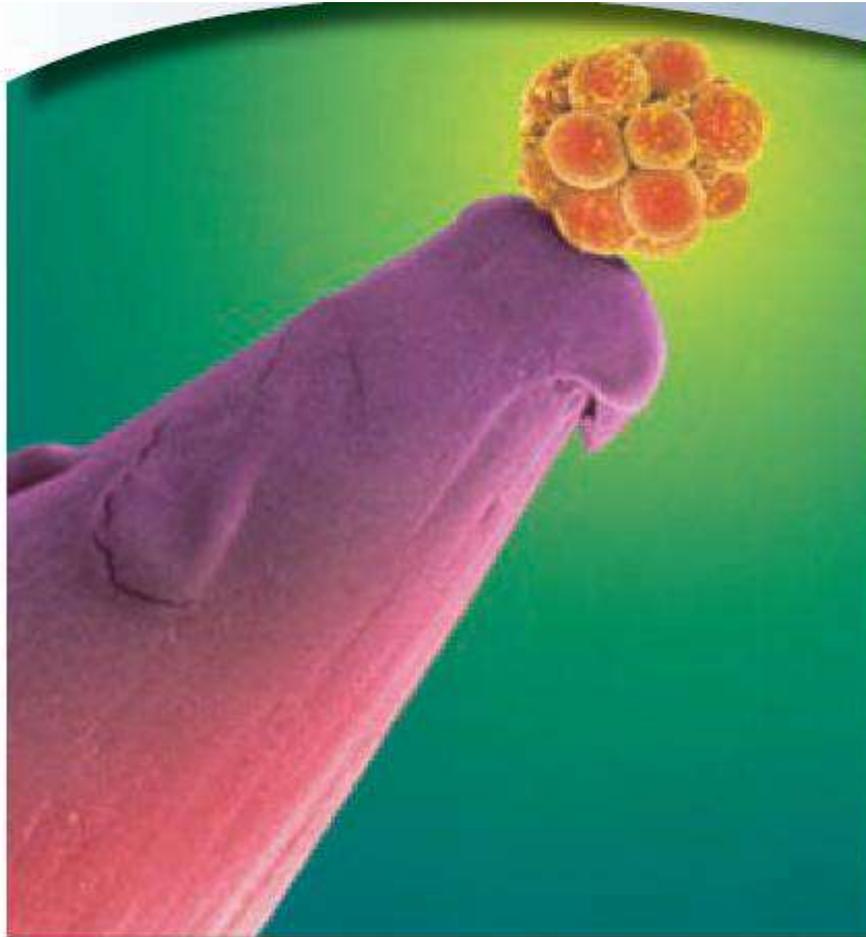


# Chapter 1

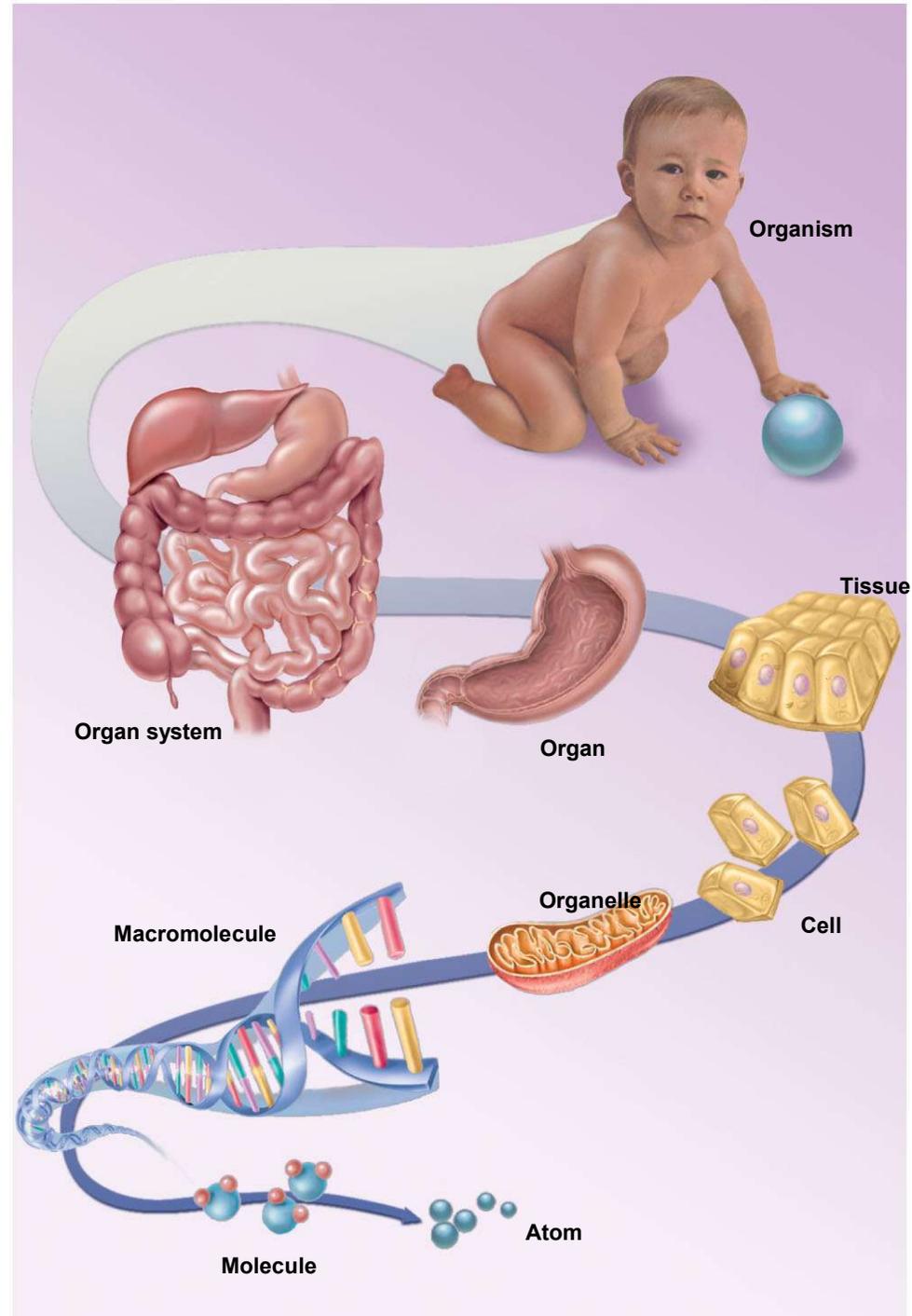
## Major Themes in A/P



# Major Themes of Anatomy and Physiology

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- 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

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- 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

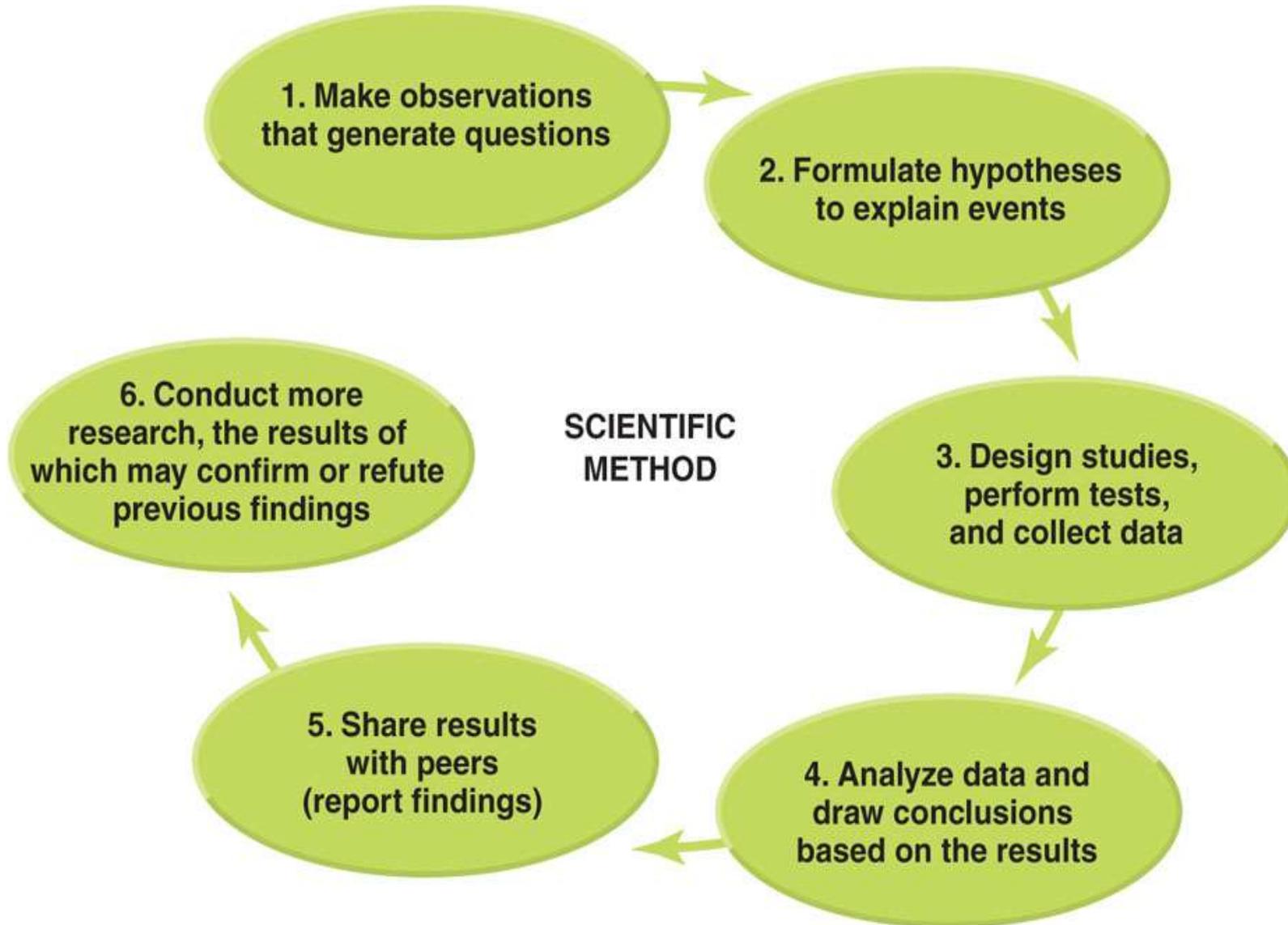
# Hypothetico-Deductive Method

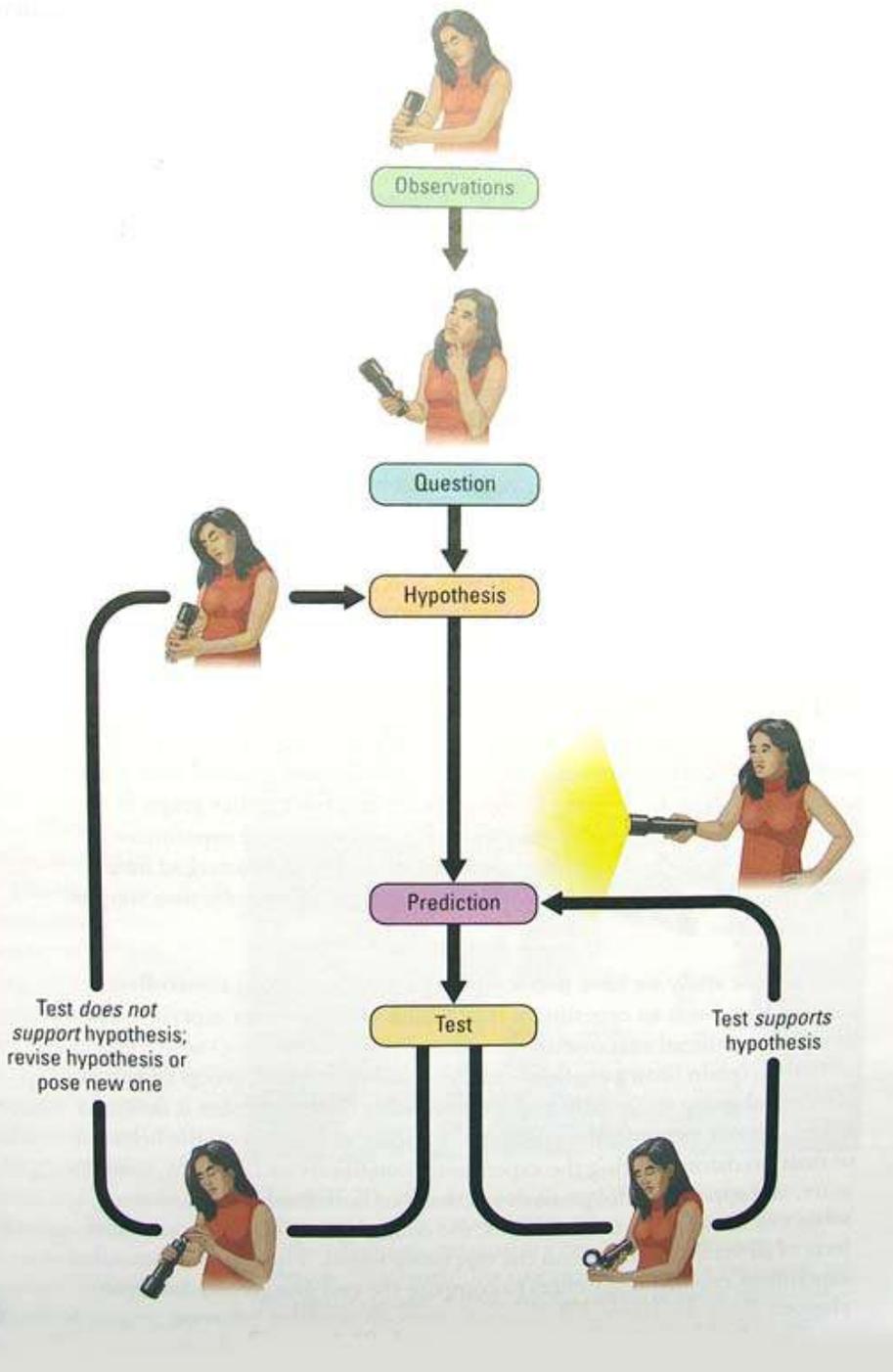
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- **Physiological knowledge** gained by this method
- Quest for truth is guided by investigator's observation which leads to a **question**
- **Hypothesis** - a method for answering questions // written as 'If-Then' statements
- A **hypothesis** =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

# 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.

# Different Perspectives on How to Investigate Science

---

- 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

# 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 /// most comprehensive understanding on specific topic /// also used to suggest 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 which then often results in bad public policy.

## Case Study

What is Evolution?

Is it a hypothesis or a theory?

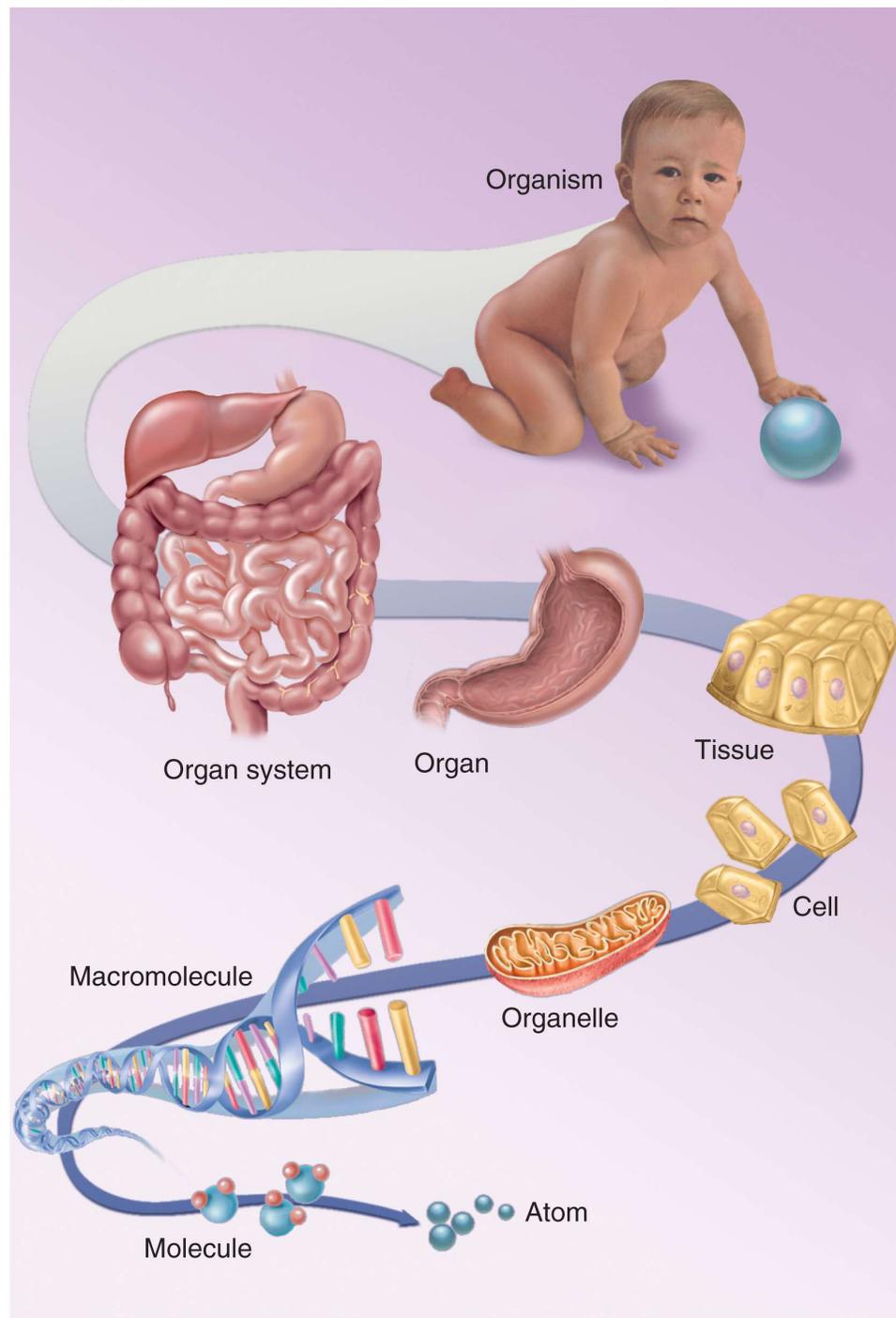
What is Creationism? (a theory or a belief system)

# Hierarchy of Complexity

Note:

Four cell types (connective cells, nervous cells, muscle cells, and epithelial cells).

These cell types make four tissue types (connective tissue, nervous tissue, muscle tissue, and epithelial tissue).

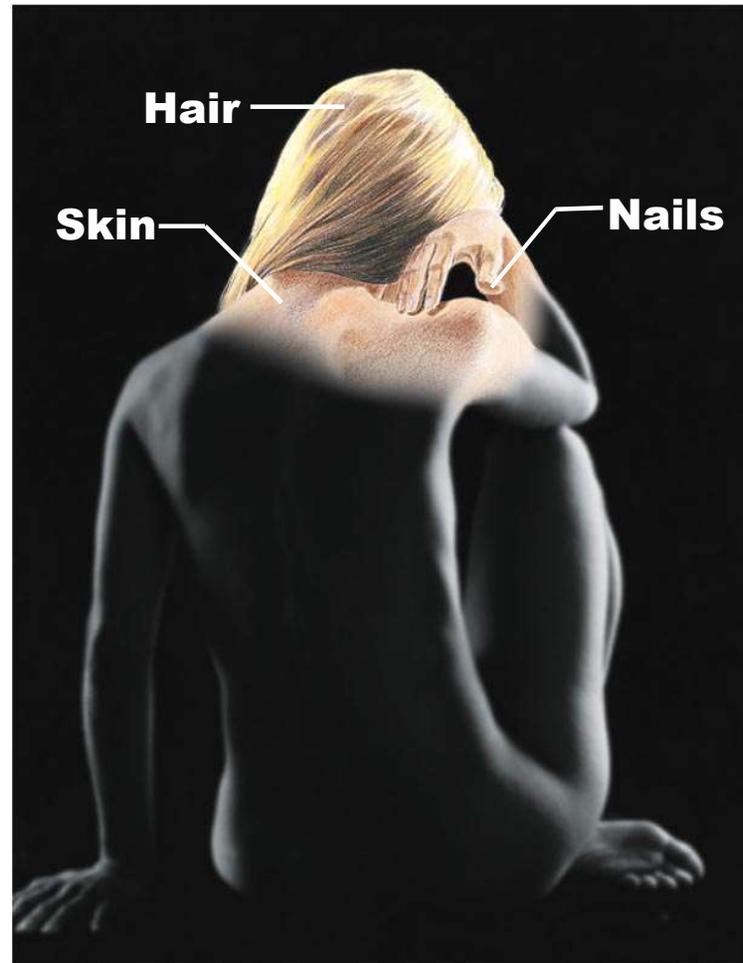


# Hierarchy of Complexity

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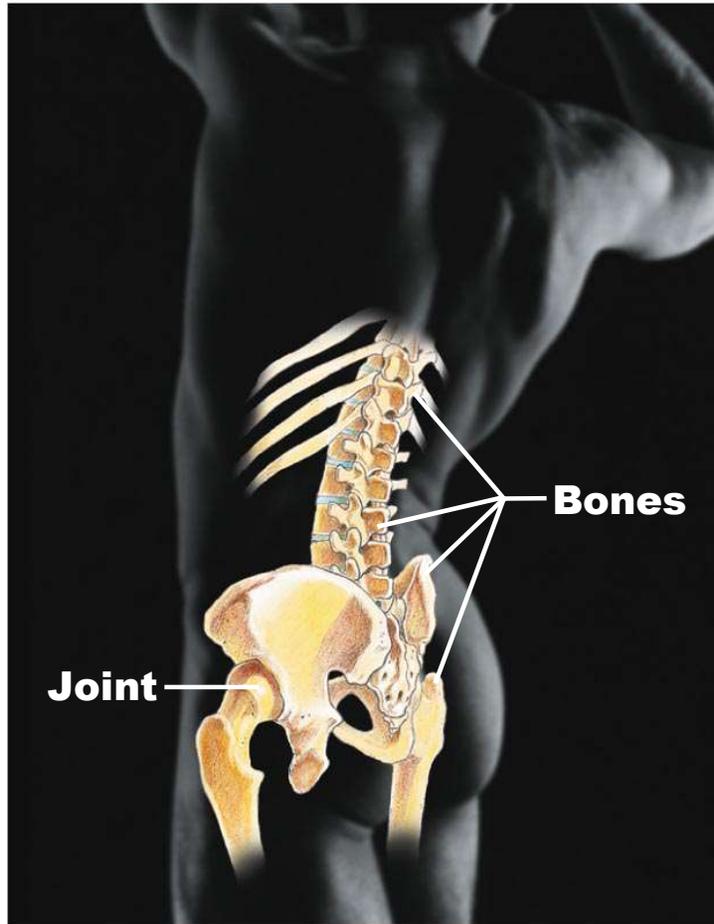
- **Organism** – a single, complete individual
- **Organ System** – human body made of 11 organ systems
- **Organ** – structure composed of two or more tissue types that work together to carry out a particular function
- **Tissue** – a mass of similar cells and cell products that form discrete region 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 eleven systems of the human body and their functions.



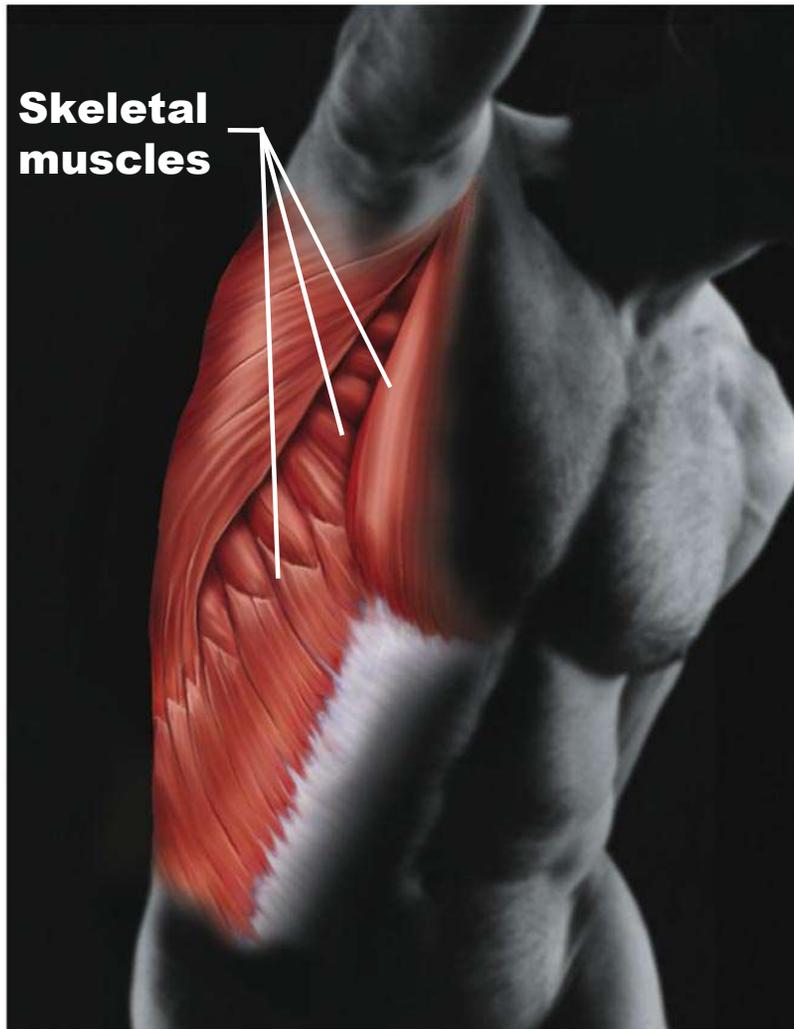
**(a) Integumentary System**

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.



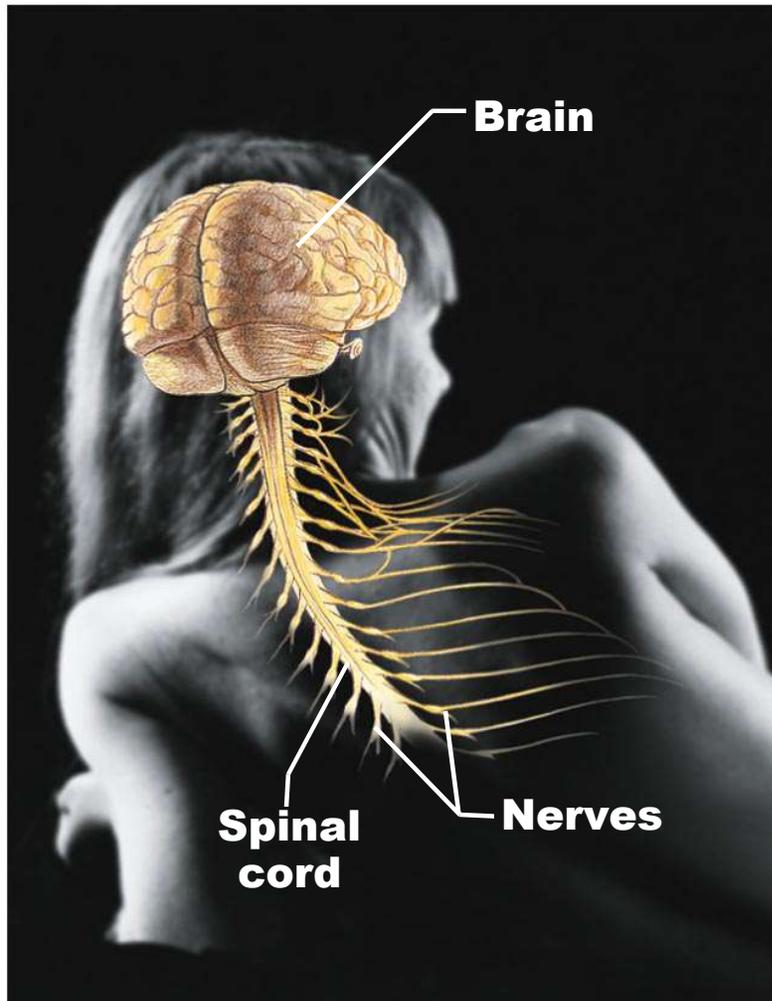
**(b) Skeletal System**

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



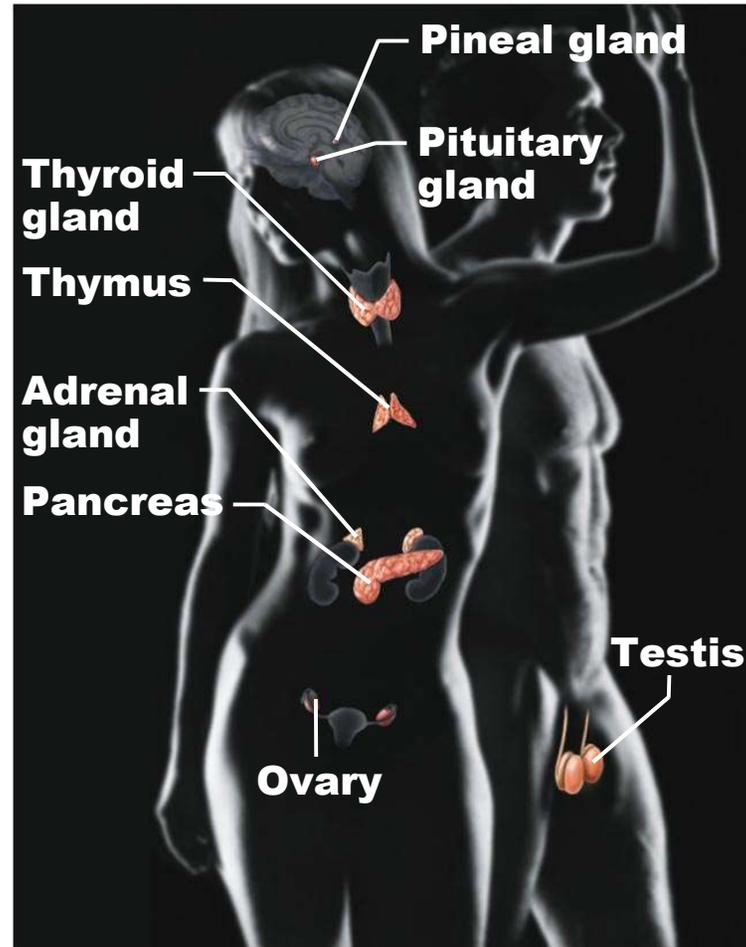
**(c) Muscular System**

Allows manipulation of the environment,  
locomotion, and facial expression.  
Maintains posture, and produces heat.



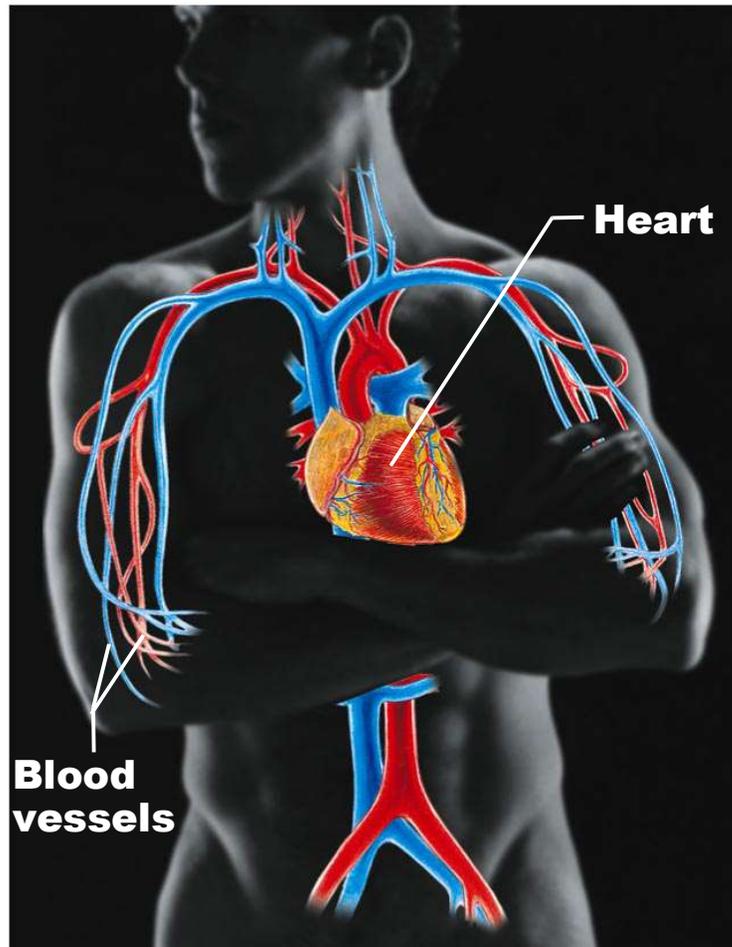
**(d) Nervous System**

As the fast-acting control system of the body, it responds to internal and external changes by activating appropriate muscles and glands.



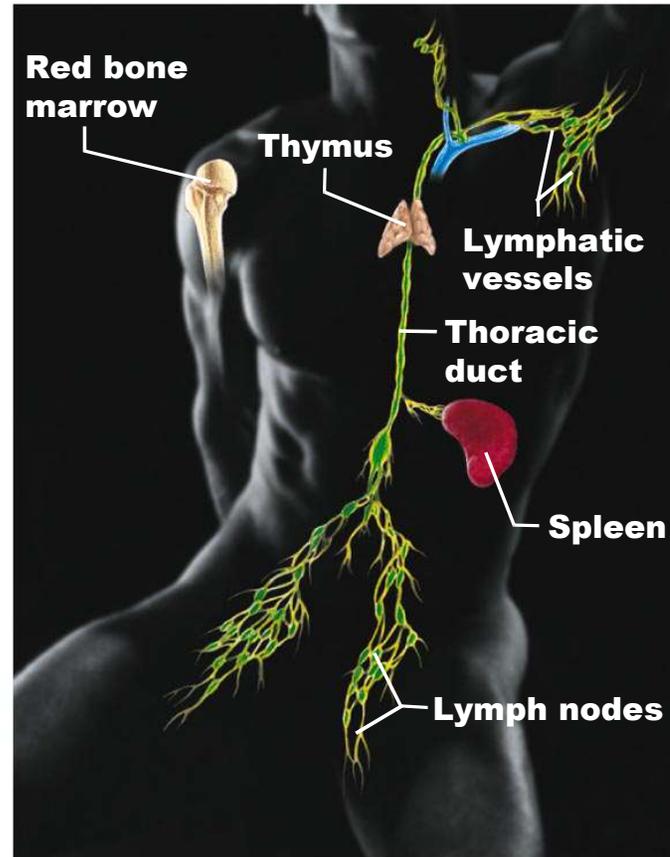
**(e) Endocrine System**

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



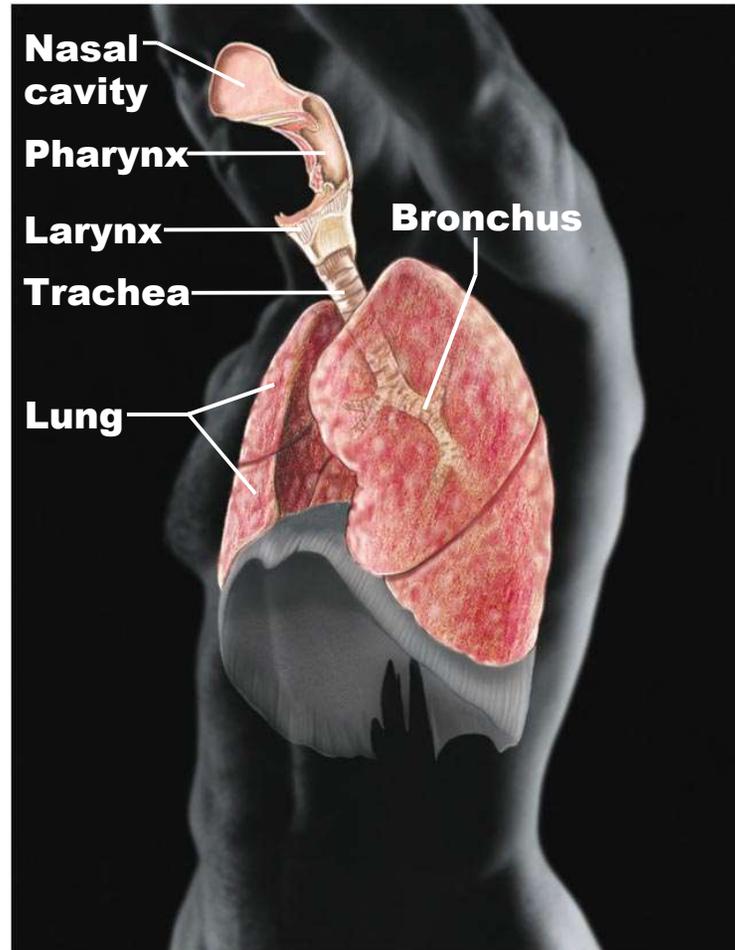
**(f) Cardiovascular System**

Blood vessels transport blood, which carries oxygen, carbon dioxide, nutrients, wastes, etc. The heart pumps blood.



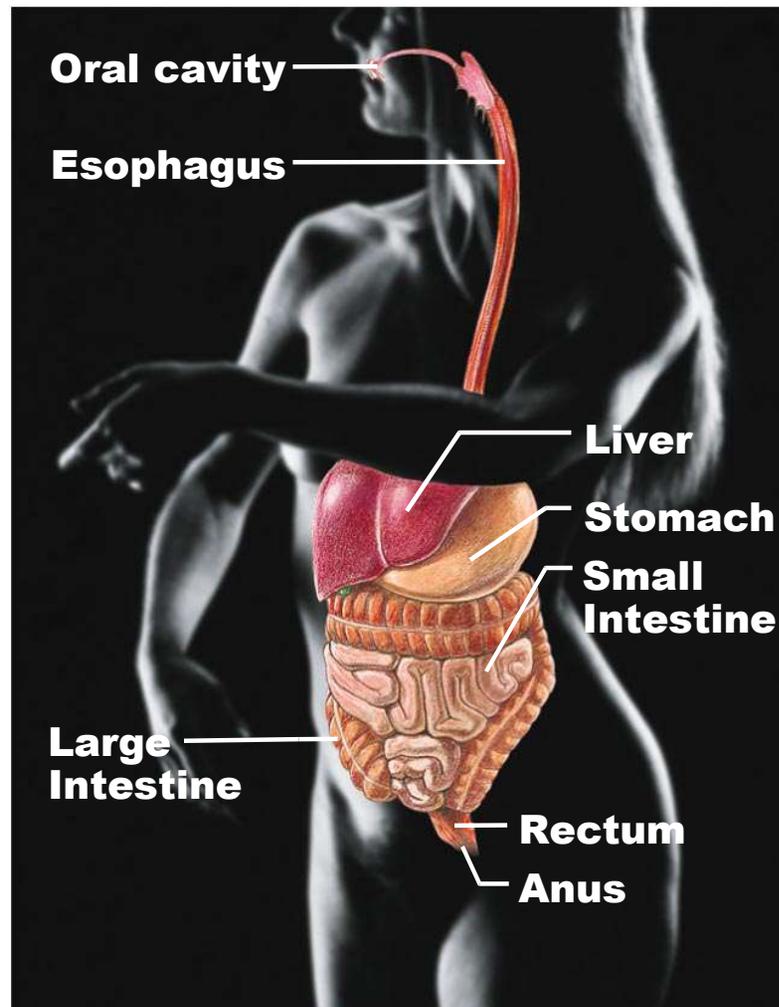
**(g) Lymphatic System/Immunity**

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.



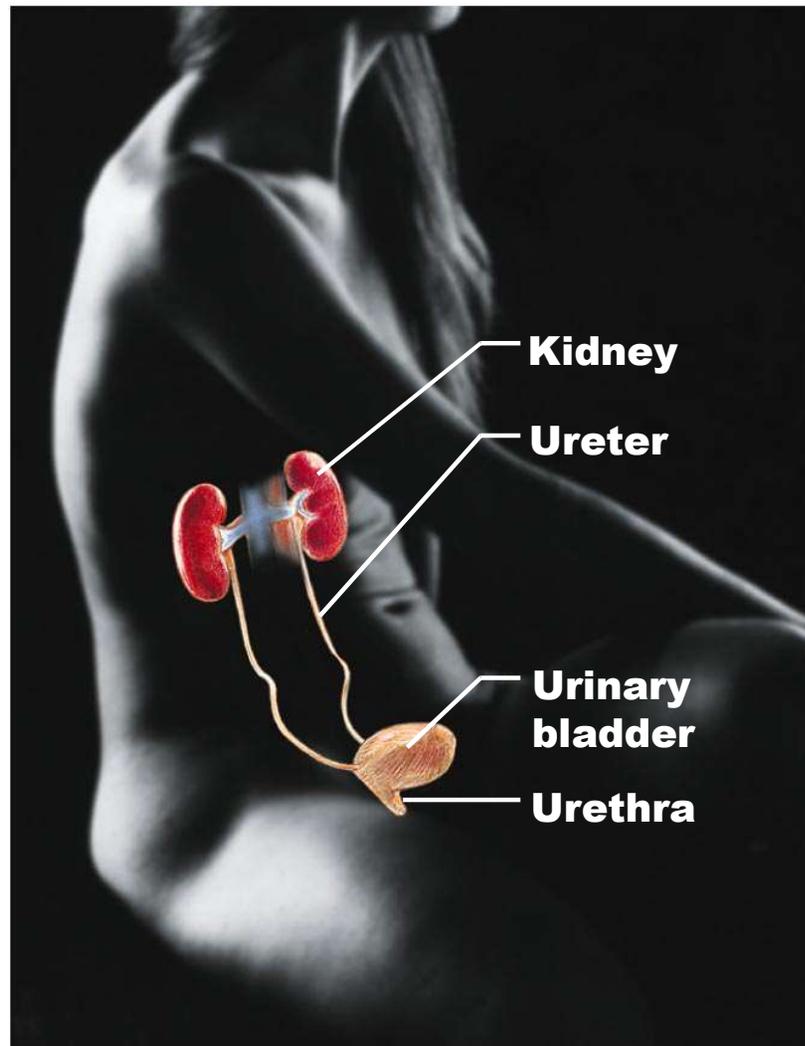
**(h) Respiratory System**

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



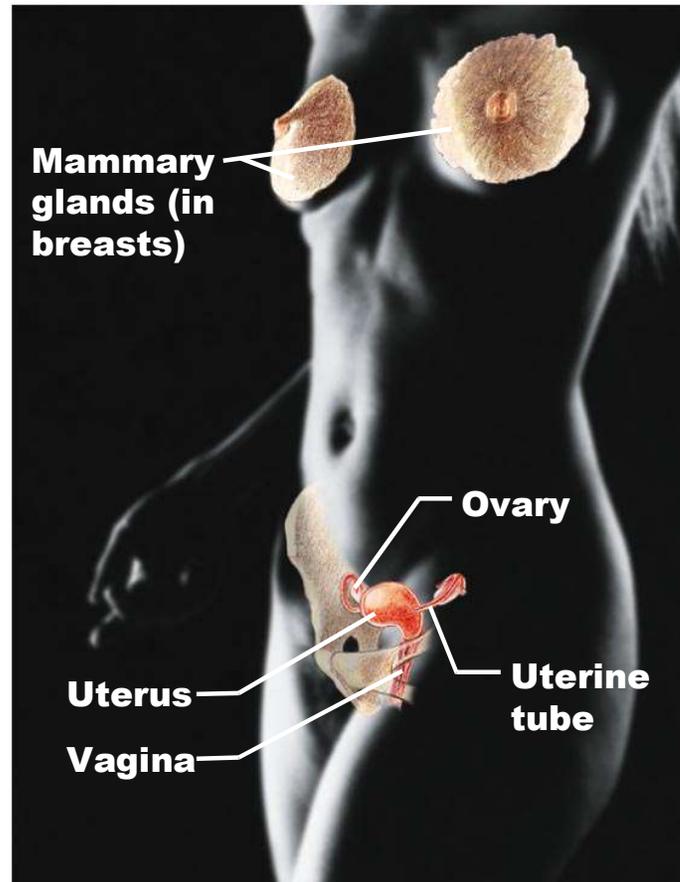
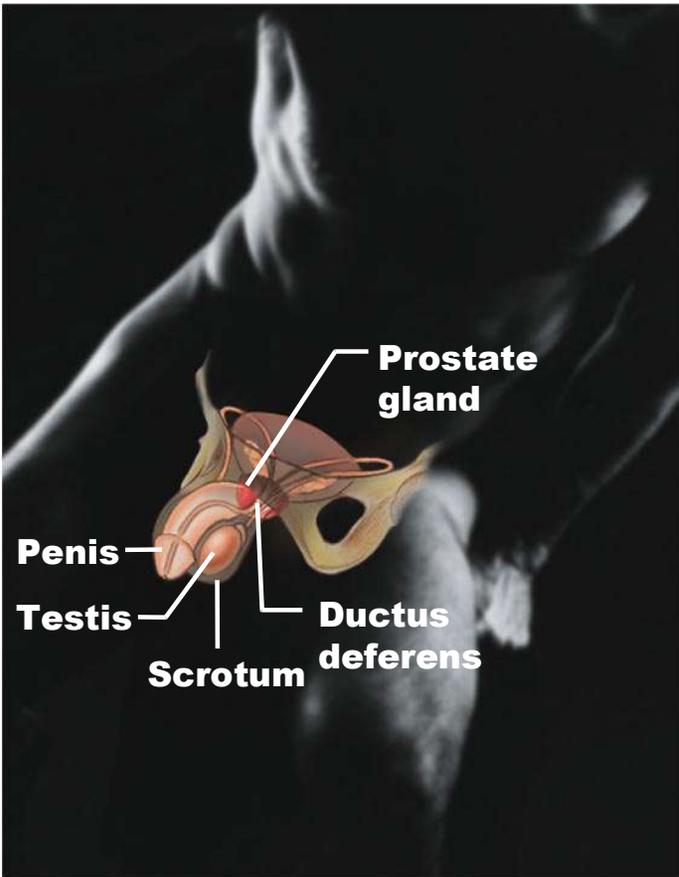
**(i) Digestive System**

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.

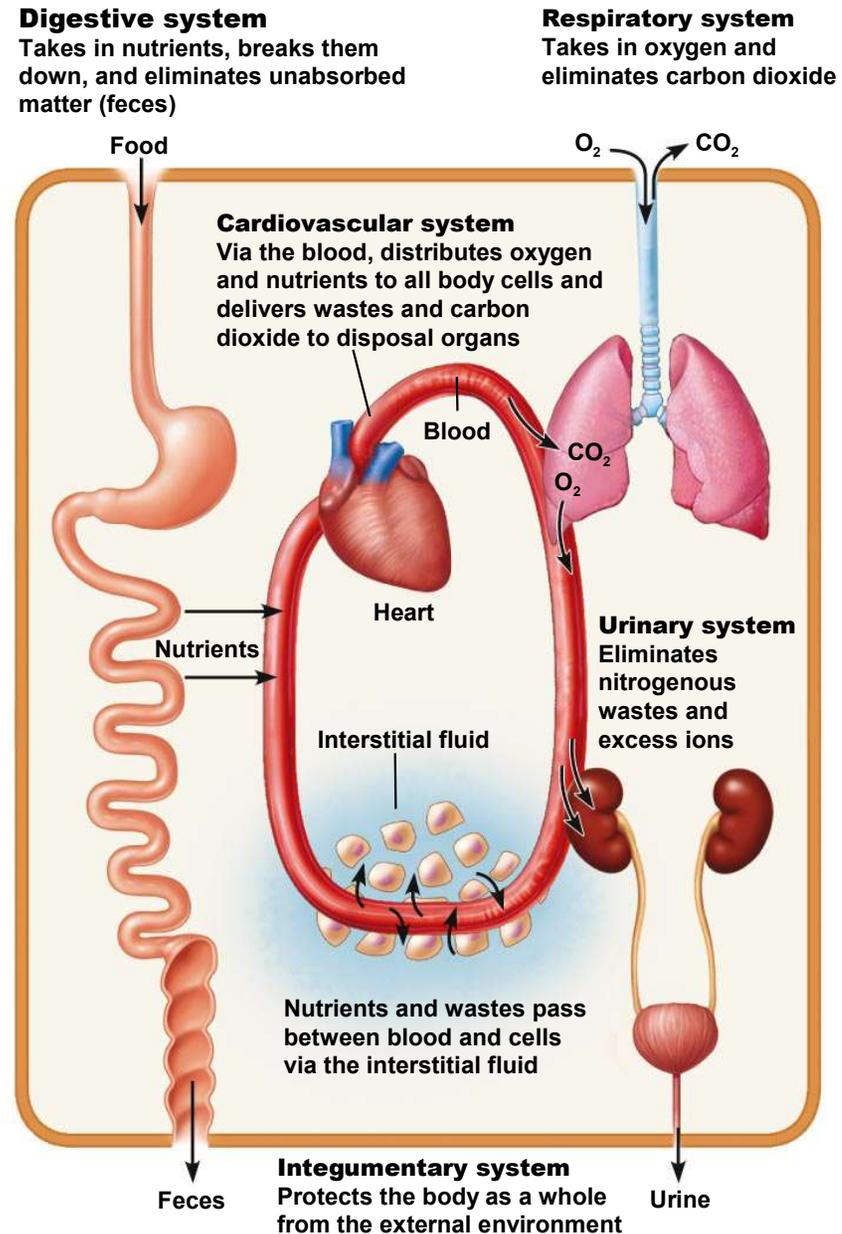
**(l) Female Reproductive System**

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.

# The Interrelationships Between Organ Systems and Cells

What is the purpose? To create a stable internal environment around our cells.

Homeostasis describes mechanisms that make adjustments using **feedback loops** to maintain a stable dynamic equilibrium within the interstitial fluid space. Nutrients must be brought to the cells and cellular waste produced by the cell's metabolism must be removed.



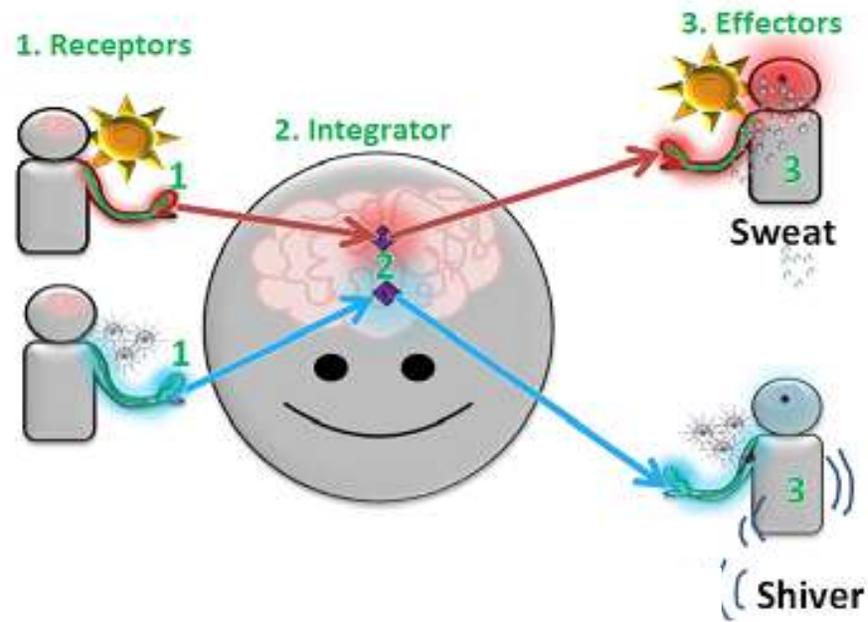
# 3 Components of a Feedback Loop

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- **Receptor** - senses change in the body // detects the “stimulus”
- **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

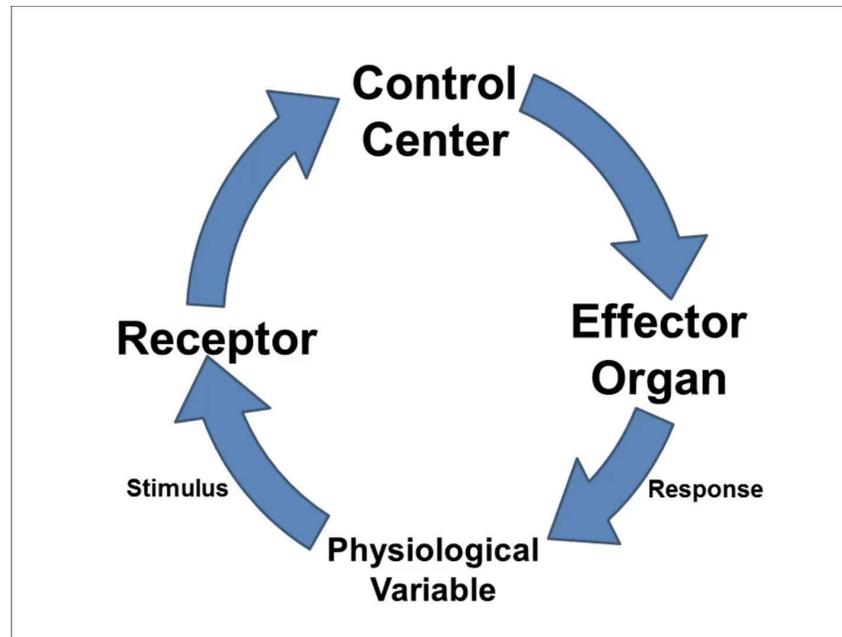
# The Integrator May Use Either the Autonomic Nervous System or the Endocrine System to Send Signal to the Effectors

- The hypothalamus is the “boss” for both the ANS and the endocrine system.
- Homeostasis may use either a positive feedback loops or negative feedback loop.

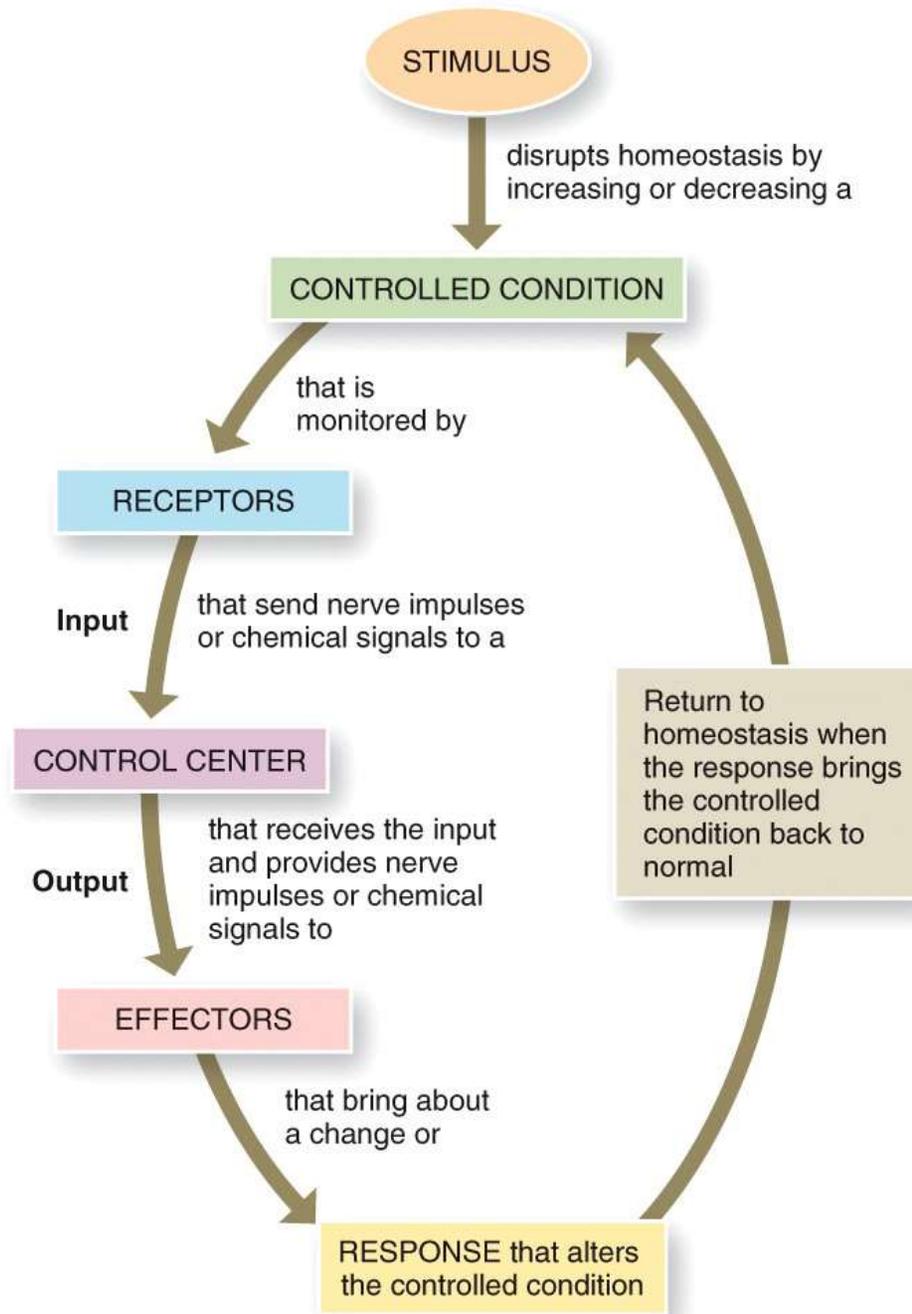


# Key Components in a Feedback Loop

Receptor ----> Control Center ----> Effector



A stimulus is recognized by the receptor when there is a change in the “internal environment”



# Homeostasis

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- **Homeostasis** – the body's ability to detect change, activate mechanisms that oppose it, and thereby maintain a relatively stable internal environment around our cells.
- **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 homeostasis causes illness and/or death**

# Medicine and Homeostasis

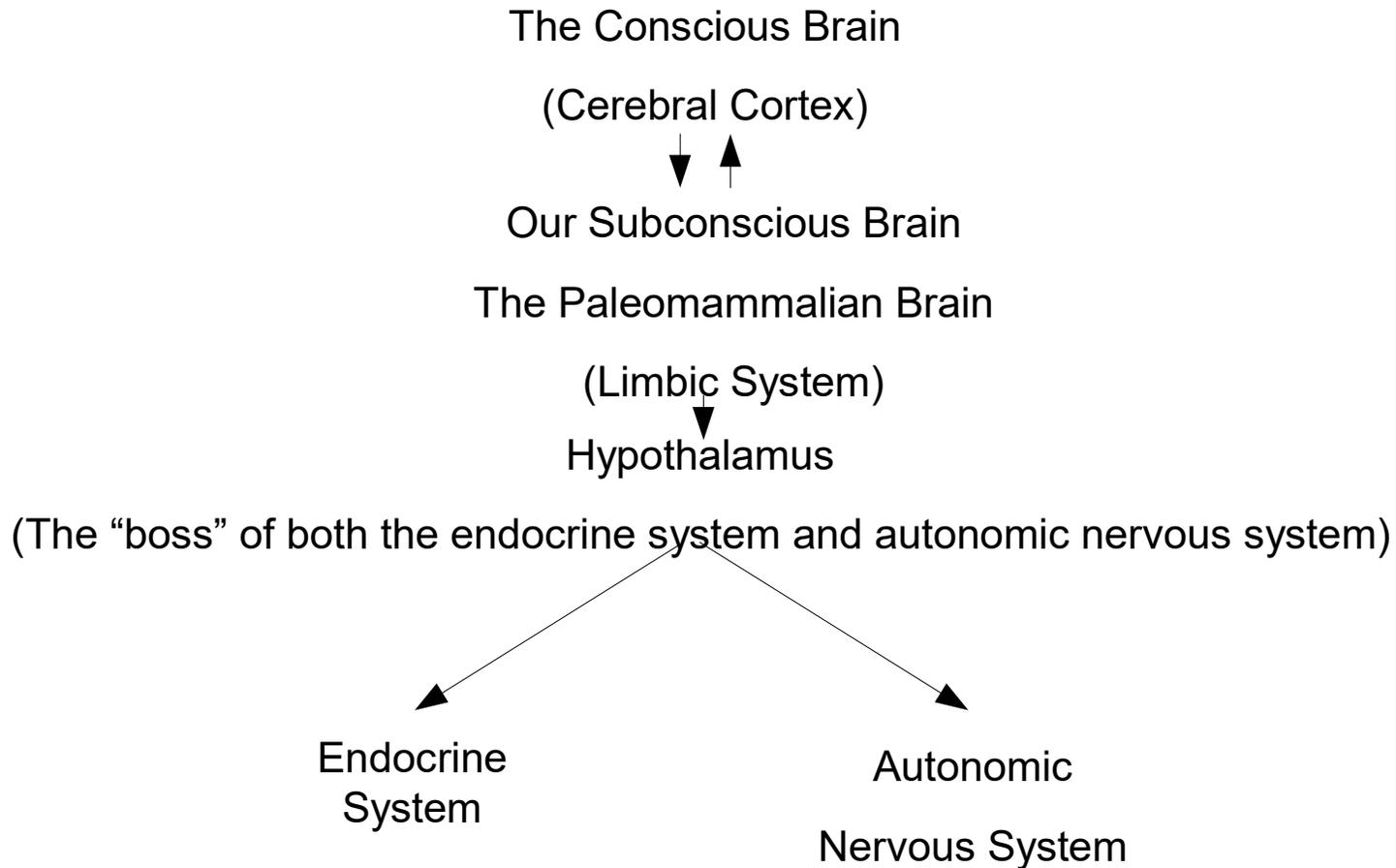
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Disease occurs when homeostasis fails.

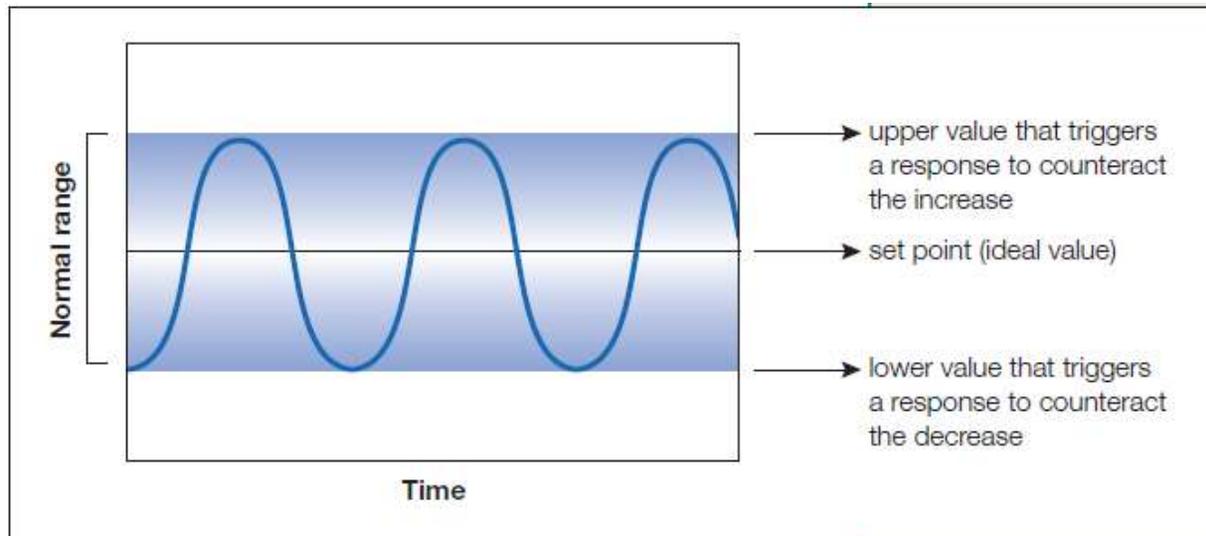
Doctors apply homeostasis to understand the cause of the disease.

There is a direct link between the mind and the body. The mind may upset homeostasis and cause disease. What is stress?

# The Mind-Body Axis (Stress & Homeostasis)

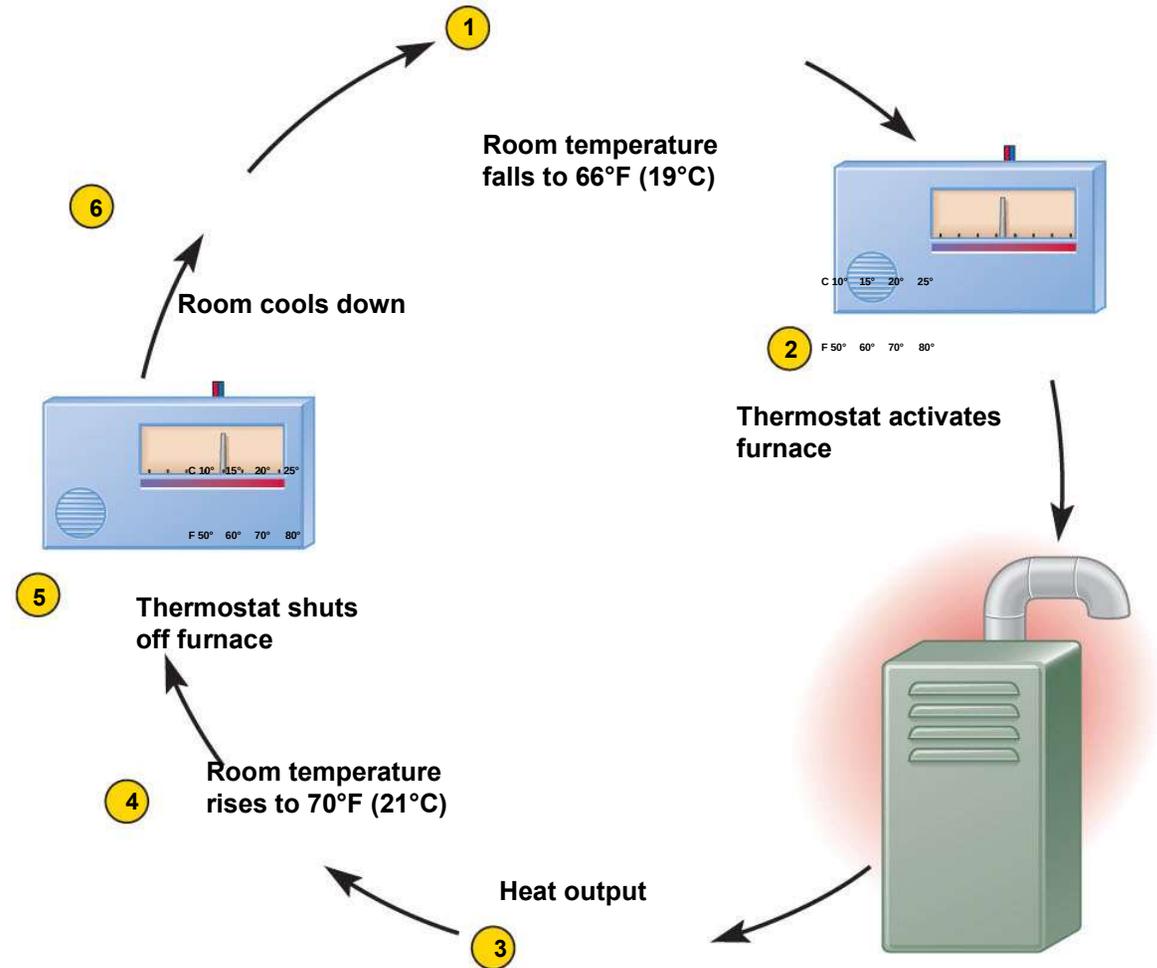


# Negative Feedback

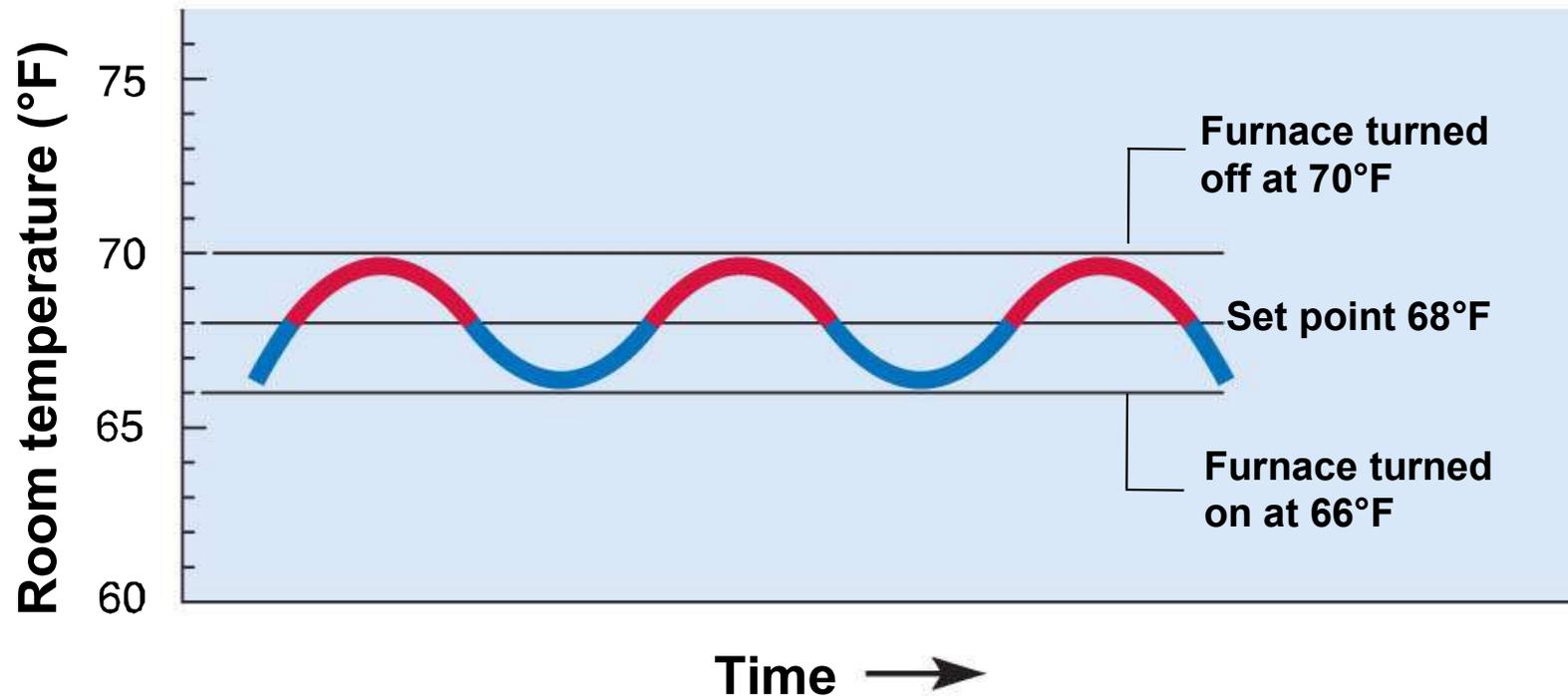


# Negative Feedback Loop

- We want the room temperature at 68 degrees
- The furnace does not keep the room temperature at 68 degrees
- The thermostat senses changes and either turns furnace on or turns furnace off to adjust temperature
- This is Dynamic equilibrium
- Almost everything in your physiology is maintained within a "normal range"



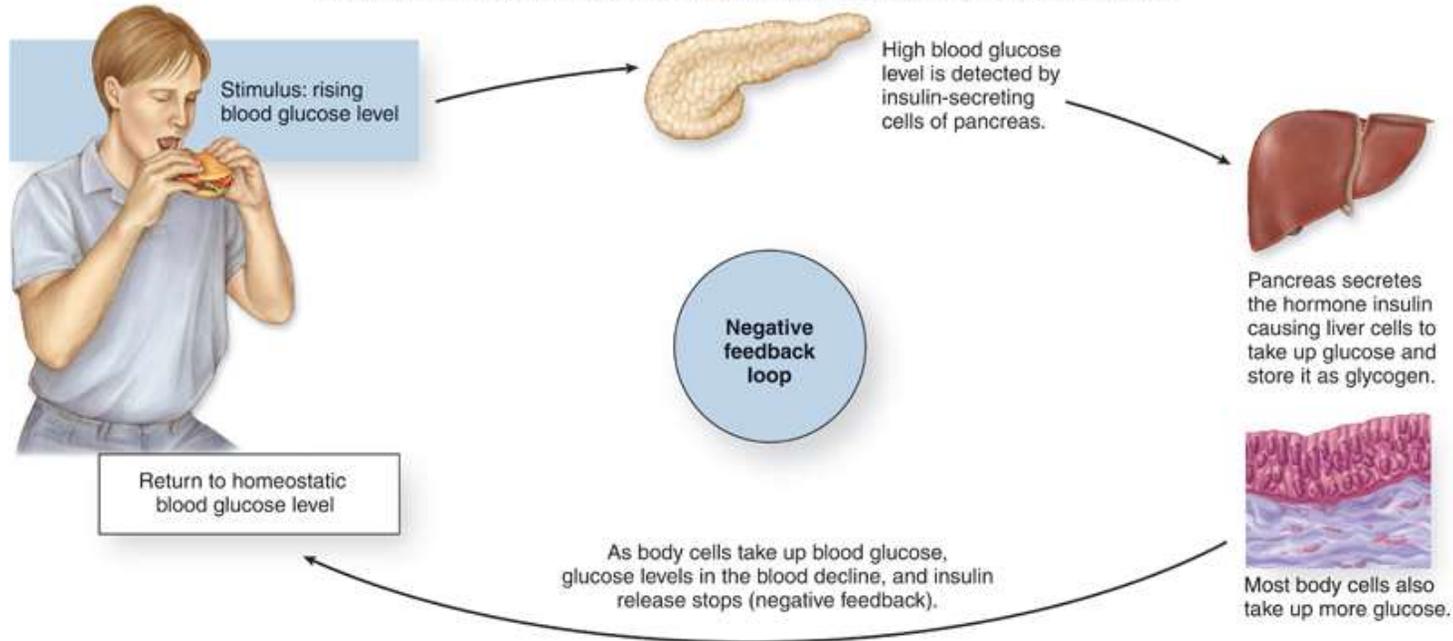
# Negative Feedback, Set Point



- 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)

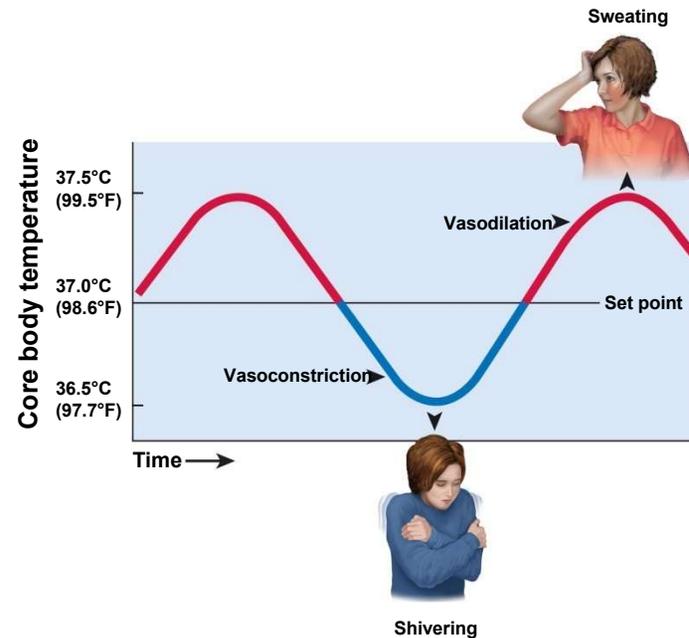
# Negative Feedback Loop

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(a) Negative feedback

# Negative Feedback in Human Thermoregulation



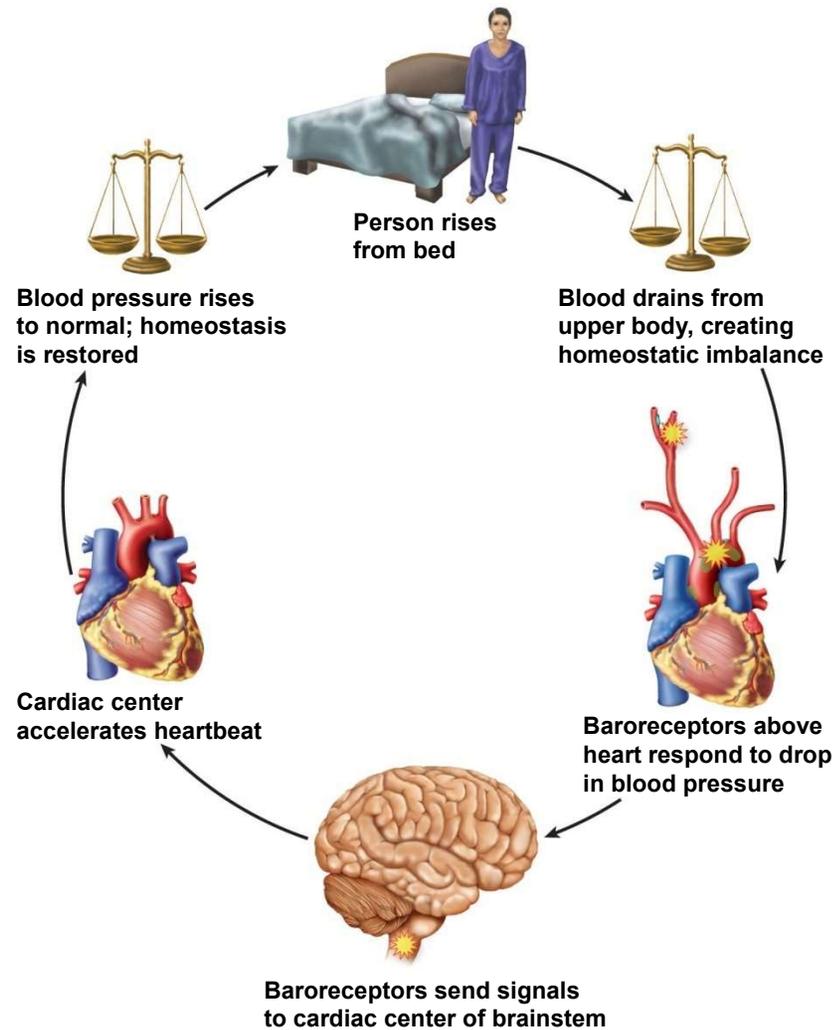
- **Brain senses change in blood temperature**
  - if too warm, vessels dilate (**vasodilation**) in the skin and sweating begins (heat losing mechanisms)
  - if too cold, vessels in the skin constrict (**vasoconstriction**) and shivering begins (heat gaining mechanism)

# Negative Feedback Control of Blood Pressure

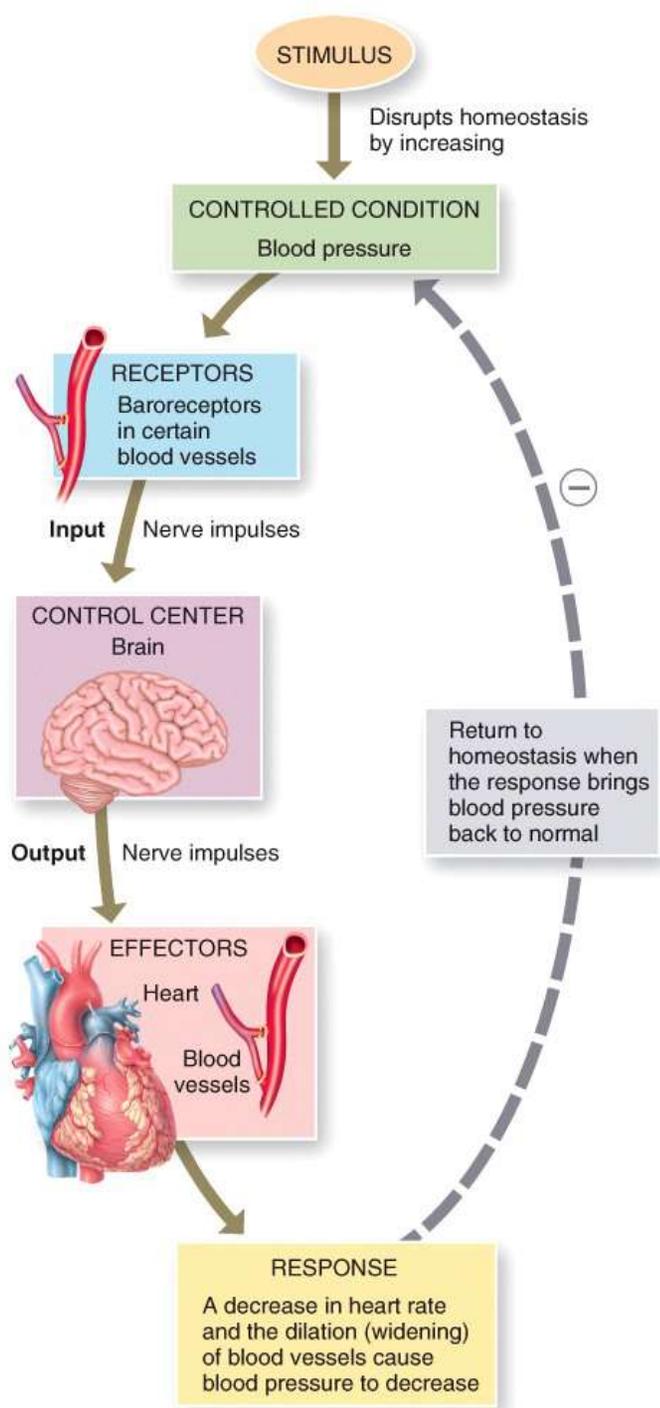
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- Sitting up in bed causes a drop in blood pressure in the head and upper thorax
- **Baroreceptors** in the arteries near the heart alert the cardiac center in the brainstem
- **Cardiac center** sends nerve signals that increase the heart rate and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

# Control of Blood Pressure



# Negative Feedback



# Positive Feedback Loops

---

- **Not a common mechanism**
- Described as a “Self-amplifying event”
  - 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

Characterized as a “self-amplifying event”

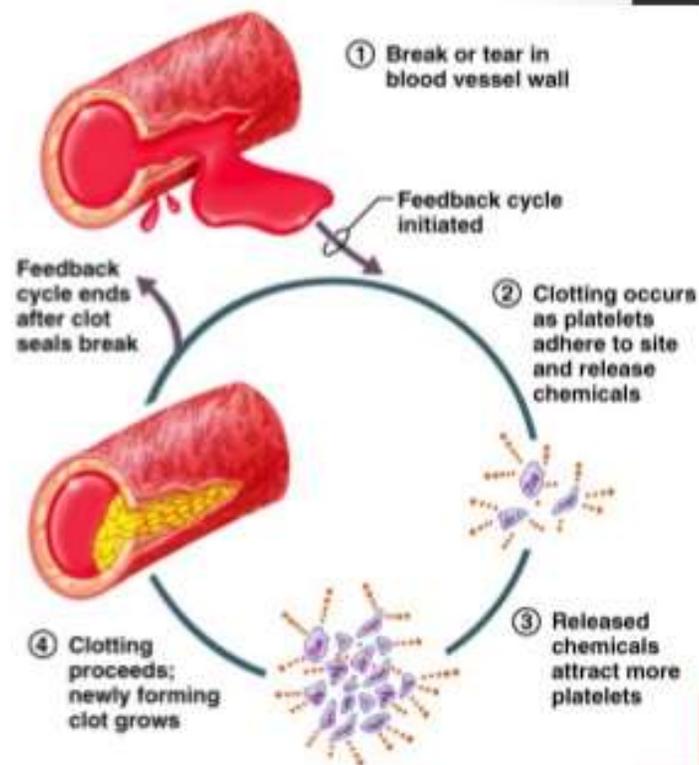
Stimulus ----> Response ----> Stimulus ----> Response ----> Stimulus ----> Response

- PFL are potentially more dangerous than negative feedback loops
- Fever is a good example of a positive feedback loop
  - Pyrogens resets the “internal thermostat” - you generate more “heat”
  - Higher temp increases rate of “chemical reactions” in cells
  - Exothermic chemical reactions further increases temperature
  - Now we are trapped a in positive feedback loop
  - Eventually, high temperatures denatures proteins
  - Denature proteins stops metabolism // cause death

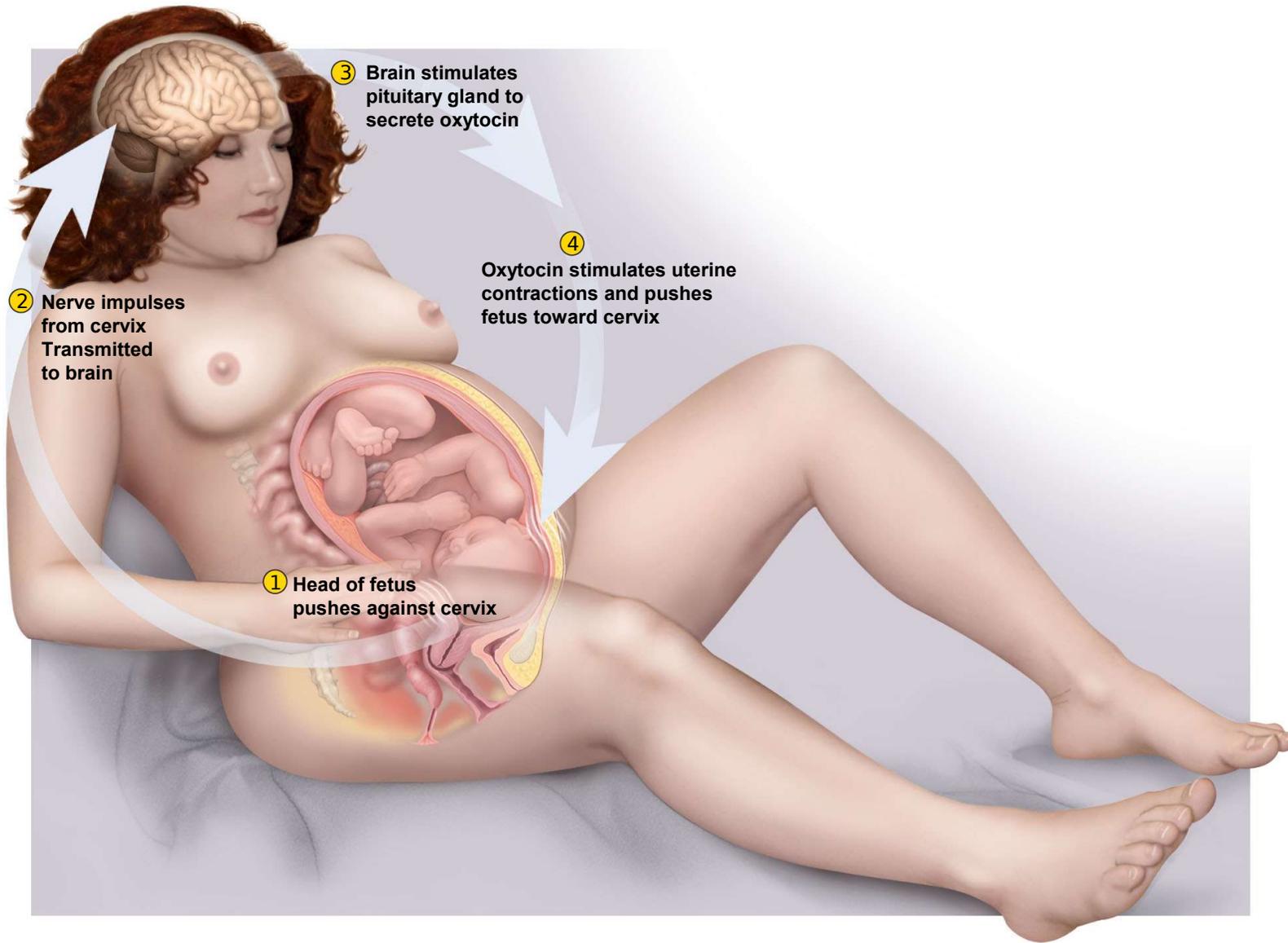
# Some Physiologic Conditions Require Positive Feedback Loops

## Positive Feedback

- In positive feedback systems, the output enhances or exaggerates the original stimulus
- Example: Regulation of blood clotting



# Positive Feedback Loops

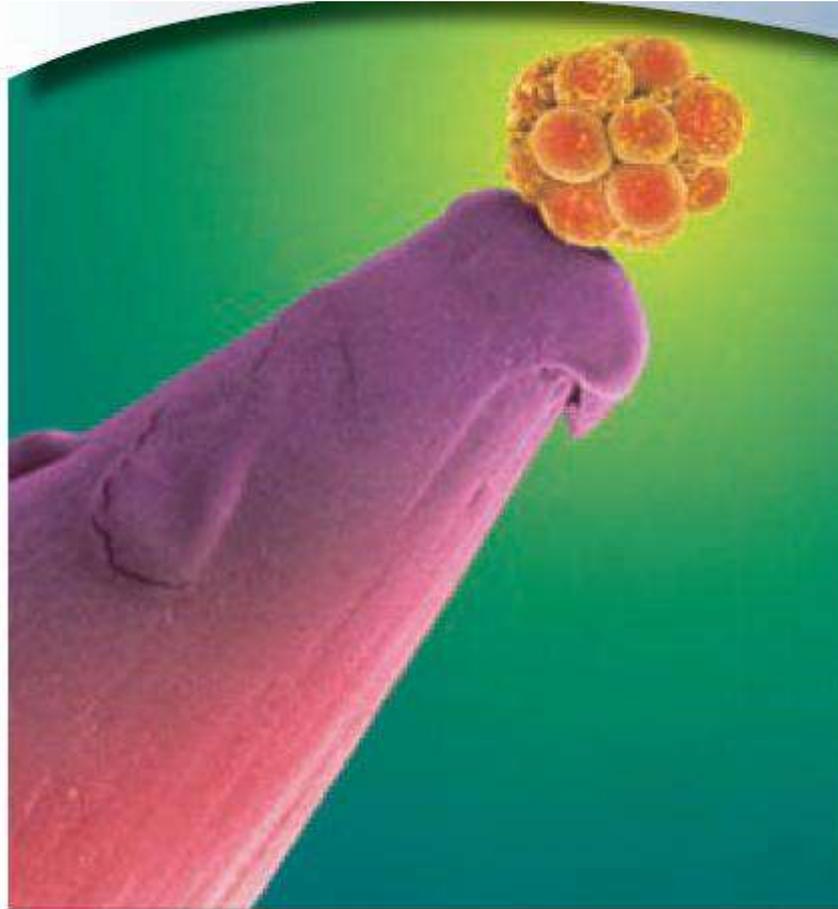


# A Dangerous Positive Feedback Loop

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- Fever > 104 degrees F
  - Bacteria and WBC release pyrogens (reset body's thermostat so body makes more heat)
  - metabolic rate increases because heat speeds up chemical reactions
  - body produces heat even faster
  - body temperature continues to rise
  - further increasing metabolic rate // more heat generated --- positive feedback!
- Cycle continues to reinforce itself
- Self-amplifying cycle
- Becomes fatal at 113 degrees F

# Evolution & Natural Selection



# Classical Genetics VS Modern Genetics VS Epigenetics



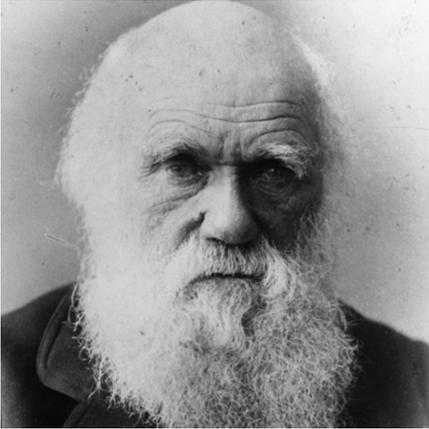
Gregor Johann Mendel was a scientist. He was also an Augustinian friar and abbot of St. Thomas' Abbey in Brno, Margraviate of Moravia.

Gregor Mendel is usually considered to be the **founder of classical genetics**. Though farmers had known for centuries that crossbreeding of animals and plants could favor certain **desirable traits**, Mendel's pea plant experiments conducted between 1856 and 1863 established many of the rules of heredity.

Gregor Mendel, through his work on pea plants, discovered the **fundamental laws of inheritance**. He deduced that **genes come in pairs and are inherited as distinct units**, one from each parent. Mendel tracked the segregation of parental genes and their appearance in the offspring as dominant or recessive traits.

Born: July 20, 1822, Hynčice, Vražné, Czech Republic    Died: January 6, 1884, Brno, Czech Republic

# Classical Genetics VS Modern Genetics VS Epigenetics



Charles Robert Darwin, was an English naturalist, geologist and biologist, best known for his contributions to the science of evolution.

Darwin formulated his bold theory in private in 1837–39, after returning from a voyage around the world aboard HMS Beagle, but it was not until two decades later that he finally gave it full public expression in *On the Origin of Species (1859)*, a book that has deeply influenced modern Western society and thought.

*Darwin explain how “natural selection” decided which genes would be selected and passed on to the next generation after “evolution altered the DNA sequence”.*

*Born: February 12, 1809, The Mount, Shrewsbury, United Kingdom Died: April 19, 1882, Down House, Downe, United Kingdom*

# Natural Selection

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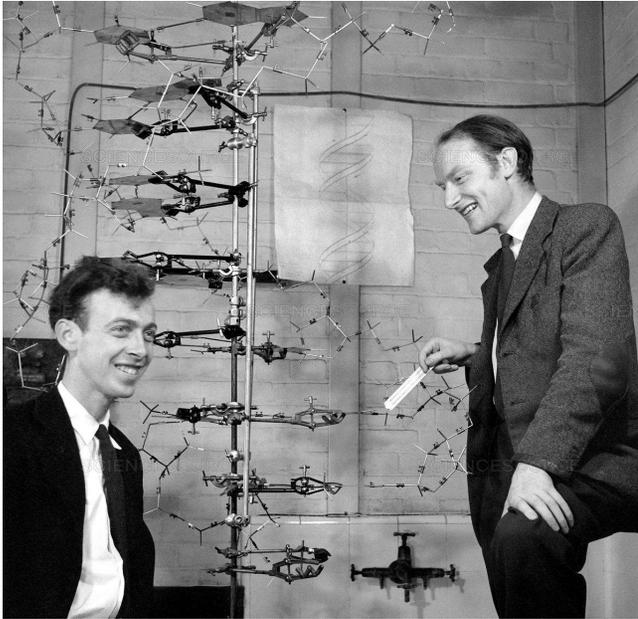
- **Charles Darwin**
  - *On the Origin of Species by Means of Natural Selection* (1859) – ‘the book that shook the world’
  - *The Ascent of Man* (1871) – about human evolution
  - Explained the Theory of Natural Selection // **how species originate and change through time**
  - changed view of “our origin, our nature and our place in the universe”
  - increases understanding of human form and function

# Evolution & Natural Selection

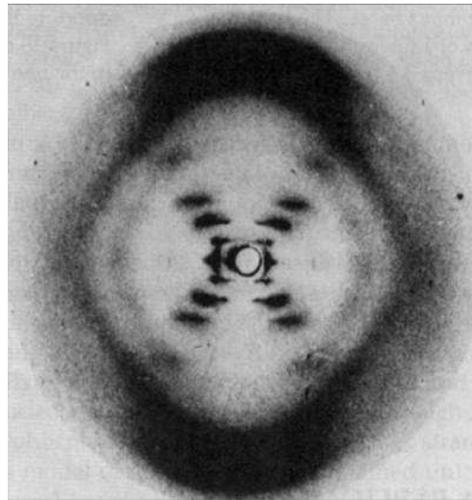
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- **Evolution** // change in genetic composition in a population of an organisms over time
  - e.g. development of bacterial resistance to antibiotics
  - e.g. appearance of new strains of AIDS virus
- **Natural Selection** // some individuals within 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
- **What is selection pressures?** – natural forces that promote the reproductive success of some individuals more than others // adaptation

# Classical Genetics VS Modern Genetics VS Epigenetics



The discovery in 1953 of the double helix, the twisted-ladder structure of **deoxyribonucleic acid (DNA)**, by James Watson and Francis Crick, marked a milestone in the history of science and gave rise to **modern molecular biology**, which is largely concerned with understanding how genes control the chemical processes.



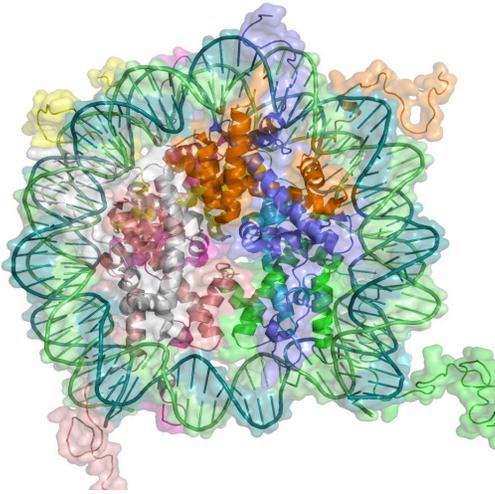
Rosalind Elsie Franklin was an English chemist and X-ray crystallographer who made contributions to the understanding of the molecular structures of DNA // Watson and Crick saw Franklin's work and used it to solve the structure of DNA – they became famous and she became a footnote in history!

# Classical Genetics VS Modern Genetics VS Epigenetics

---

- Gregor Mendel is considered the **father of Classical Genetics**. He worked with pea plants in the mid 1850s to demonstrate patterns of heredity. He coined the terms dominant and recessive traits. Mendel's early work predated our understanding of molecular biology and DNA's role as the informational molecule responsible for heredity by almost 80 years.
- Charles Darwin wrote *On the Origin of Species* in 1859. He explained how Evolution and Natural Selection create new species.
- Darwin's and Mendel's early work is known as **Classical Genetics** which was updated and renamed **Modern Genetics** in the 1940's to incorporate the role of DNA .
- Epigenetics extends our understanding of Modern Genetics. A consensus definition of the concept of an **epigenetic trait** is a “stably heritable phenotype resulting from changes in a chromosome **without alterations in the DNA sequence**”. This was formulated at a Cold Spring Harbor meeting in 2008

# Classical Genetics VS Modern Genetics VS Epigenetics

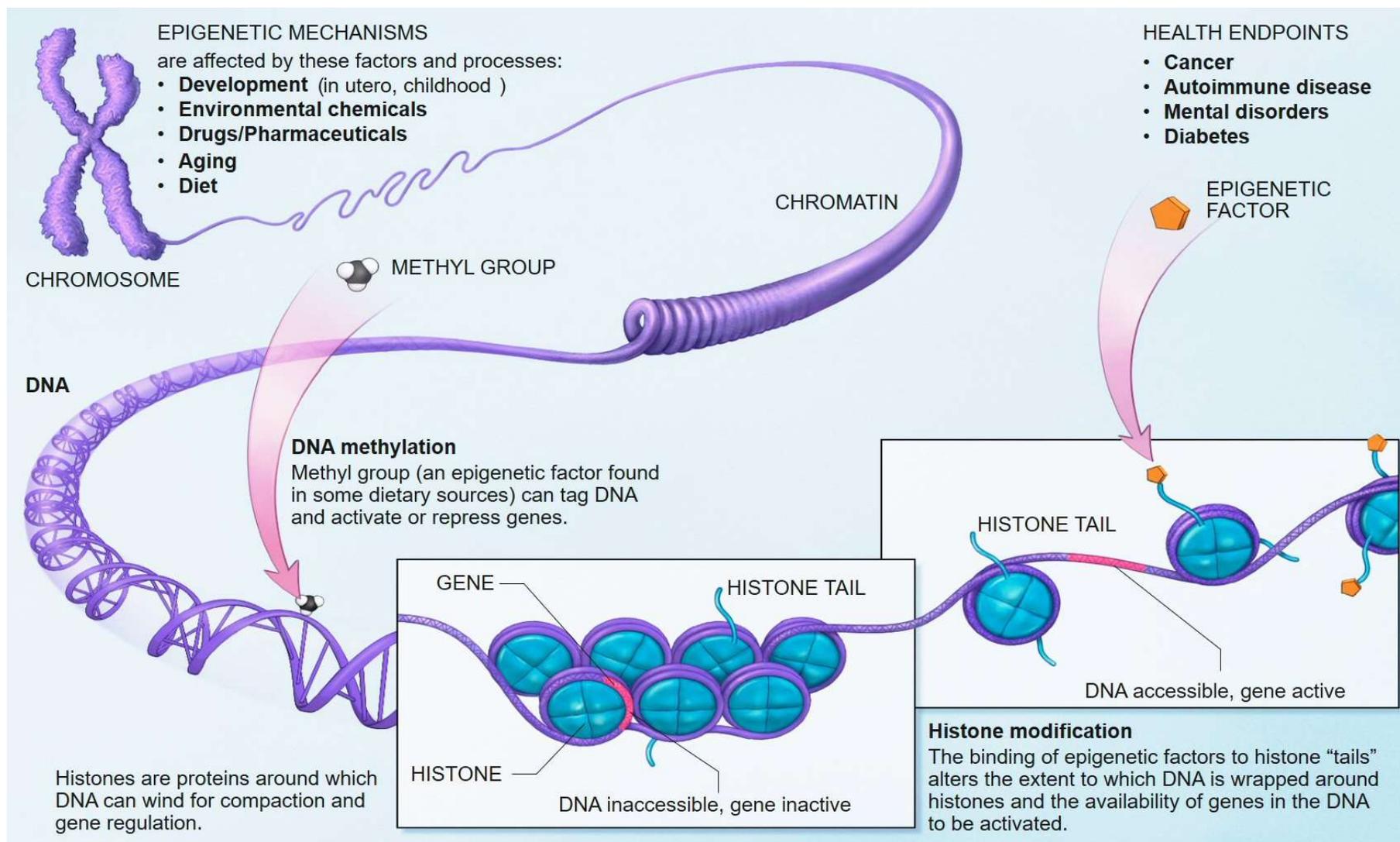


Epigenetics is the study of heritable phenotype changes that do not involve alterations in the DNA sequence. The Greek prefix epi- (ἐπι- "over, outside of, around") in epigenetics implies features that are "on top of" or "in addition to" the traditional genetic basis for inheritance.

Epigenetics most often denotes changes that affect gene activity and expression, but can also be used to describe any heritable phenotypic change. Such effects on cellular and physiological phenotypic traits may result from external or environmental factors, or be part of normal developmental program.

The standard definition of epigenetics requires these alterations to be heritable, either in the progeny of cells or of organisms. (Wiki)

# Classical Genetics VS Modern Genetics VS Epigenetics



# Human Origins & Adaptations

---

- **Theory of natural selection**
  - Explains how species originate and how genes change over time
  - changed view of “our origin, our nature and our place in the universe”
  - Increased our understanding of human form and function
  - showed our inter-connection to other species

# Evolution, Selection, and Adaptation

---

- **What is evolution?**
  - change in genetic composition of a population for an organisms over time
  - Multicellular organisms change slowly over time
  - Bacteria have very short generation times // Able to demonstrate evolution in real time with bacteria (examples)
    - We see evolution occur as bacteria develop resistance to antibiotics
    - Virus also evolve // e.g appearance of new strains of AIDS virus or the appearance of new seasonal flu

# Evolution, Selection, and Adaptation

---

- **Natural Selection**

- some individuals within a species have hereditary advantage over their competitors
  - better camouflage // e.g. brown bears vs polar bears
  - disease resistance
  - ability to attract mates
  - ability to produce more offspring
- Natural selection is a force that determines which genes are expressed in the next generation
- Selection Pressures – natural forces that promote the reproductive success of some individuals more than others
- **Epigenetics** is a new biologic concept to explain how gene expression maybe altered more rapidly than traditional genetics

# Evolution, Selection, and Adaptation

---

- **Adaptations**
  - features of an organism's anatomy, physiology, or behavior that have evolved in response to these selection pressures and enable the organism to cope with the challenges of its environment.

# Our Animal Relations

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- **Human's closest relative - chimpanzee**
  - difference of only 1.6% in DNA structure
  - chimpanzees and gorillas differ by 2.3%
  - Bonobos, chimpanzees, and humans share 98.7% of their genes
- **Study of evolutionary relationships**
  - help us chose animals for biomedical research (the animal model)
  - rats and mice used extensively due to issues involved with using chimpanzees

# Vestiges of Human Evolution

- **Vestigial Organs** – remnants of organs that apparently were better developed and more functional in the ancestors of a species, and now serve little or no purpose
  - E.g. piloerector muscle
  - E.g. auricularis muscles

# Life in the Trees

- Primates – order of mammals to which humans, monkeys, and apes belong
- Earliest Primates
  - squirrel-sized, arboreal, insect-eating African mammals
  - moved to trees due to safety, food supply and lack of competition
- Adaptations for arboreal (treetop) life style
  - mobile shoulders
  - opposable thumbs made hands prehensile to grasp branches and encircle them with the thumb and finger
  - forward-facing eyes (stereoscopic vision) // depth perception for leaping and catching prey
  - color vision // distinguish ripe fruit and young, less toxic foliage
  - larger brains and good memory // remember food sources and improved social organization

# Walking Upright

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- African forest became grassland 4-5 million years ago // producing more predators and less protection
- Bipedalism - standing and walking on 2 legs // helps spot predators, carry food or infants
- Adaptations for bipedalism
  - skeletal and muscular modifications
  - increased brain volume
  - family life and social changes

# Walking Upright

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- ***Australopithecus*** – oldest bipedal primate // “Lucy” walked the earth 4 million years ago
- ***Homo genus*** (appeared 2.5 million years ago) // taller, larger brain volume, probable speech, tool-making
- ***Homo erectus*** (appeared 1.8 million years ago) // migrated from Africa to parts Asia
- **Other Homo species** discovered recently still matter of considerable debate how these species fit into the puzzle
- ***Homo sapiens*** originated in Africa 200,000 years ago // humans are *Homo sapiens* // sole surviving hominid species // We are hominids!
- **Evolutionary (Darwinian) medicine** traces some of our diseases and imperfections to our past

# Analyzing Medical Terms

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- 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

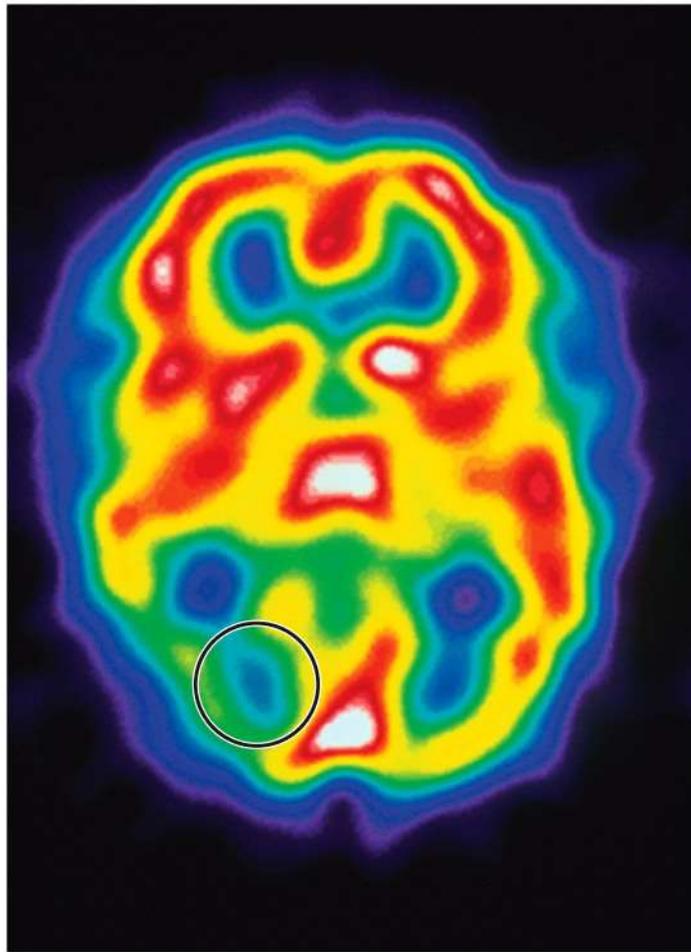
**TABLE 1.2****Singular and Plural Forms of  
Some Noun Terminals**

<b>Singular Ending</b>	<b>Plural Ending</b>	<b>Examples</b>
-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**

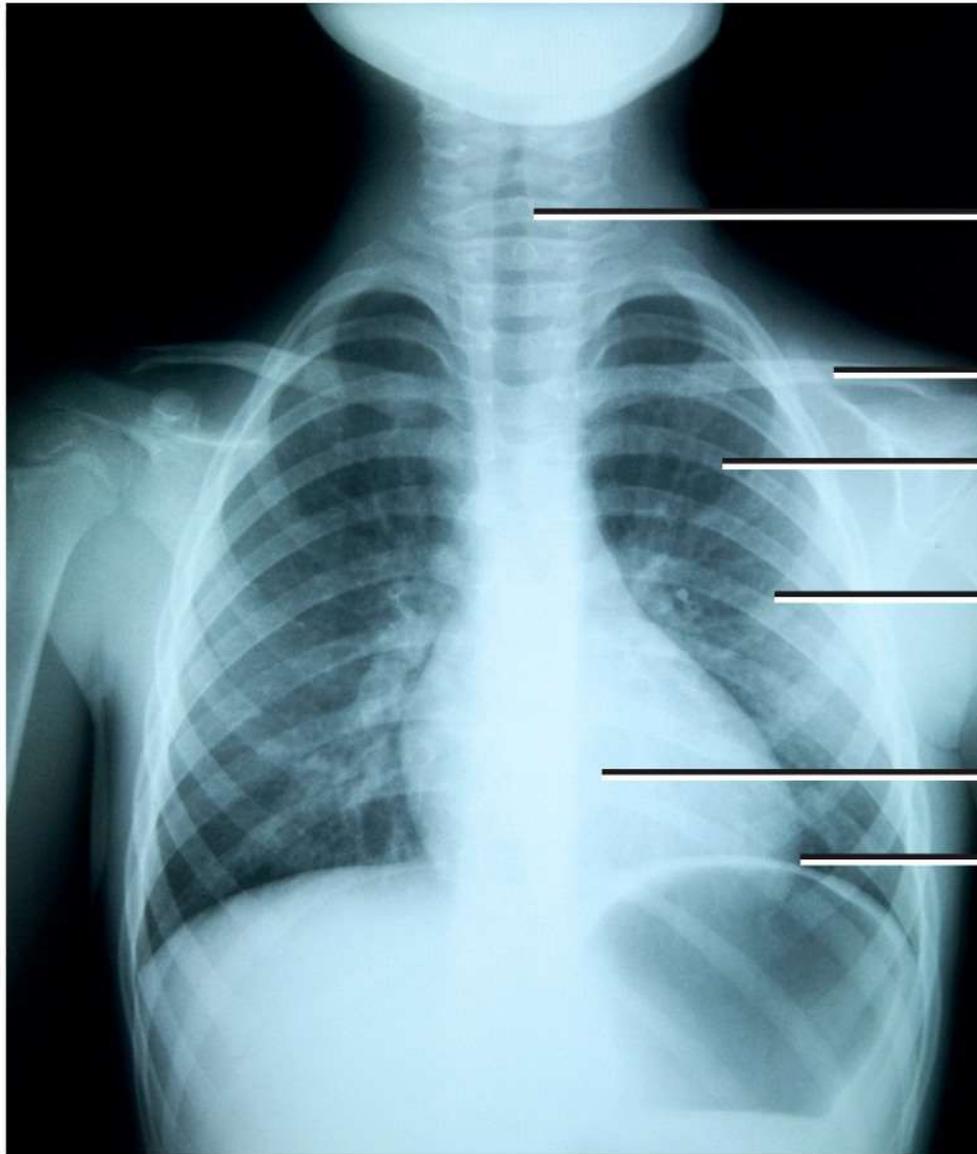
# Imaging Technology

Not Learning Objectives



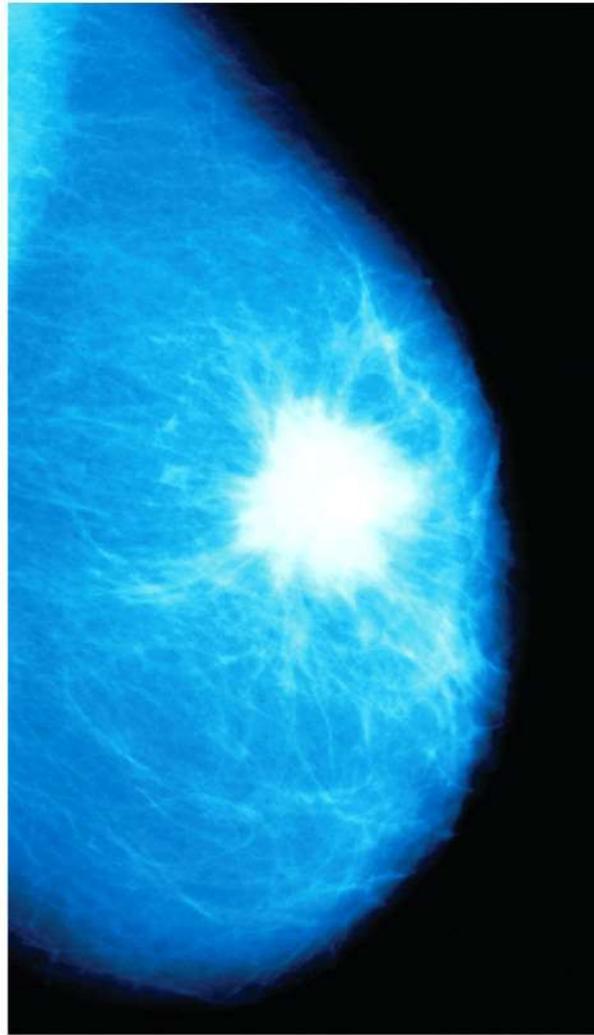
Dept. of Nuclear Medicine, Charing Cross Hospital/Photo Researchers, Inc.

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



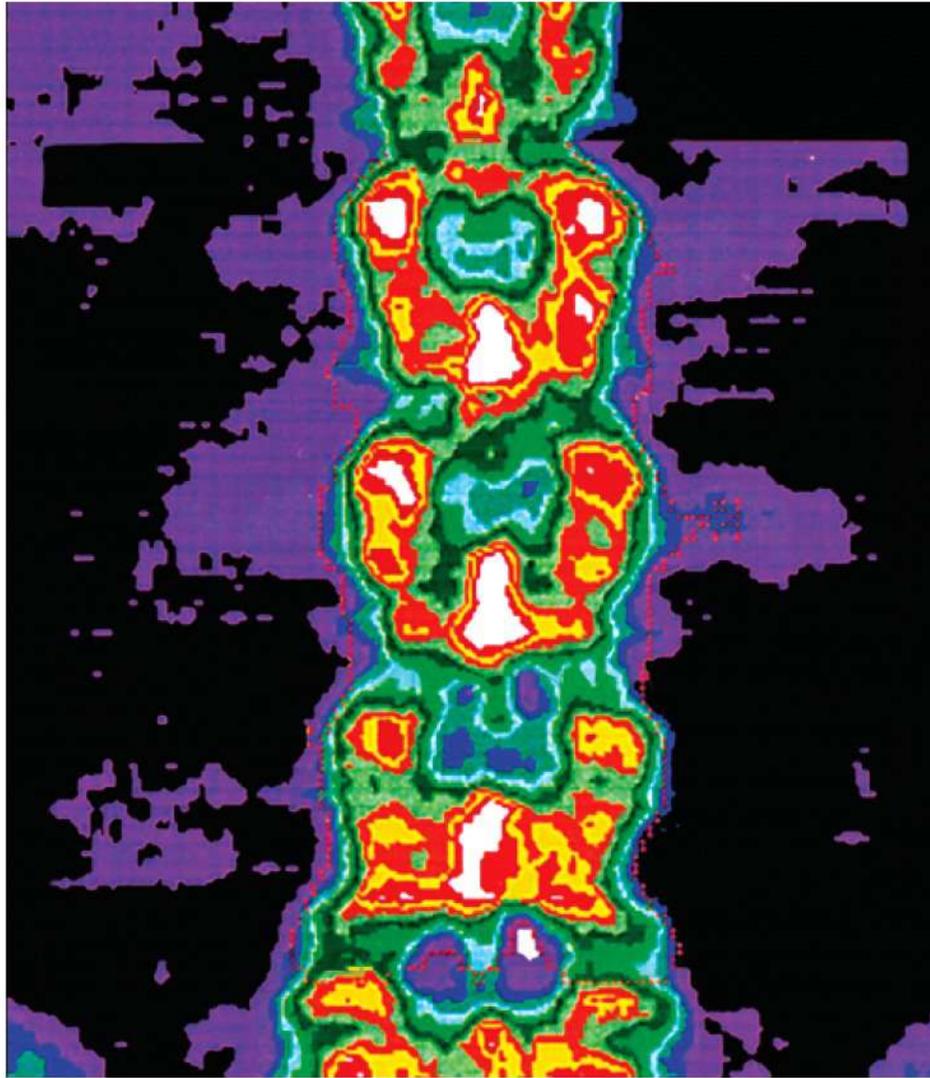
- Vertebral column
- Left clavicle
- Left rib
- Left lung
- Heart
- Diaphragm

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)



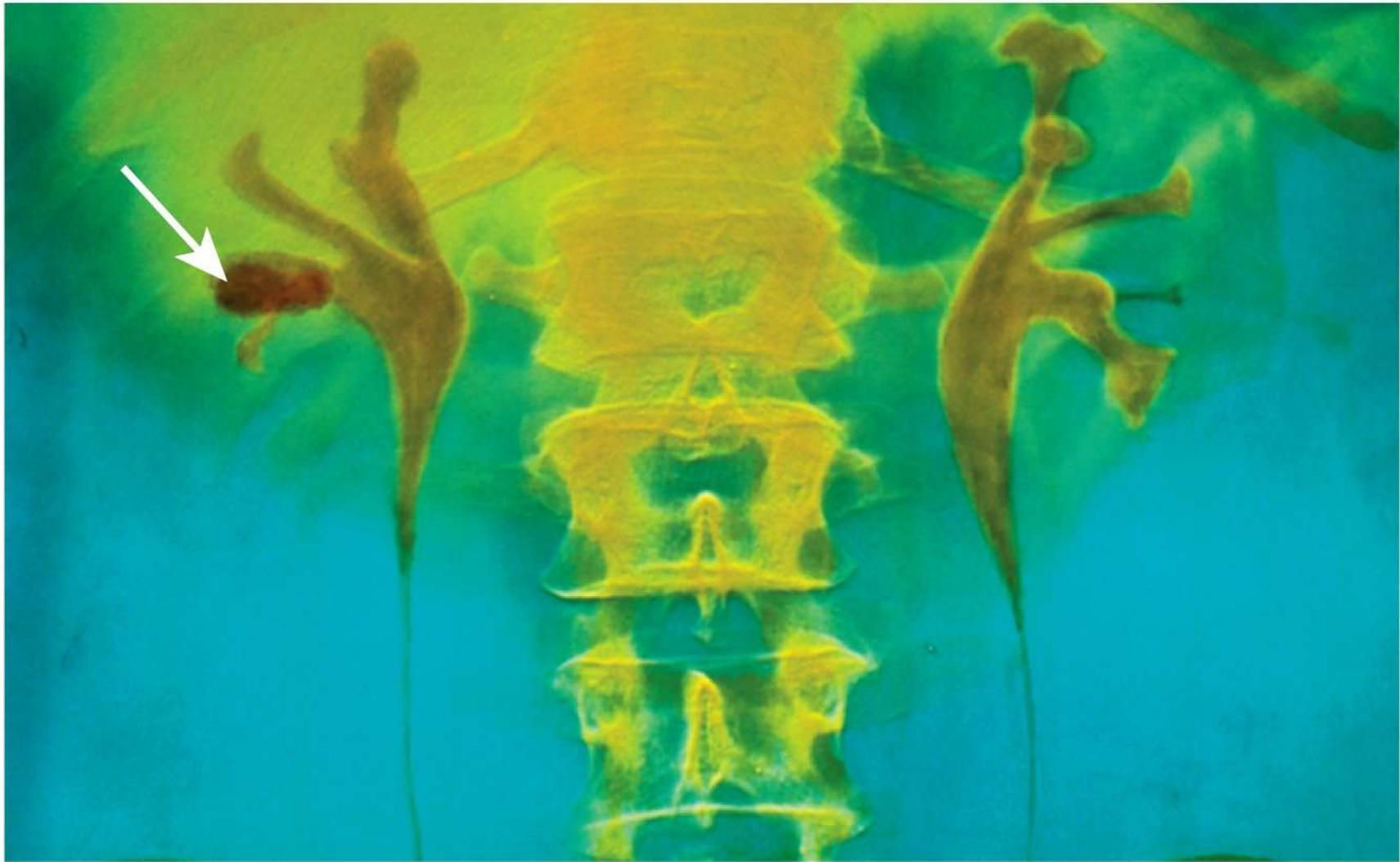
Zephyr/Photo Researchers, Inc.

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)



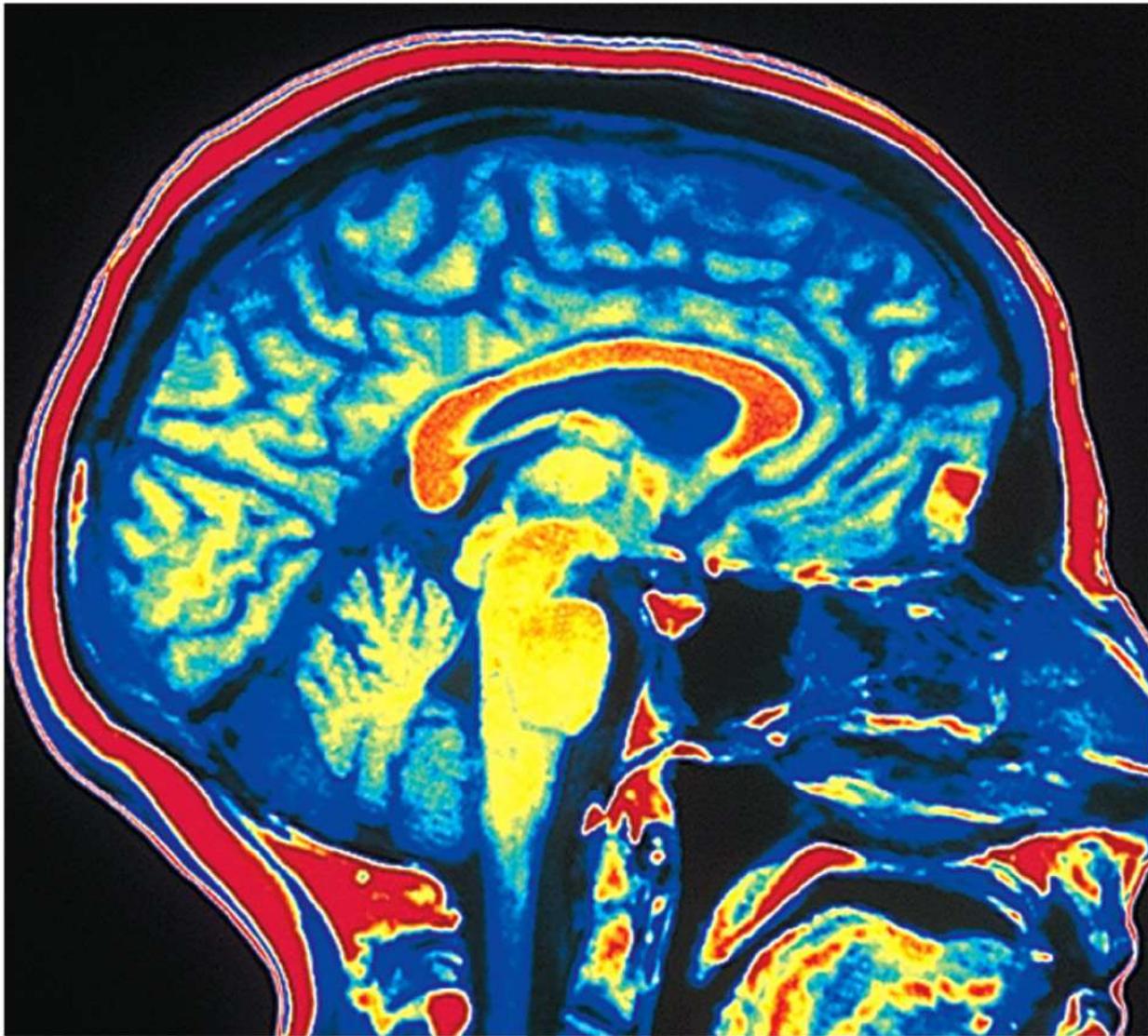
CNRI/Science Photo Library/Photo Researchers, Inc.

Intravenous urogram showing kidney stone (arrow) in right kidney



Science Photo Library/Photo Researchers, Inc.

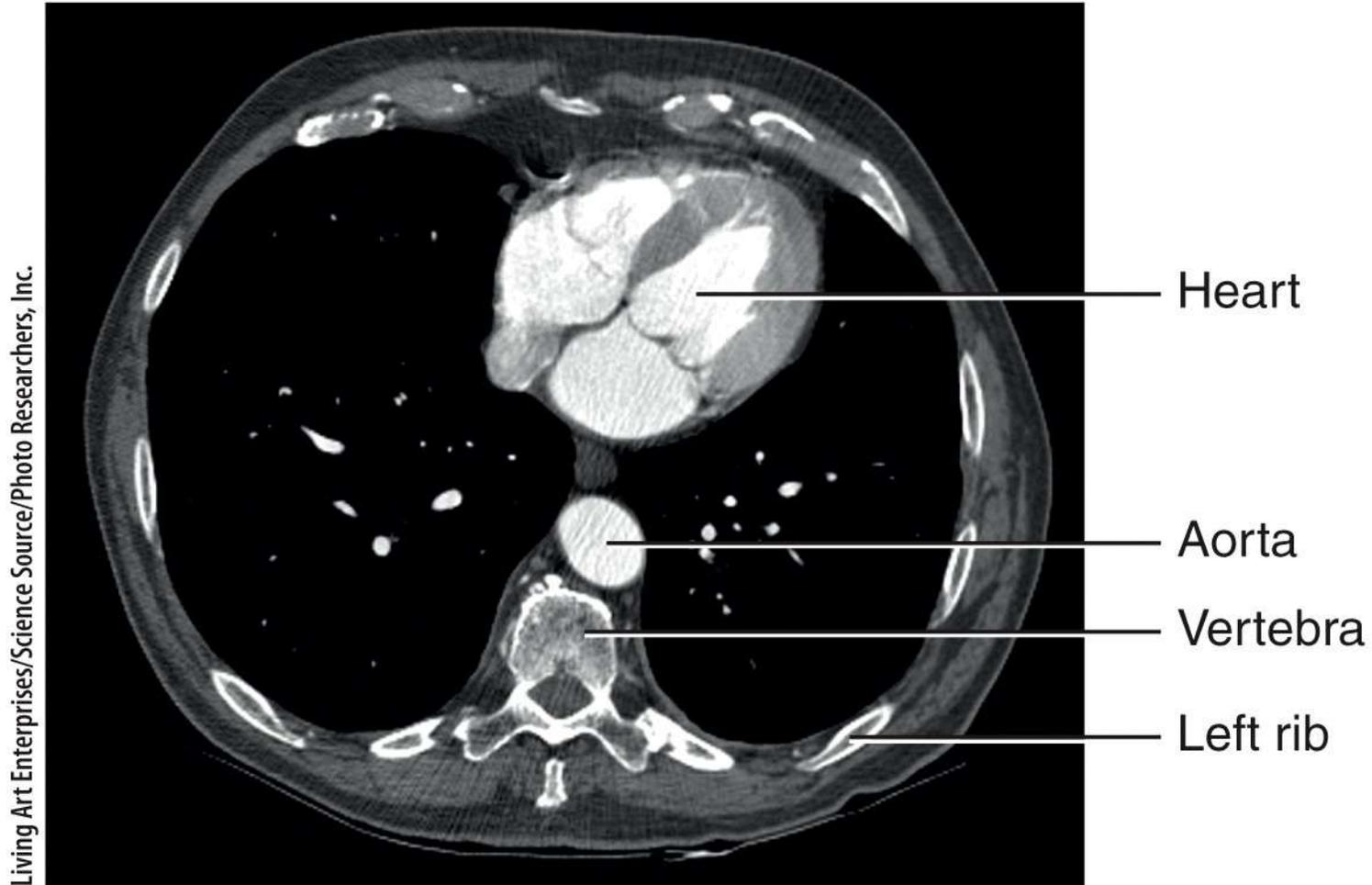
Barium contrast x-ray showing cancer of the ascending colon (arrow)



Scott Camazine/Photo Researchers, Inc.

Magnetic resonance image of brain in sagittal section

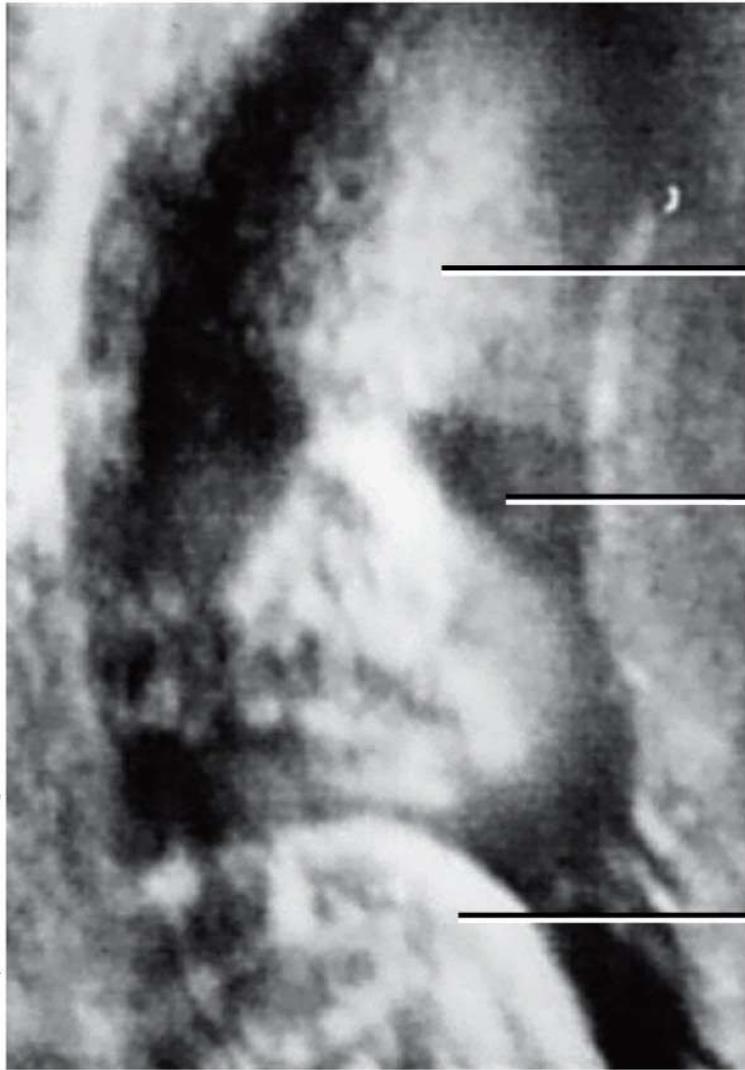
ANTERIOR



POSTERIOR

Computed tomography scan of thorax in inferior view

Courtesy Andrew Joseph Tortora and Damaris Soler



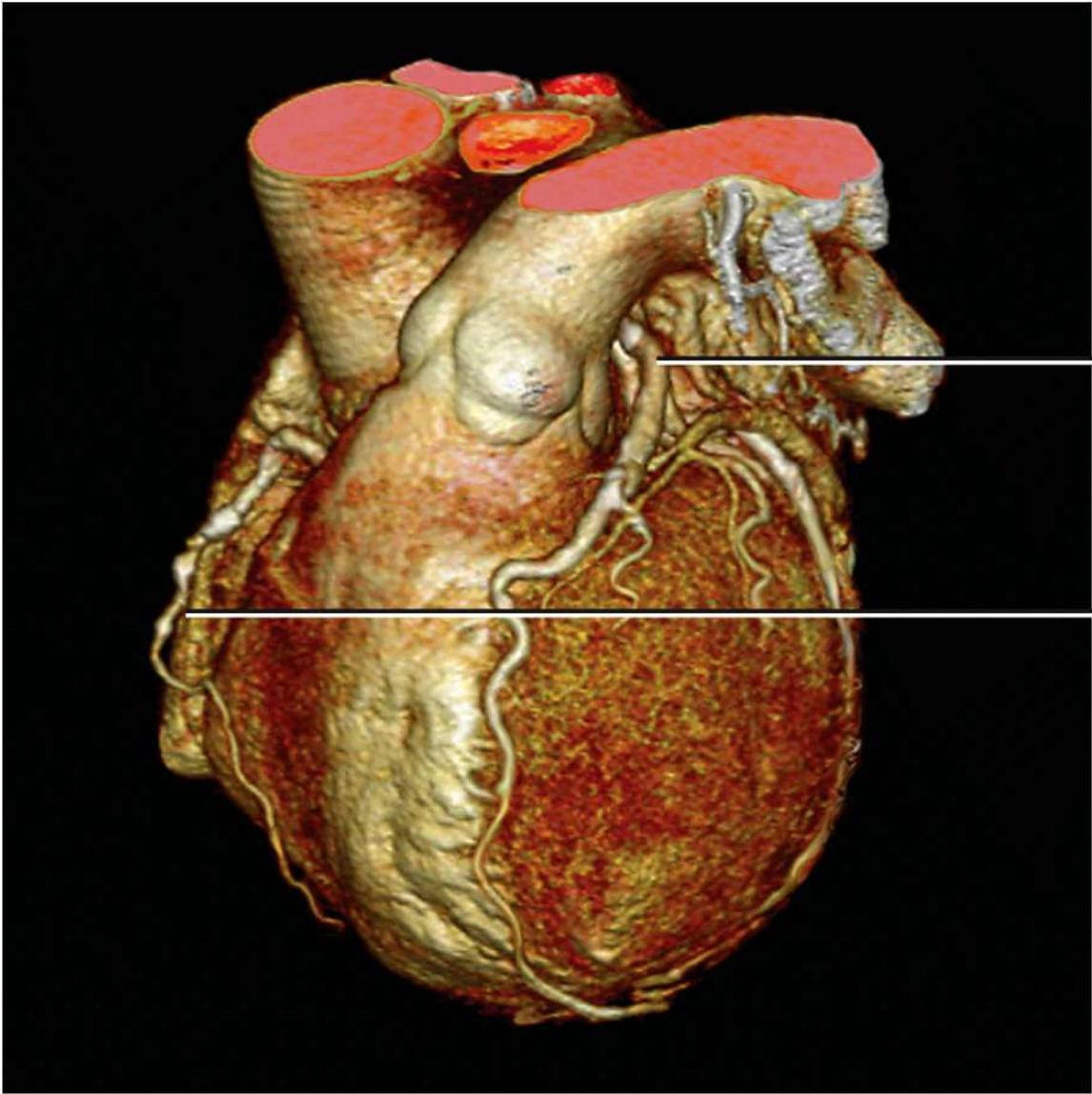
Forehead

Eye

Hand

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

ISM/Phototake

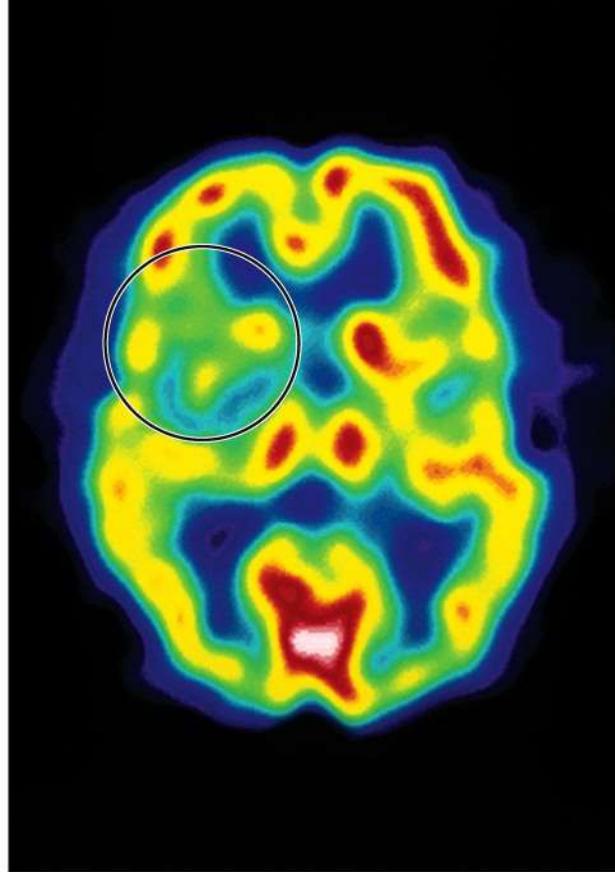


Normal left coronary artery

Blocked right coronary artery

CCTA scan of coronary arteries

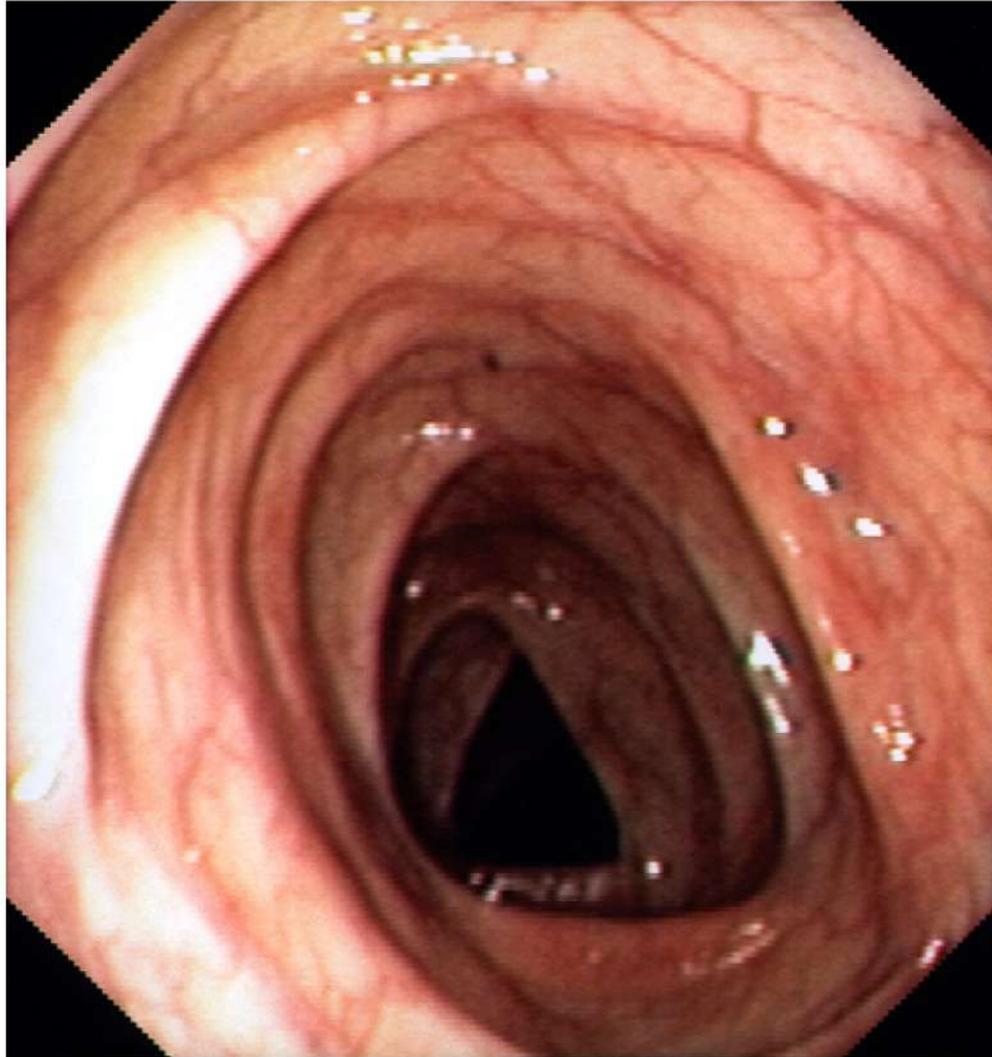
ANTERIOR



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

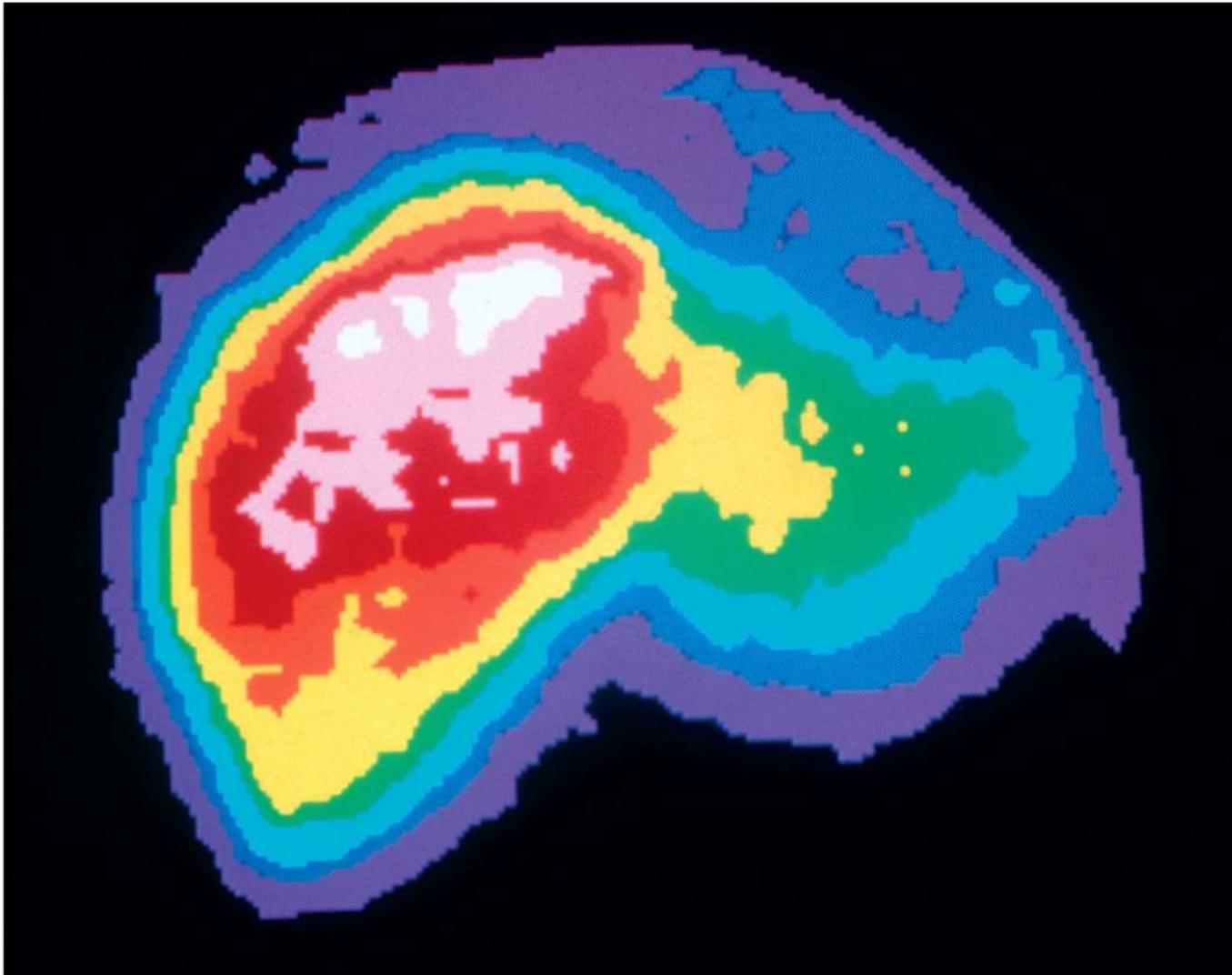
POSTERIOR

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