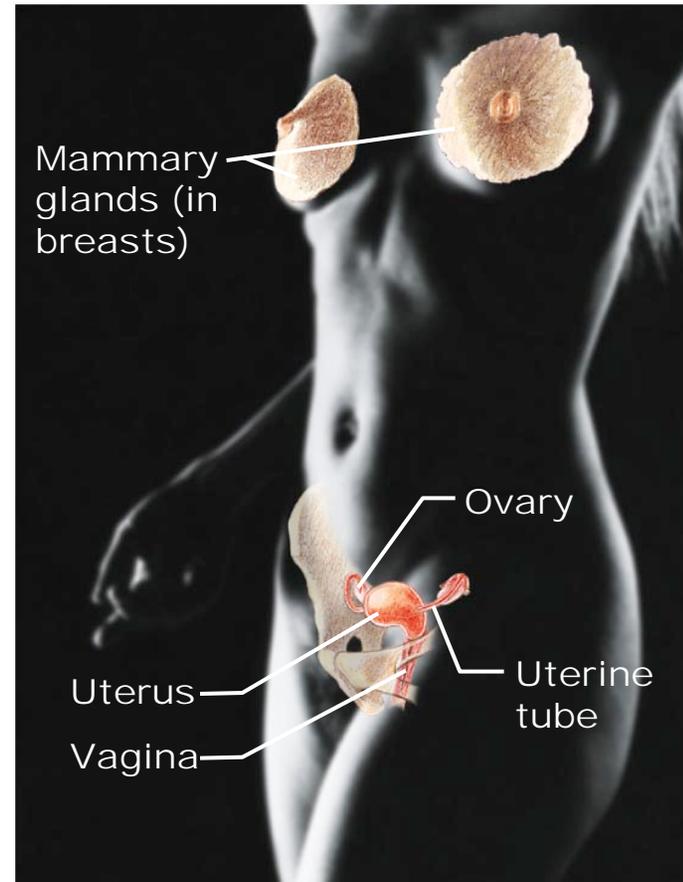
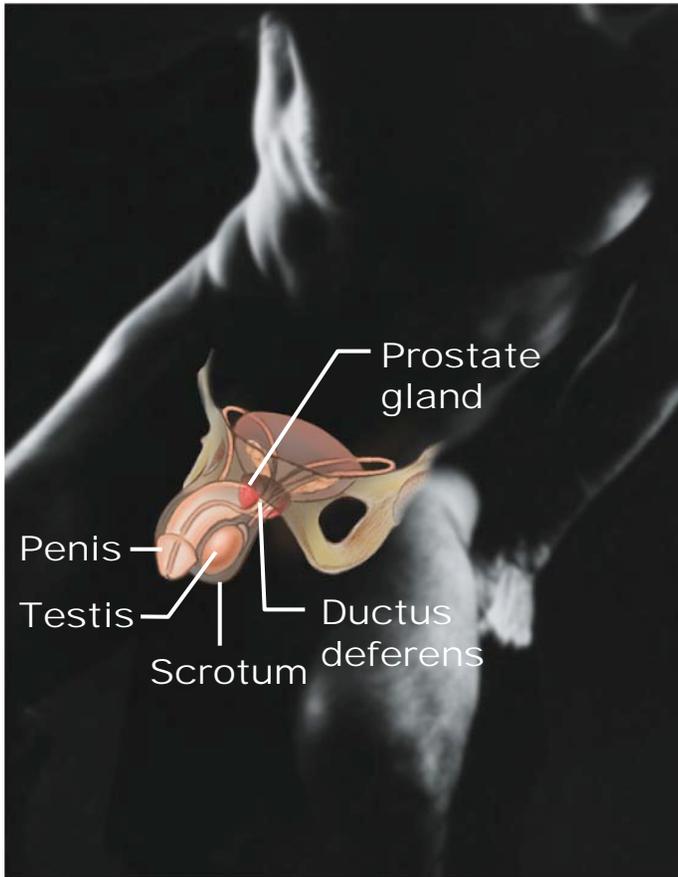
Keeps blood constantly supplied with oxygen and removes carbon dioxide. The gaseous exchanges occur through the walls of the air sacs of the lungs.



- (i) Digestive System**
Breaks down food into absorbable units that enter the blood for distribution to body cells. Indigestible foodstuffs are eliminated as feces.



- (j)** Urinary System
Eliminates nitrogenous wastes from the body. Regulates water, electrolyte and acid-base balance of the blood.



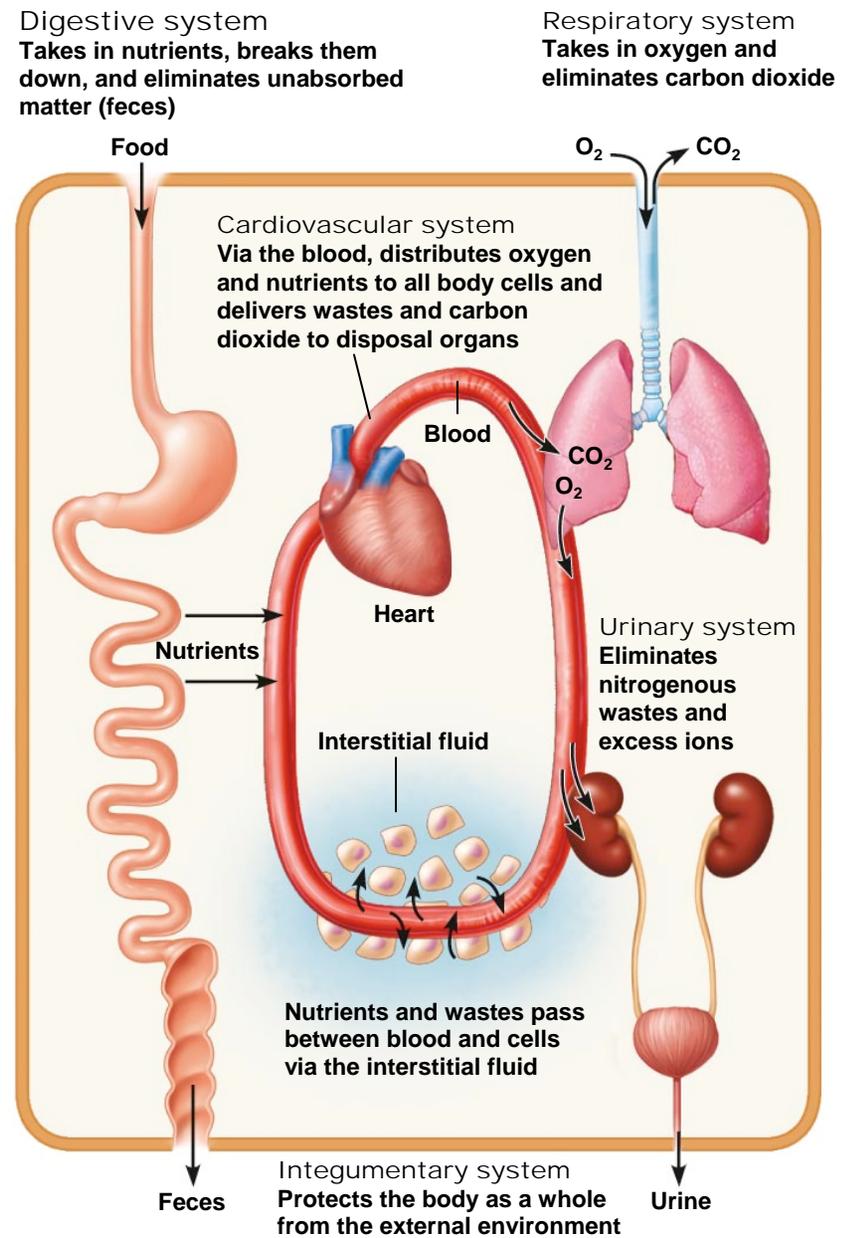
(k) Male Reproductive System

Overall function is production of offspring. Testes produce sperm and male sex hormone, and male ducts and glands aid in delivery of sperm to the female reproductive tract. Ovaries produce eggs and female sex hormones. The remaining female structures serve as sites for fertilization and development of the fetus. Mammary glands of female breasts produce milk to nourish the newborn.

(l) Female Reproductive System

Overall function is production of offspring. Testes produce sperm and male sex hormone, and male ducts and glands aid in delivery of sperm to the female reproductive tract. Ovaries produce eggs and female sex hormones. The remaining female structures serve as sites for fertilization and development of the fetus. Mammary glands of female breasts produce milk to nourish the newborn.

Examples of interrelationships among body organ systems.



Two Different Ways to Look at the Hierarchy of Complexity

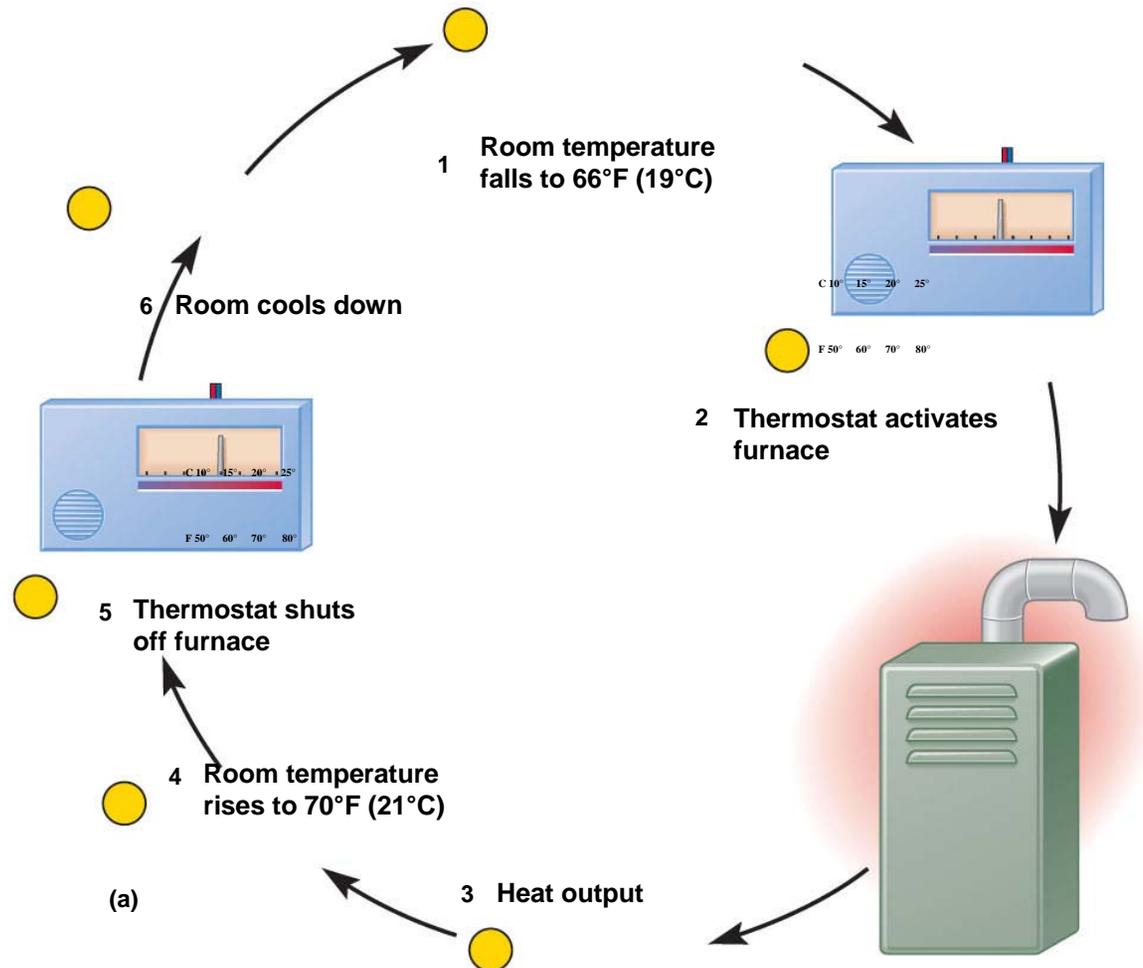
- Reductionism
 - theory that a large, complex system such as the human body can be understood by studying its simpler components
 - first espoused by Aristotle
 - highly productive approach
 - essential to scientific thinking
- Holism
 - there are ‘emergent properties’ of the whole organism that cannot be predicted from the properties of the separate parts
 - humans are more than the sum of their parts
 - complementary theory to reductionism

Homeostasis

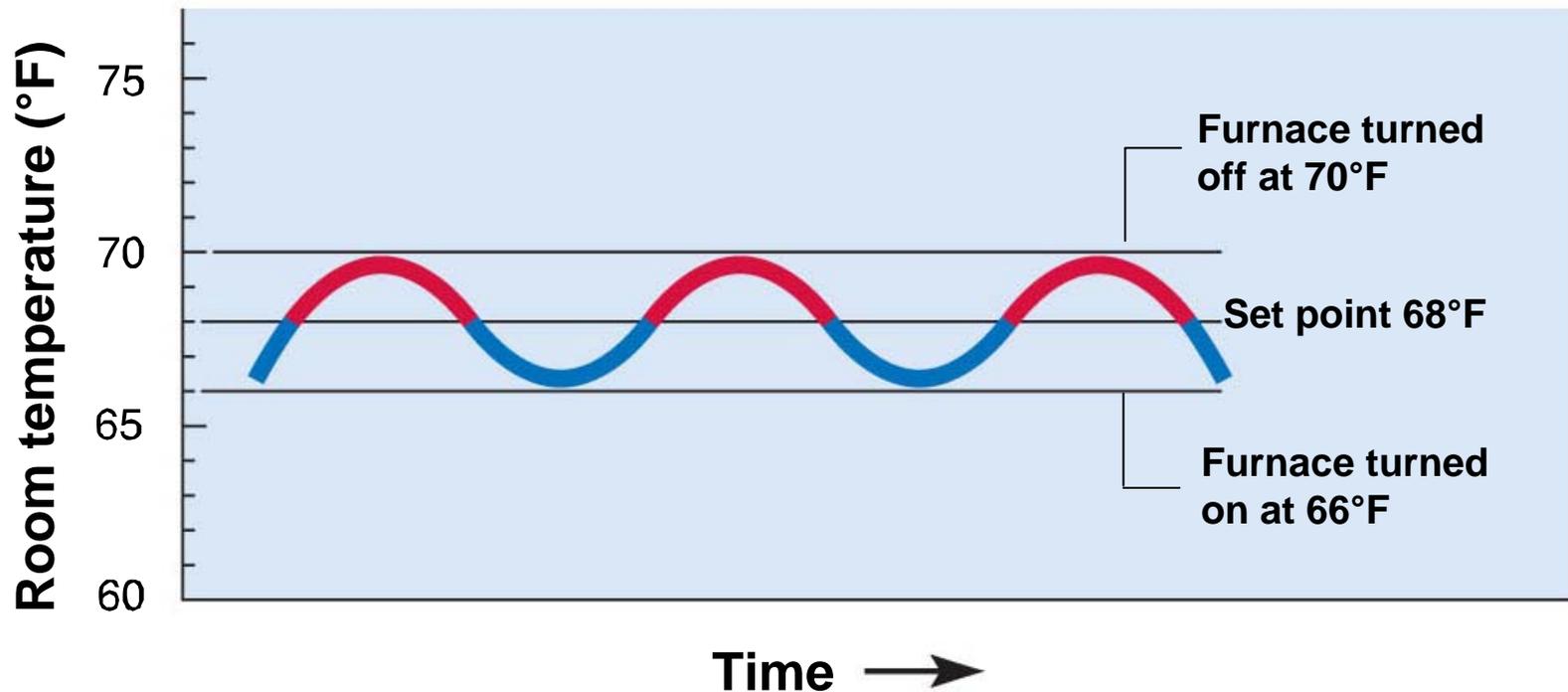
- **Homeostasis** – the body’s ability to detect change, activate mechanisms that oppose it, and thereby maintain relatively **stable internal conditions**
- **Claude Bernard (1813-78)**
 - constant internal conditions regardless of external conditions /// internal body temperature ranges from 97 to 99 degrees F (38 C) 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 mechanisms** 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**

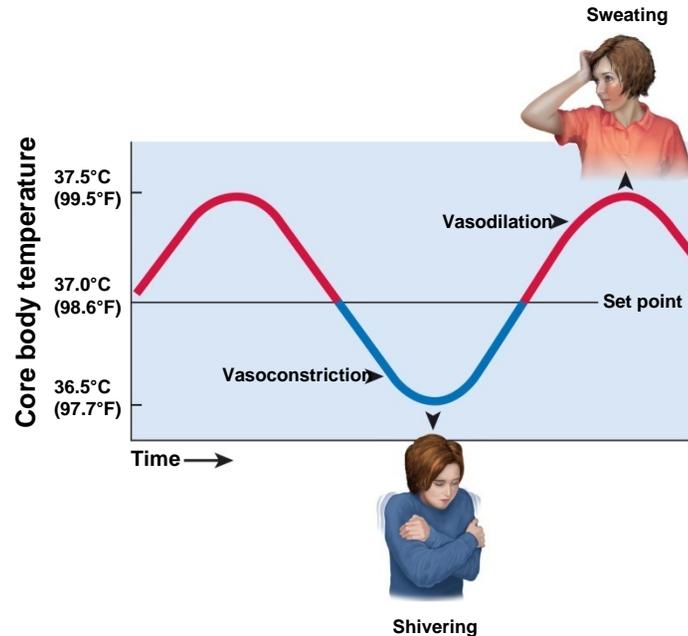


Negative Feedback, Set Point



- Room temperature does not stay at set point of 68 degrees -- it only averages 68 degrees
- Similar graph for blood glucose concentration over time (70 to 100 mg/dl blood sugar vs time)

Negative Feedback in Human Thermoregulation

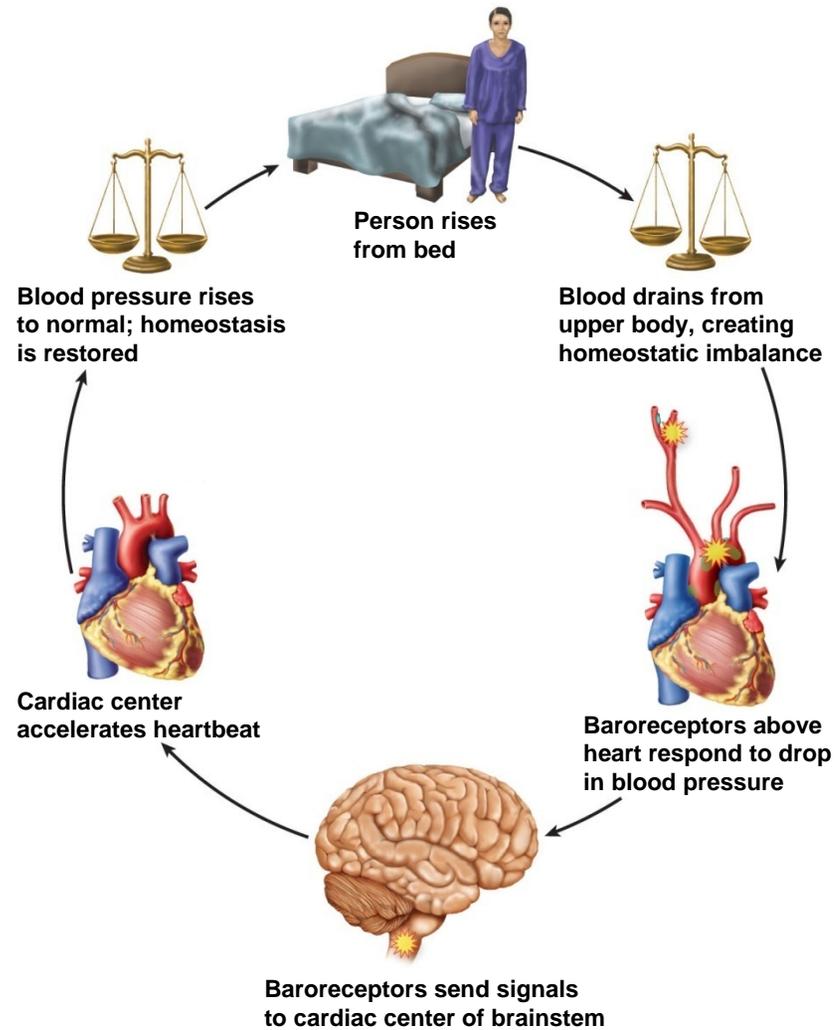


- **Brain senses change in blood temperature**
 - if too warm, vessels dilate (**vasodilation**) in the skin and sweating begins (heat losing mechanisms)
 - if too cold, vessels in the skin constrict (**vasoconstriction**) and shivering begins (heat gaining mechanism)

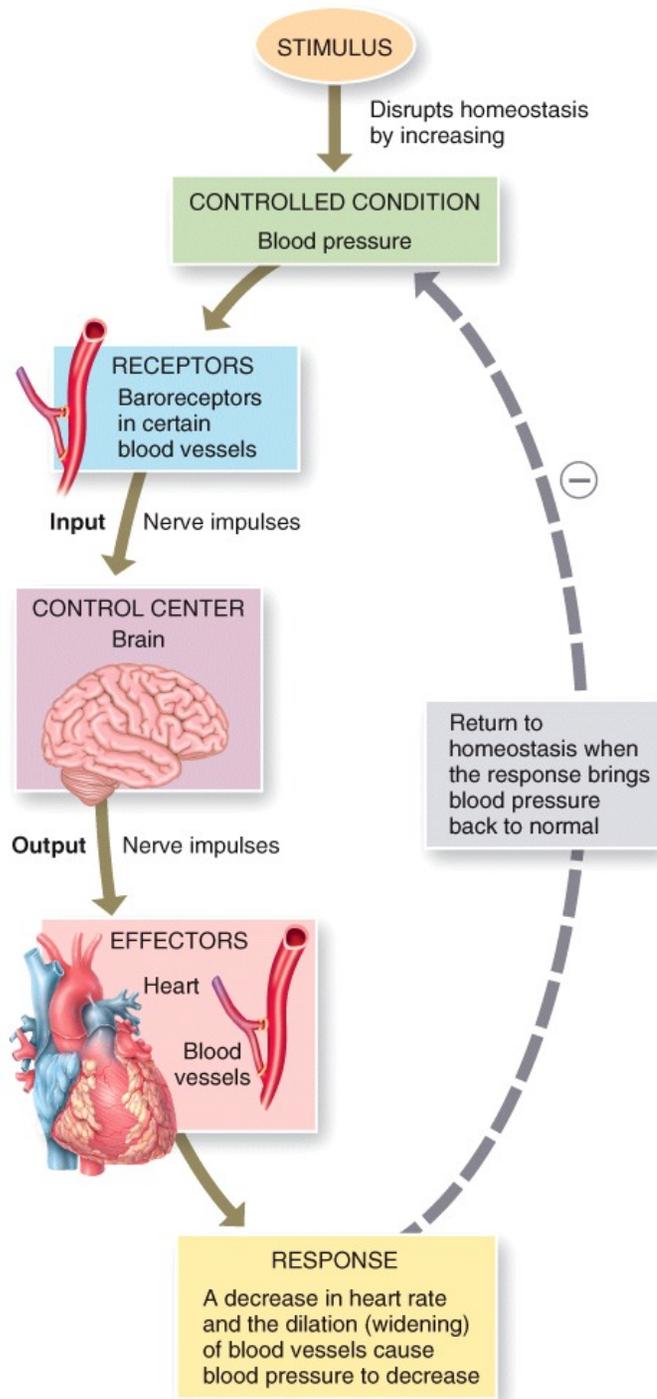
Negative Feedback Control of Blood Pressure

- 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 feedback loop may produce dizziness in the elderly

Control of Blood Pressure

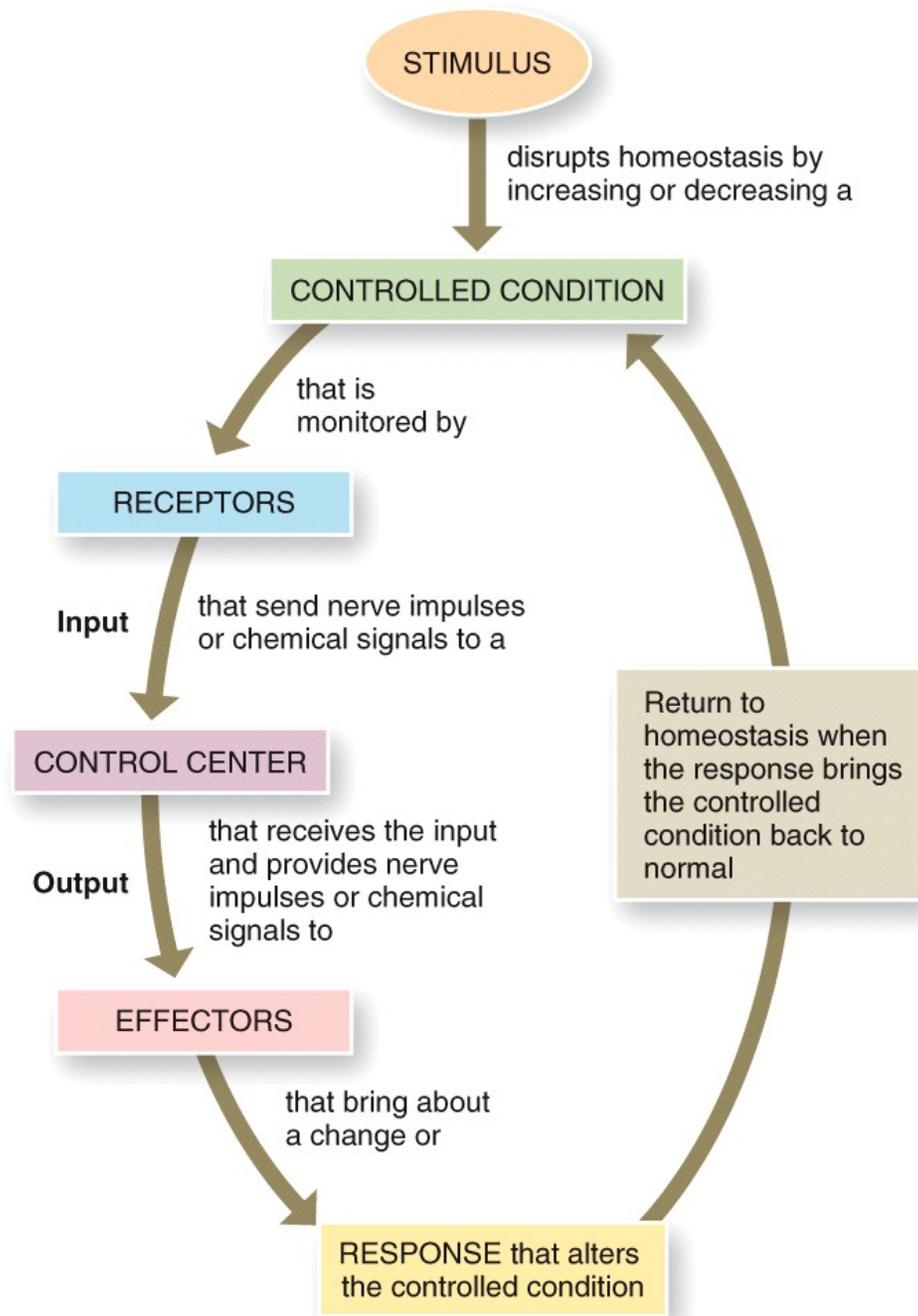


Negative Feedback



3 Components of a Feedback Loop

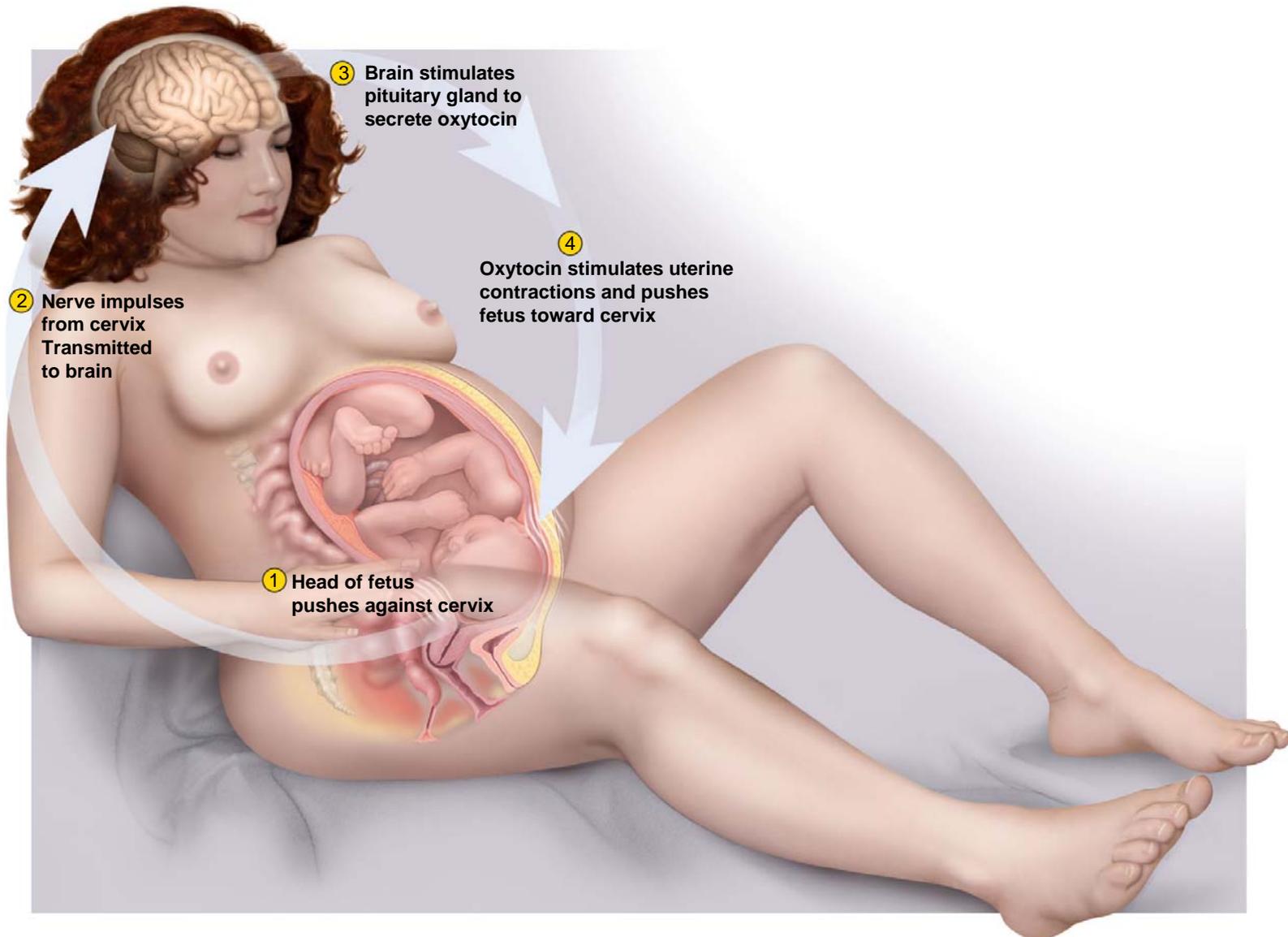
- **Receptor** - senses change in the body
- **Integrating Center (Control Center)** - control center that processes the sensory information, 'makes a decision', and directs the response
- **Effector** – carries out the final corrective action to restore homeostasis



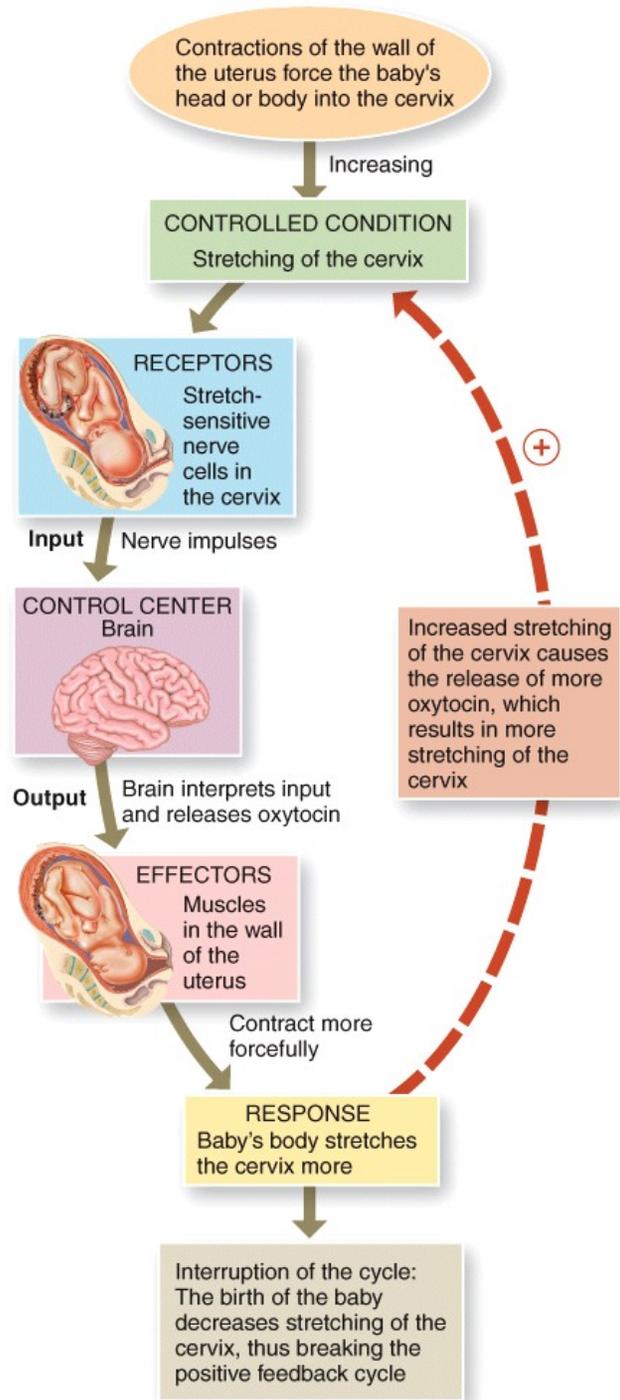
Positive Feedback Loops

- **Not a common mechanism**
- **Self-amplifying cycle**
 - leads to greater change in the same direction
 - feedback loop is repeated – change produces more change // potentially very dangerous!!!
- **Normal way of producing rapid changes**
 - occurs with childbirth, blood clotting, protein digestion, fever, and generation of nerve signals

Positive Feedback Loops



Positive Feedback



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

Human Origins & Adaptations

- **Charles Darwin**

- *On the Origin of Species by Means of Natural Selection* (1859) – ‘book that shook the world’
- *The Ascent of Man* (1871) – human evolution

- **The Theory of Natural Selection**

- how species originate and change through time
- changed view of “our origin, our nature and our place in the universe”
- increases understanding of human form and function

Evolution & Natural Selection

- **Evolution** = change in genetic composition in a population of an organisms over time
 - development of bacterial resistance to antibiotics
 - appearance of new strains of AIDS virus
- **Natural Selection** // some individuals within a species have hereditary advantage over their competitors
 - better camouflage // disease resistance // ability to attract mates
 - e.g. polar bears vs brown bears // wolf vs dog
- produce more offspring, genes more likely to be passed on to next generation
- **Selection Pressures** – natural forces that promote the reproductive success of some individuals more than others // adaptation

Analyzing Medical Terms

- Terminology based on word elements
 - lexicon of 400 word elements on the inside of 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

TABLE 1.2

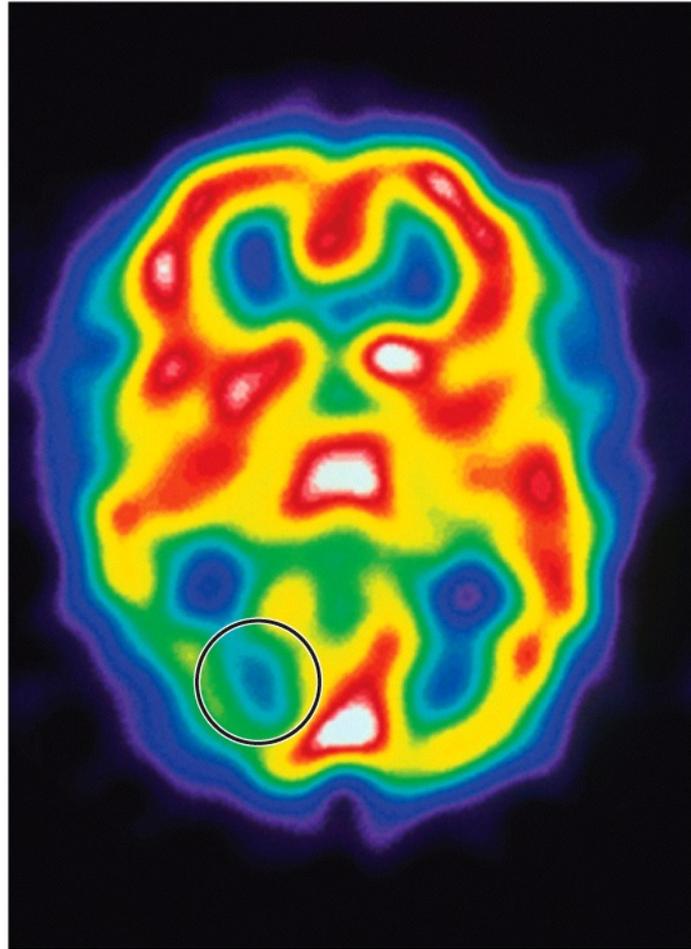
Singular and Plural Forms of Some Noun Terminals

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

**Useful Tables
in Textbook**

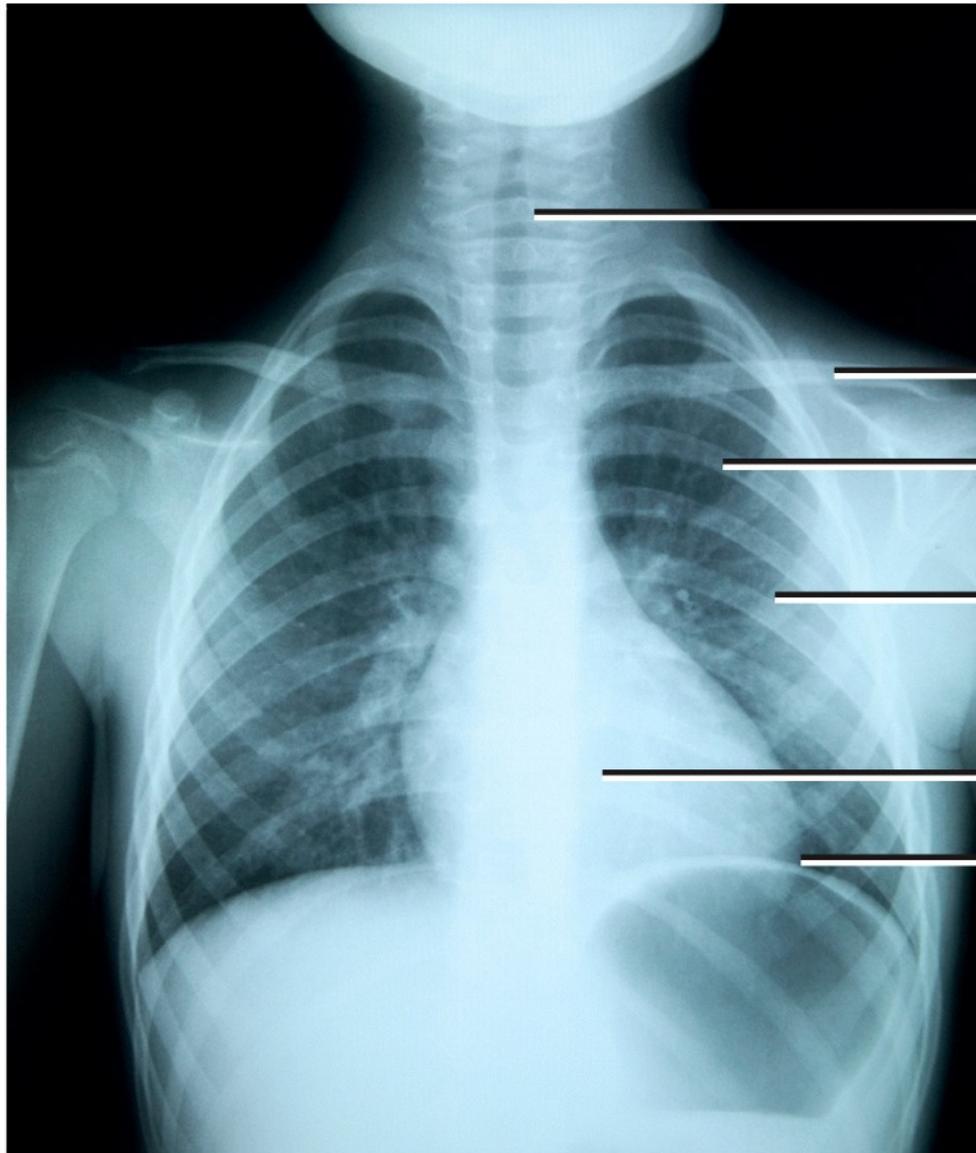
Imaging Technology

Not Learning Objectives



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)



Vertebral
column

Left clavicle

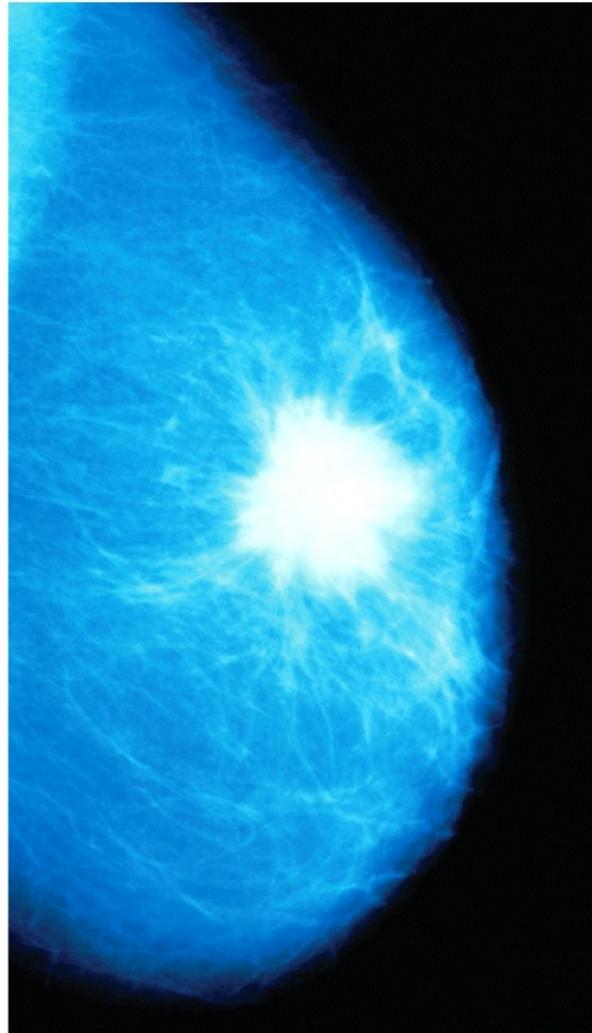
Left rib

Left lung

Heart

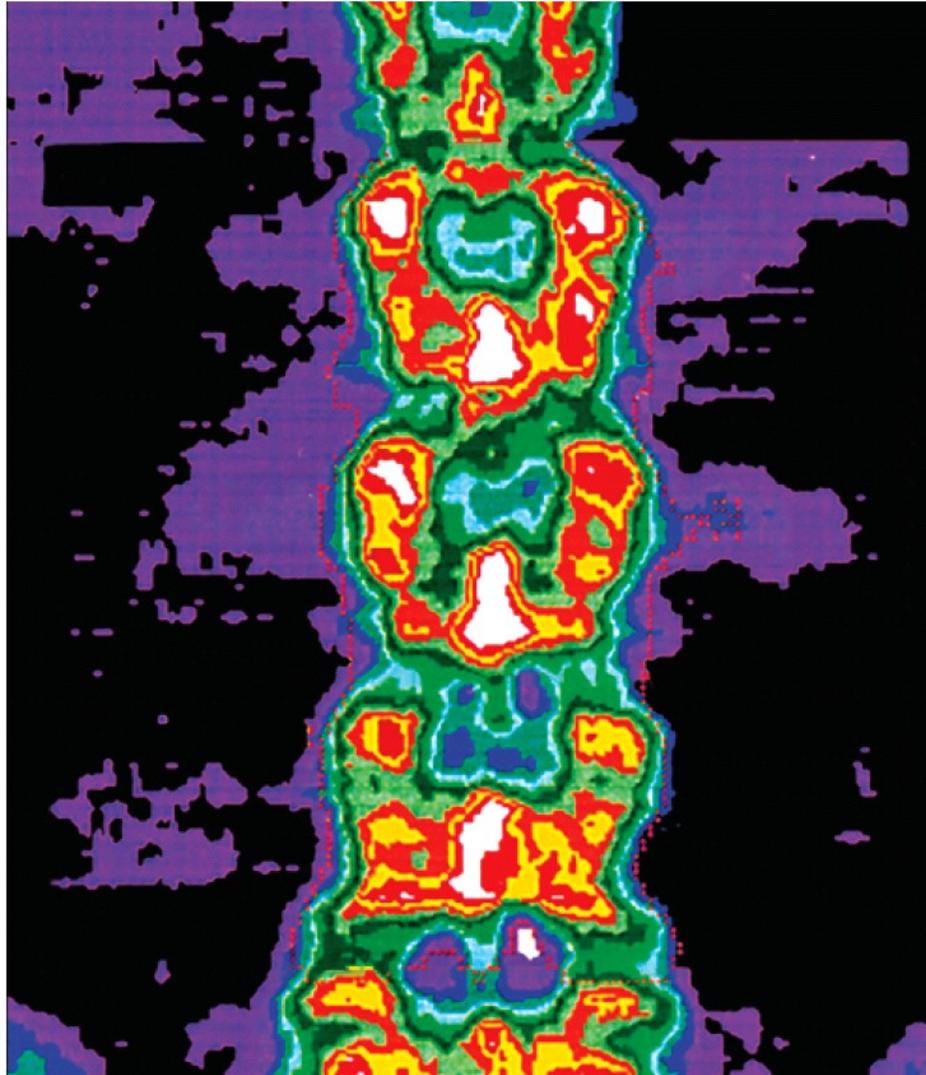
Diaphragm

Radiograph of thorax in anterior view



Breast Cancer Unit, Kings College Hospital, London/Photo Researchers, Inc.

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



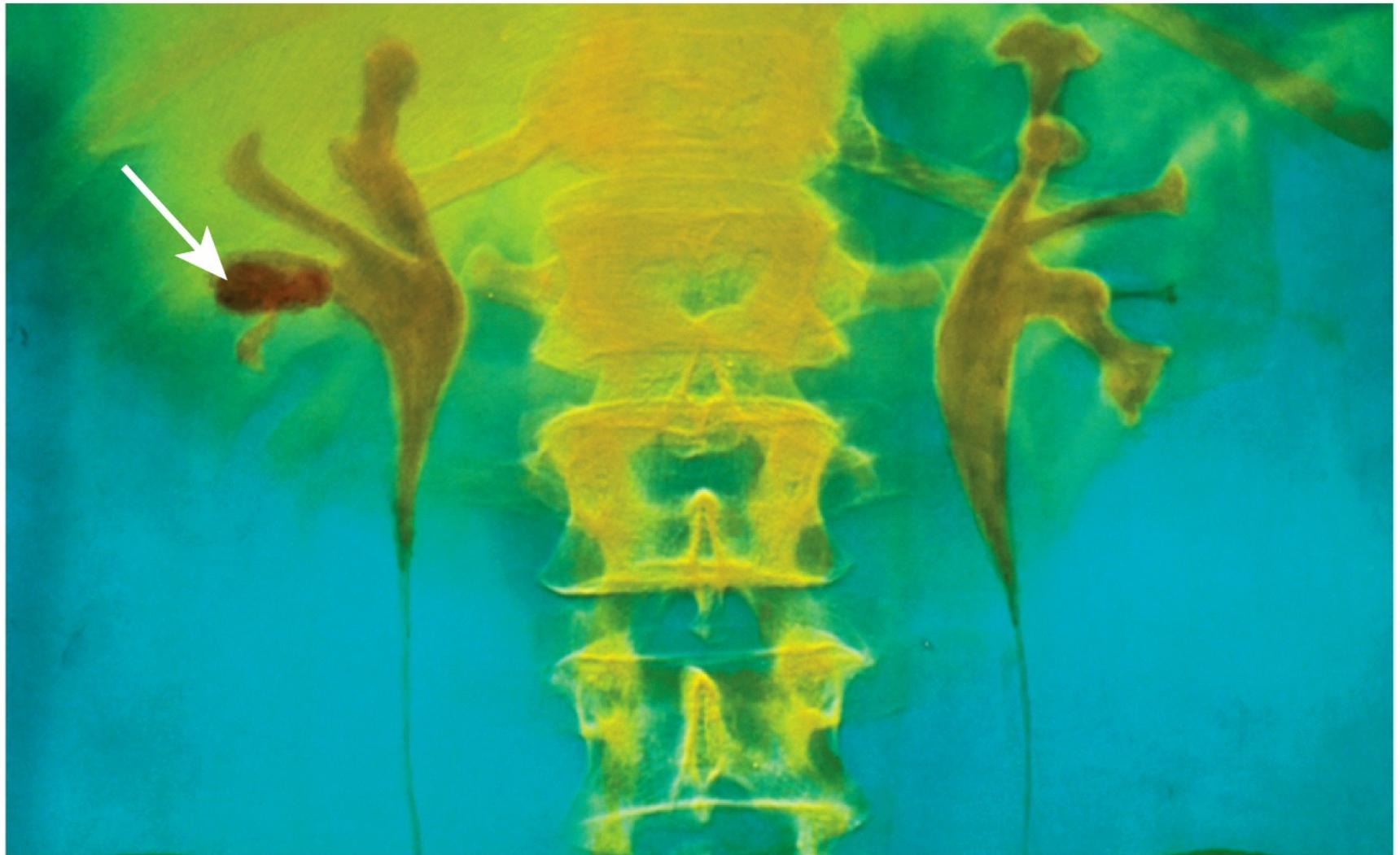
Zephyr/Photo Researchers, Inc.

Bone densitometry scan of lumbar spine in anterior view



Cardio-Thoracic Centre, Freeman Hospital, Newcastle-Upon-Tyne/Photo Researchers, Inc.

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

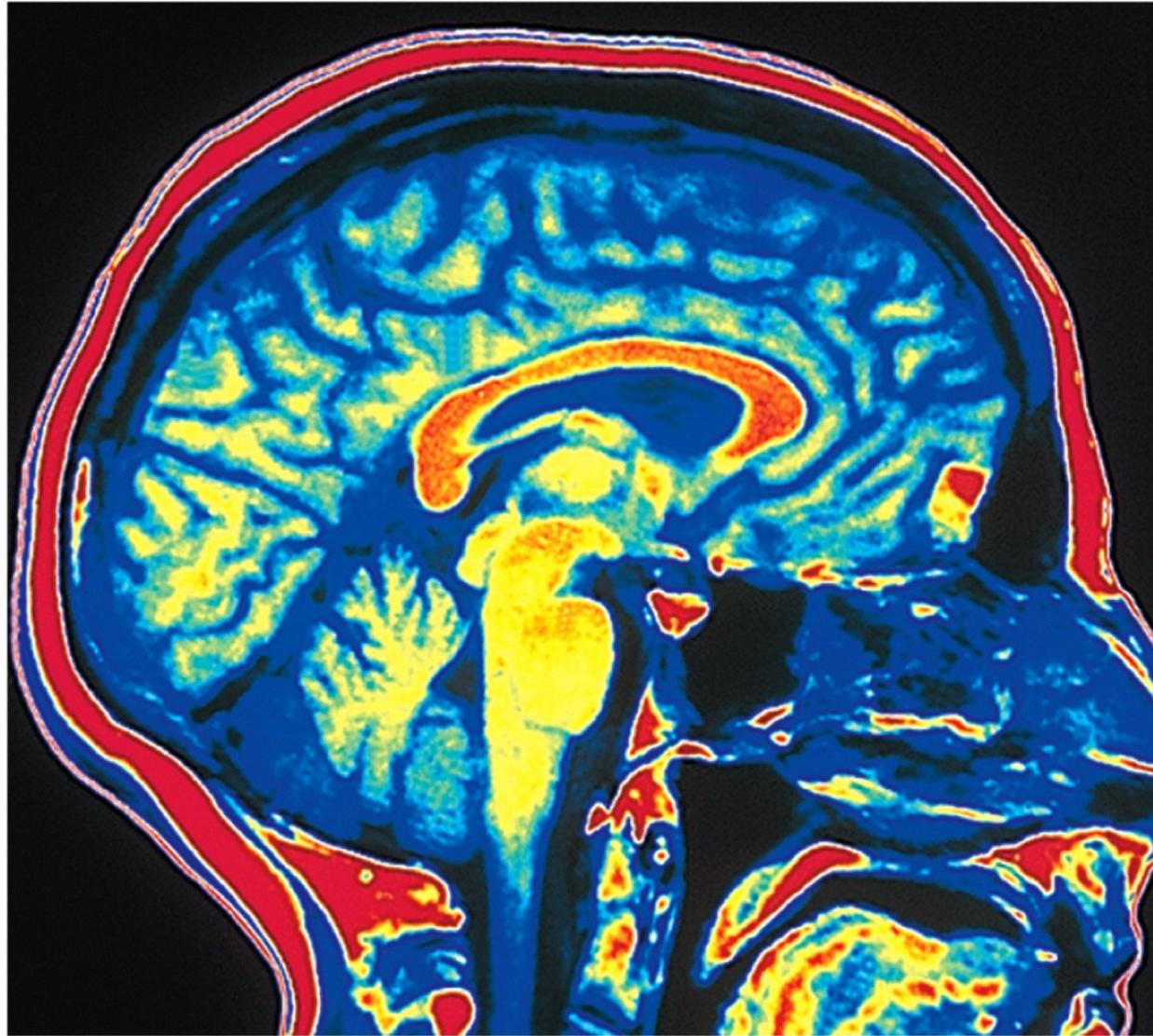


Intravenous urogram showing kidney stone (arrow) in right kidney



Science Photo Library/Photo Researchers, Inc.

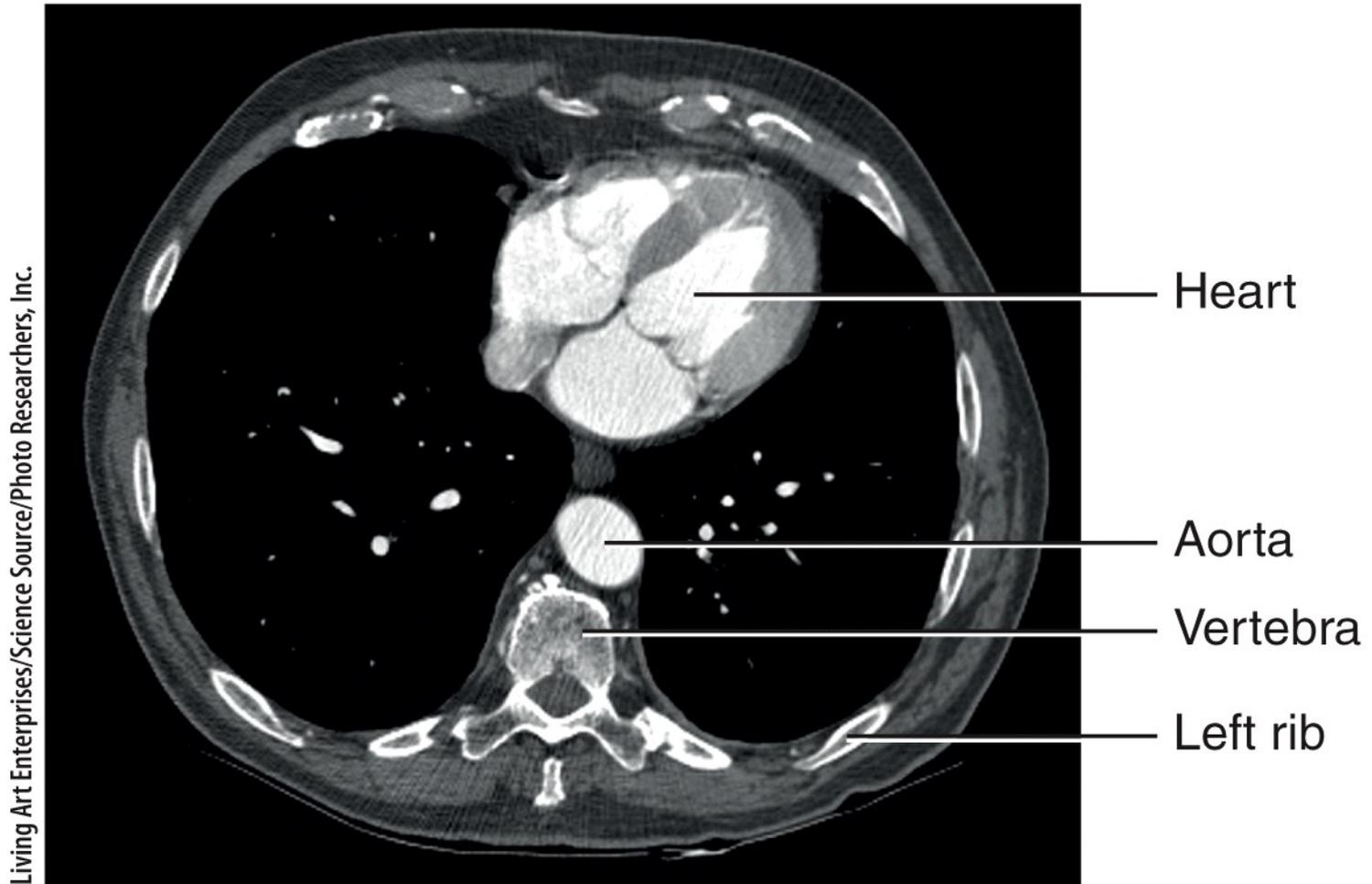
Barium contrast x-ray showing cancer of the ascending colon (arrow)



Scott Camazine/Photo Researchers, Inc.

Magnetic resonance image of brain in sagittal section

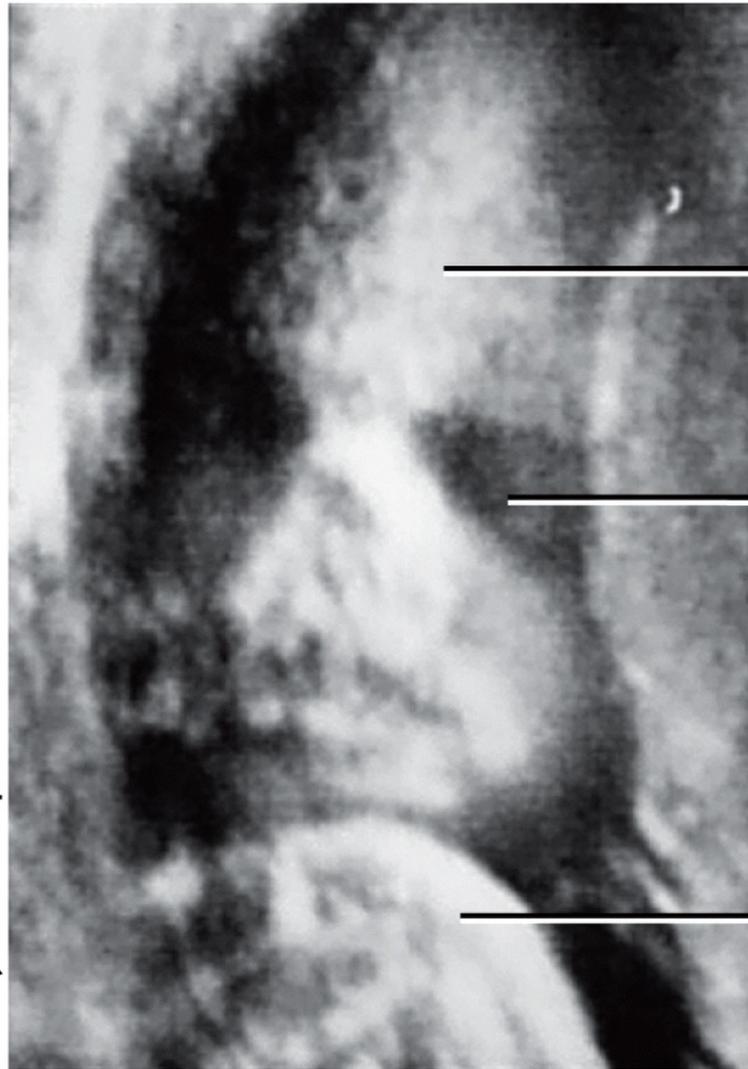
ANTERIOR



POSTERIOR

Computed tomography scan of thorax in inferior view

Courtesy Andrew Joseph Tortora and Damaris Soler



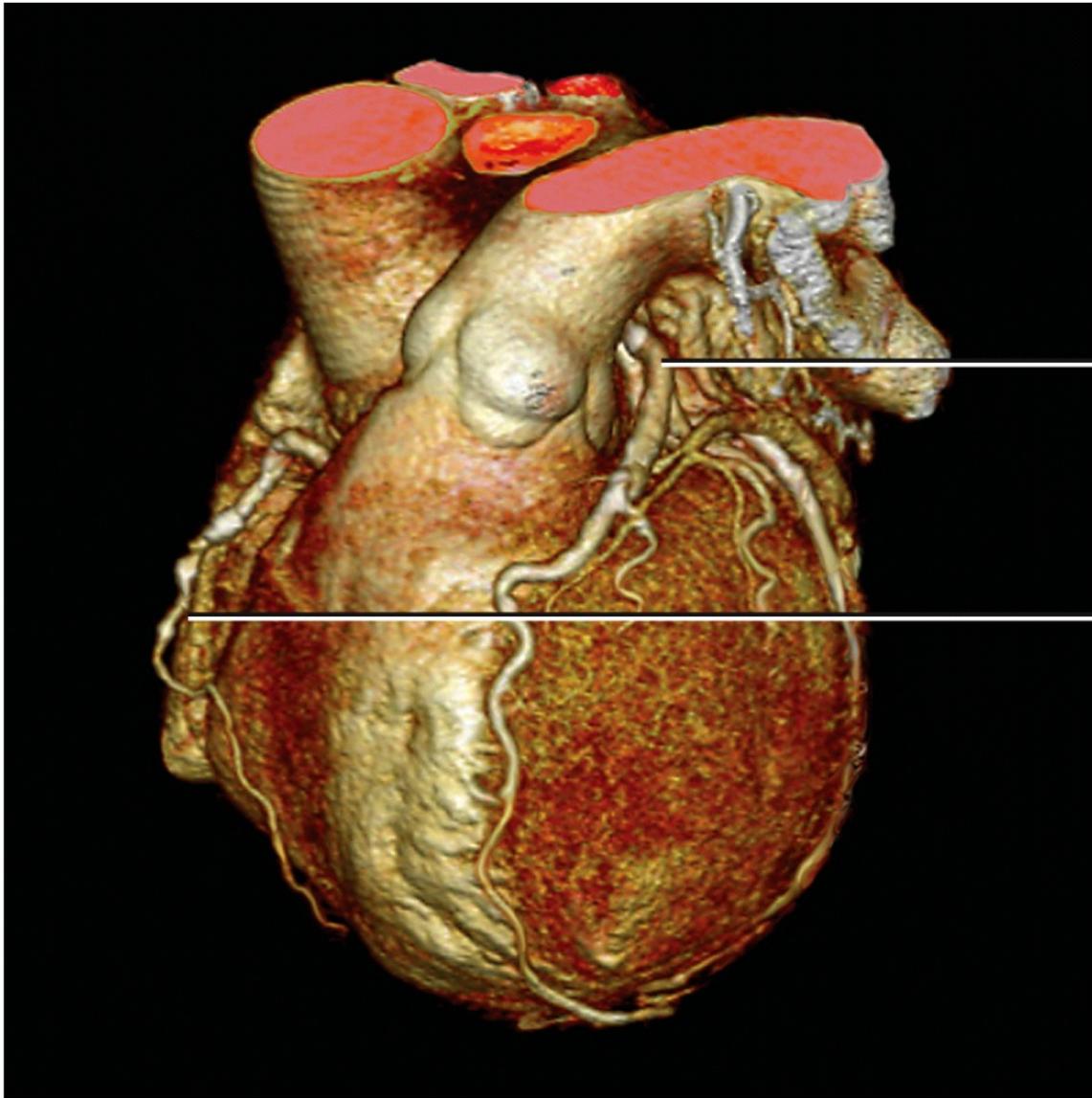
Forehead

Eye

Hand

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

ISM/Phototake

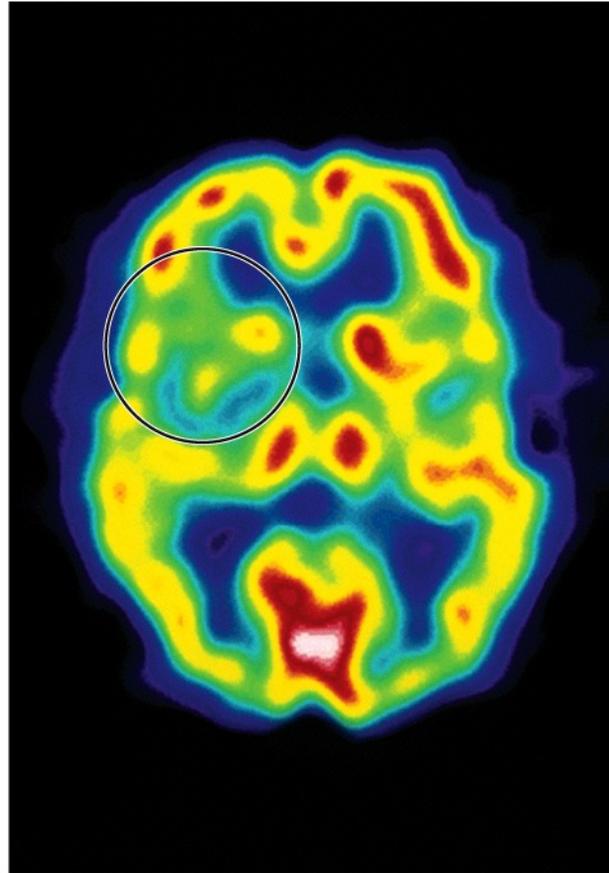


Normal left
coronary artery

Blocked right
coronary artery

CCTA scan of coronary arteries

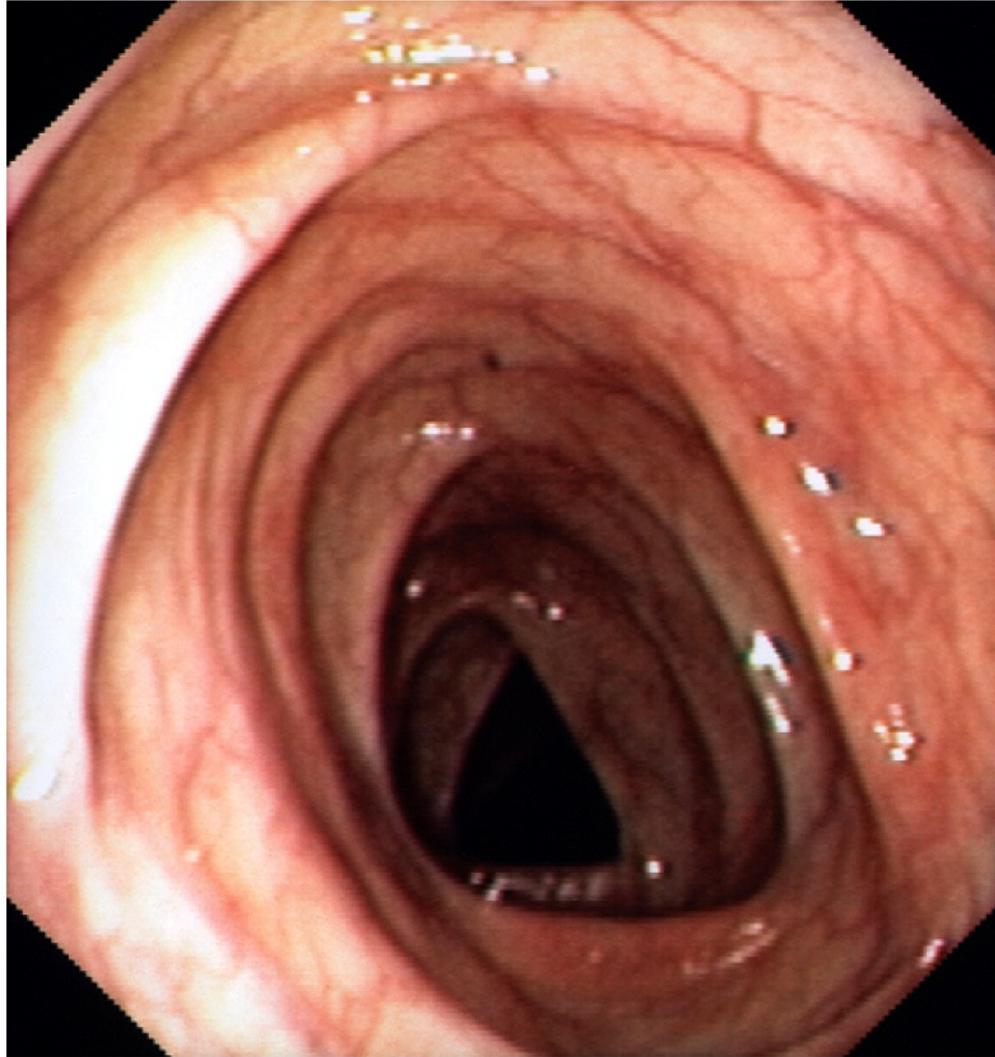
ANTERIOR



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

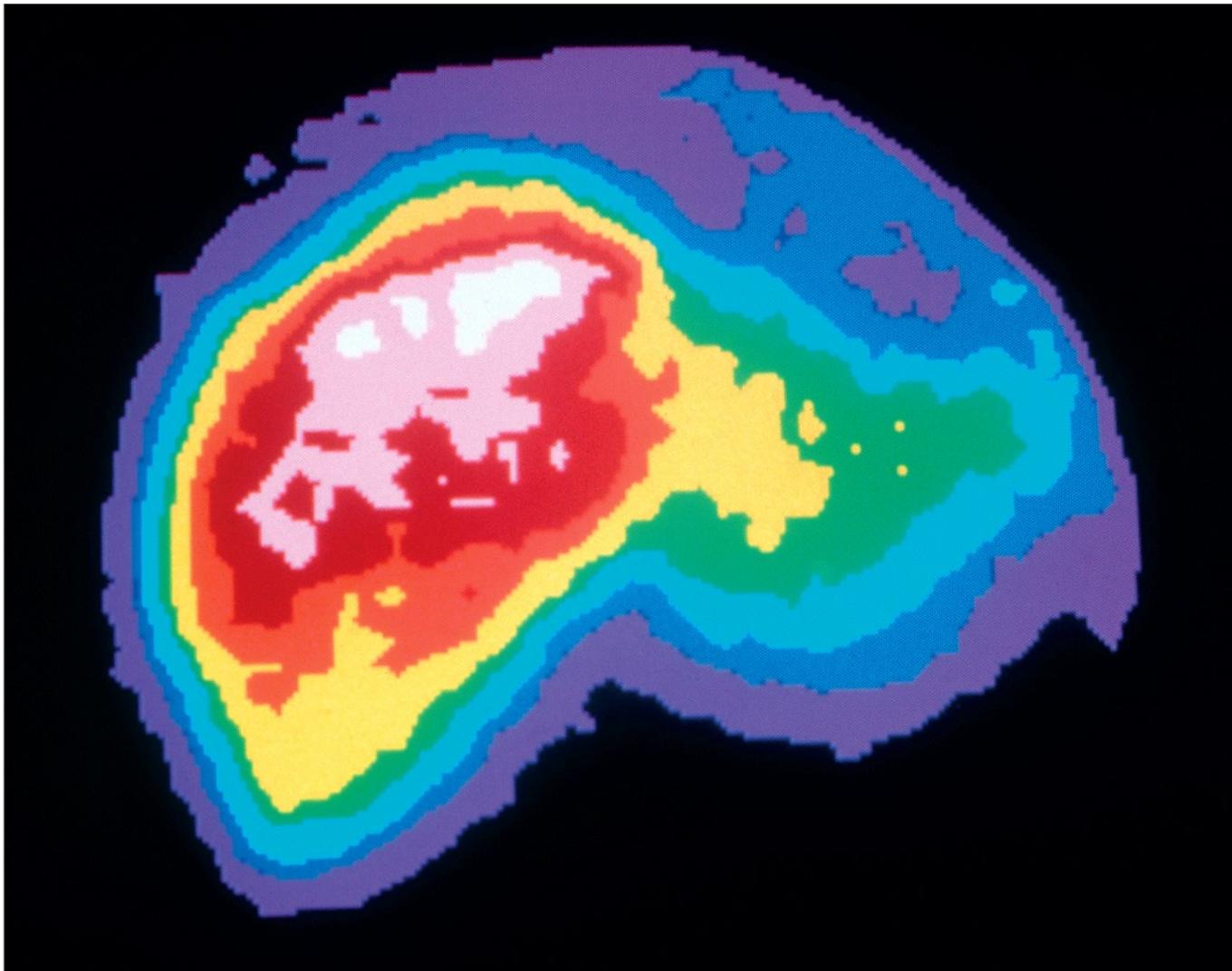
POSTERIOR

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



©Camal/Phototake

Interior view of colon as shown
by colonoscopy



Publiphoto/Photo Researchers, Inc.

Radionuclide (nuclear) scan of normal human liver