

## CHAPTER 01

### INTRODUCTION

TO

# ANATOMY and PHYSIOLOGY

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## I. The Scope of Anatomy and Physiology

### A. Anatomy - The Study of Form

1. Anatomy is the study of **structure**, often done by dissection of cadavers.

Different levels of anatomy include:

**gross anatomy** (structures observed via the unaided eye)  
microscopic anatomy (**histology**- tissues; **cytology**- cells)  
**ultrastructure** (finer details; electron microscope)

2. Other ways to study anatomy include:

**palpation:** feeling with hands; i.e.- swollen liver, pulse.

**auscultation** listening to natural sounds of the body (i.e., lung/heart).

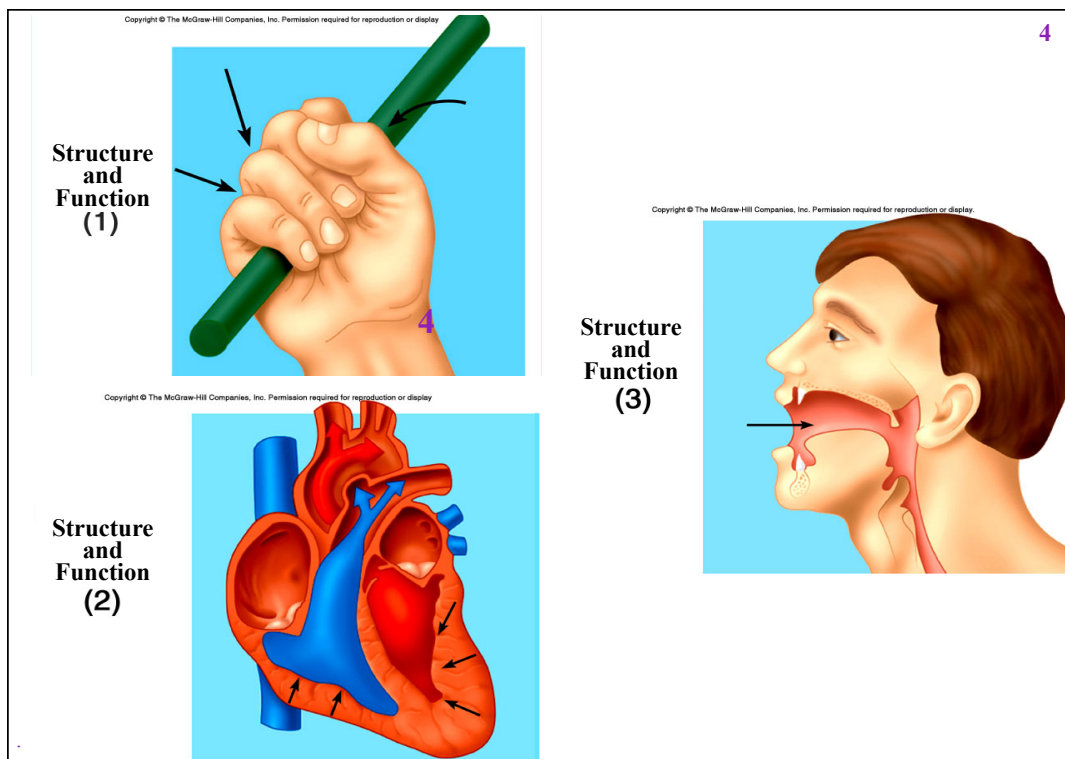
**percussion:** tapping for echo sounds- reveals abnormal pockets of air/fluid.

## B. Physiology - The Study of Function

1. **Physiology** is the study of **function**, and is primarily an experimental science.  
Specialties: **neuro-**, **cellular-**, **patho-** etc.
2. **Comparative physiology** employs *other species* to enable us to learn more about human physiology/evolution/form-function relationships.

## C. Unity of Form and Function

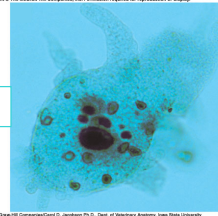
Anatomy is the result of physiology, and physiology is made possible by anatomic structure.



## II. The Nature of Life

### A. What Is Life?

Amoeba



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#### 1. Life is a collection of *properties*:

<b>cellular organization</b>	microscopic units of structure all functions of the body
<b>biochemical unity</b>	all contain similar components: <b>proteins, lipids, carbohydrates, DNA</b> etc. these are <u>unique</u> to <i>living materials</i> or those of <i>biological origin</i> .
<b>metabolism</b>	all physical and chemical changes that occur within living cells. either <b>catabolism</b> or <b>anabolism</b> . assists in maintenance of <b>homeostasis</b> .

#### 1. Life is a collection of *properties*: (cont.)

<b>responsiveness</b>	<b>excitability</b> via <b>detection of a change in conditions (stress)</b> ; <u>detection</u> by cell (i.e. eye, taste) <u>reaction</u> to stress via receptors may cause an <u>action</u> by an <b>effector</b> (i.e. muscle/gland).
<b>development</b>	change in form and/or function over lifetime <b>growth</b> : increase in size <b>differentiation</b> : non-specialized to specialization

2. Clinical and legal definitions of life vary from those of the scientist.  
A person is declared **legally dead** when he/she has not shown brain waves for 30 minutes, has no reflexes, and no heartbeat or respiration without assistance.

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<b>table 1.1 Characteristics of Animal Life</b>			
Process	Examples	Process	Examples
Movement	Change in position of the body part; motion of an internal organ	Digestion	Breakdown of food substances into simpler forms that can be absorbed and used
Responsive-ness	Reaction to a change taking place inside or outside the body	Absorption	Passage of substances through membranes and into body fluids
Growth	Increase in body size without change in shape	Circulation	Movement of substances from place to place in body fluids
Reproduction	Production of new organisms and new cells	Assimilation	Changing of absorbed substances into chemically different forms
Respiration	Obtaining oxygen, using oxygen in releasing energy from foods and removing carbon dioxide	Excretion	Removal of wastes produced by metabolic reactions

<b>table 1.2 Requirements of Organisms</b>					
Factor	Characteristic	Use	Factor	Characteristic	Use
Water	A chemical substance	For metabolic processes, as a medium for metabolic reactions to transport substances, and to regulate body temperature	Oxygen	A chemical substance	To help release energy from food substances
Food	Various chemical substances	To supply energy and raw materials for the production of necessary substances and for the regulation of vital reactions	Heat	A form of energy	To help regulate the rates of metabolic reactions
			Pressure	A force	Atmospheric pressure for breathing; hydrostatic pressure to help circulate blood

## B. Human Organization - A Hierarchy of Structural Complexity

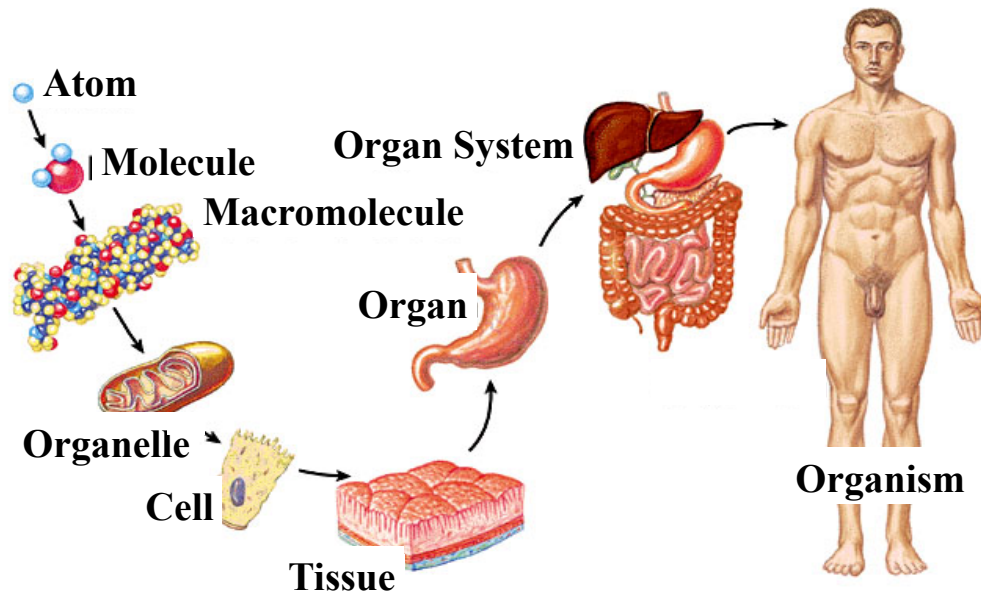
### 1. Humans are organisms.

<b>organism</b>	<i>single, complete individual</i>
<b>organ system</b>	<i>group of organs; unique purpose</i> i.e., circulatory, respiratory, digestive reproductive, nervous etc.
<b>Tissues</b>	<i>group of similar cells and non-living products serving a specific function.</i> may form a discrete region of an organ.
<b>histology:</b> the study of tissues	Four primary classes: <b>muscular, nervous, epithelia and connective</b>

<b>Cytology:</b> The study of cells	<b>Cells:</b> smallest unit of an organism capable of performing all basic functions of life. Surrounded by a membrane (lipid/protein) <i>eukaryotic has a membrane enclosed nucleus</i> at some point in life (i.e. RBCs) few may be multi-nucleate: i.e., liver, some bone marrow. <i>prokaryotic has <u>no</u> nuclear membrane</i> <u>example:</u> bacteria
<b>Cytoplasm:</b> the gelatinous fluid within all cells	
<b>organelles</b>	- microscopic cellular structures that carry out individual functions. e.g., mitochondria, lysosomes, Golgi complex, centrioles, etc.
<b>molecules</b>	- make up all cellular components; - are comprised of <b>atoms</b> . <i>subatomic particles: protons, neutrons, electrons.</i>

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## Organization of Human Body



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Level	Example	Illustration
Atom	Hydrogen atom, lithium atom	Figure 2.1
Molecule	Water molecule, glucose molecule	Figure 2.10
Macro-molecule	Protein molecule, DNA molecule	Figure 2.18
Organelle	Mitochondrion, Golgi apparatus, nucleus	Figure 3.12
Cell	Muscle cell, nerve cell	Figure 3.2
Tissue	Simple squamous epithelium, loose connective tissue	Figure 5.1
Organ	Skin, femur, heart, kidney	Figure 7.2
Organ system	Integumentary system, skeletal system, digestive system	Figure 7.17
Organism	Human	Figure 23.26

2. **Reductionism** suggests that a human body can be understood by **studying its simpler components.** (*smaller and smaller discovery*).
3. **Holism** suggests that there are properties possessed by the whole organism *that are not apparent (not obvious) from the study of its parts*, such as psychological factors.

Treating the **whole person** *not just individual symptoms*.

### III. Scientific Method

#### A. The Inductive Method

The inductive method involves **making numerous observations** *and then forming generalizations and predictions.*

#### B. The Hypothetico-Deductive Method

The hypothetico-**deductive** *method* begins with the formulation of a **hypothesis** (an educated guess) followed by a **deduction**.

An experiment will help the scientist decide whether to abandon the hypothesis. **Must be testable!**  
Over time, assuming acceptance -> **theory**.

### C. Experimental Design

1. Experimental design must employ a **large enough sample size**, and a **control** group. The control group receives the same conditions with the *exception* of the variable under observation.
2. **Placebos** are used to rule out *psychosomatic* effects seen with medication trials.
3. Experimenter bias can be minimized through the use of the **double-blind method** in which neither the physician nor the patient know which treatment was received; *only the scientist in charge knows*.
4. Experiments must undergo rigorous **statistical testing** to help rule out chance events.

### D. Peer Review

1. Most scientific journals subject manuscripts to rigorous (sometimes!) **peer review** prior to publication.

### E. Facts, Laws, and Theories

1. **Basic research** involves determining how nature works, while **applied science** seeks to study the application to human welfare.
2. A scientific “fact” is an **observation**; a law of nature is a **generalization** supported by much scientific evidence.  
A **theory** is a *well-substantiated statement* designed to explain a natural **phenomenon**.  
phenomenon = simply an event.

## IV. Homeostasis and Feedback

### A. Homeostasis

1. **Homeostasis** is the body's ability to **maintain relatively constant internal conditions**, *and to return to those conditions if upset*. Failure to maintain: illness or death.

Not static; not exact- regulation attempts *to stabilize an acceptable range* (average = set point, i.e. 37°C temp.)

**Dynamic (changing) equilibrium**: balanced change.  
**Feedback loops**: general name for these mechanisms which alter the original changes that triggered them.

**Autoregulation**: change is automatic

**Extrinsic regulation**: involves **nervous** or **endocrine** (hormones) systems.

**Hormones**: chemical messengers produced in one part of the body having an effect in another (target).

Both systems may adjust other systems simultaneously.

*Examples*: lack of digestion during exercise-  
 effect of nervous system.  
 reduced oxygen to stomach;  
 increase heart rate to bring oxygen to muscles.

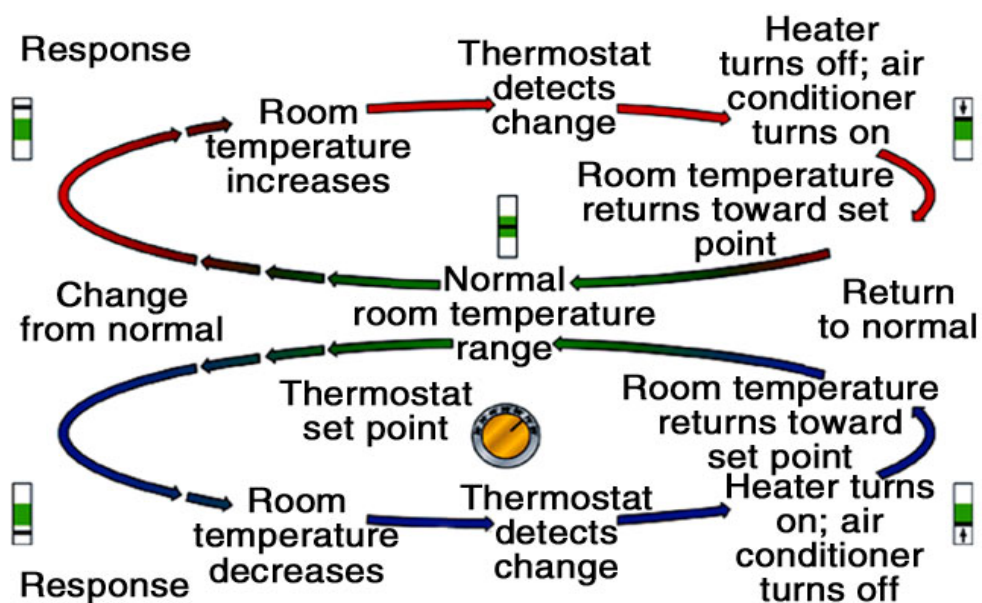
## IV. Homeostasis and Feedback

### B. Negative Feedback and Stability

1. **Negative feedback** is the main way the body *returns to stable conditions*.  
How a thermostat works to control a room's temperature illustrates the idea of negative feedback.
2. Human "thermostats" involve:  
**vasoconstriction** or **vasodilation** of blood vessels to exchange heat with the outside environment.  
This thermoregulation is autoregulated.

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## Homeostatic Mechanism



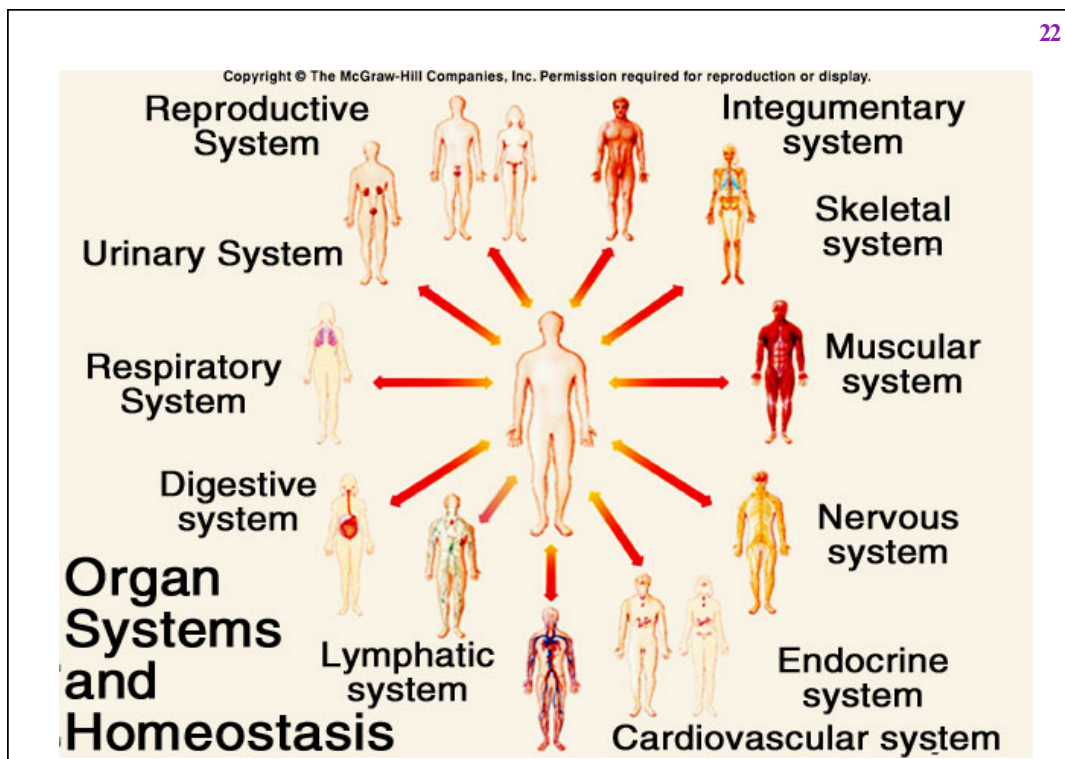
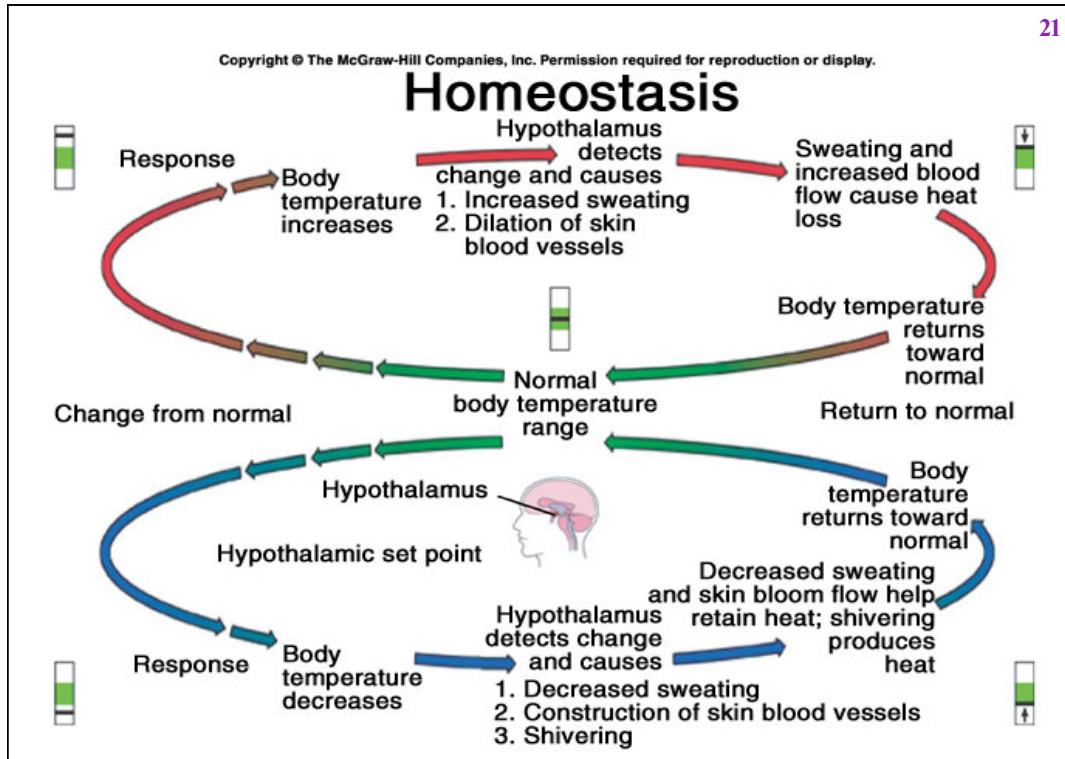


table 1.4	Organ Systems	
Organ system	Major Organs	Major function
Integumentary	Skin, hair, nails, sweat glands, sebaceous glands	Protect tissues, regulate body temperature, support sensory receptors
Skeletal	Bones, ligaments, cartilages	Provide framework, protect soft tissue, provide attachments for muscles, produce blood cells, store inorganic salts
Muscular	Muscles	Cause movements, maintain posture, produce body heat
Nervous	Brain, spinal cord, nerves, sense organs	Detect changes, receive and interpret sensory information, stimulate muscles and glands
Endocrine	Glands that secrete hormones (pituitary gland, thyroid gland, parathyroid glands, adrenal glands, pancreas, ovaries, testes, pineal gland, and thymus gland)	Control metabolic activities
Cardiovascular	Heart, arteries, capillaries, veins	Move blood through blood vessels and transport substances throughout body
Lymphatic	Lymphatic vessels, lymph nodes, thymus, spleen	Return tissue fluid to the blood, carry certain absorbed food molecules, defend the body against infection
Digestive	Mouth, tongue, teeth, salivary glands, pharynx, esophagus, stomach, liver, gallbladder, pancreas, small and large intestine	Receive, break down, and absorb food; eliminate unabsorbed material
Respiratory	Nasal cavity, pharynx, larynx, trachea, bronchi, lungs	Intake and output of air, exchange of gases between air and blood
Urinary	Kidneys, ureters, urinary bladder, urethra	Remove wastes from blood, maintain water and electrolyte balance, store and transport urine
Reproductive	Male: scrotum, testes, epididymides, vasa deferentia, seminal vesicles, prostate gland, bulbourethral glands, urethra, penis Female: ovaries, uterine tubes, uterus, vagina, clitoris, vulva	Produce and maintain sperm cells, transfer sperm cells to female reproductive tract Produce and maintain egg cells, receive sperm cells, support development of an embryo and function in birth process

## IV. Homeostasis and Feedback

### C. Positive Feedback and Rapid Change

1. **Positive feedback** is a **self-amplifying cycle**, such as the increasing output of oxytocin and uterine contractions during labor and childbirth.  
Generally, positive feedback mechanisms produce **quick results**.
2. Some pathogens trigger high fevers that are regulated by positive feedback designed to rid the body of the pathogen. Such **positive feedback** can be life-threatening.

Example: very high temperature  
(108°F may initiate **runaway**)  
great distance from the set point

## V. Noninvasive Medical Imaging

- i. **X rays, and radiography,**  
are the oldest and still most used method of imaging the body. **High energy radiation** passes through the body but is **absorbed** by *bone, teeth, tuberculosis nodules and tumors*.  
**hollow organs/spaces:** electron opaque substances  
**angiogram:** injected substances (blood vessel visualization)  
**mammography:** images sometimes overlap
- ii. **Sonography:**  
high frequency waves- *echo analysis reconstructs image*.  
is useful in obstetrics because of its safety, although *it does not produce a sharp image*.

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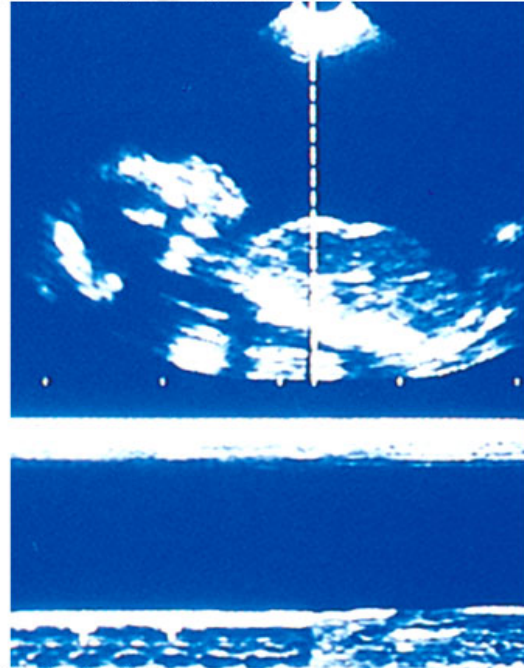
## Ultrasonography



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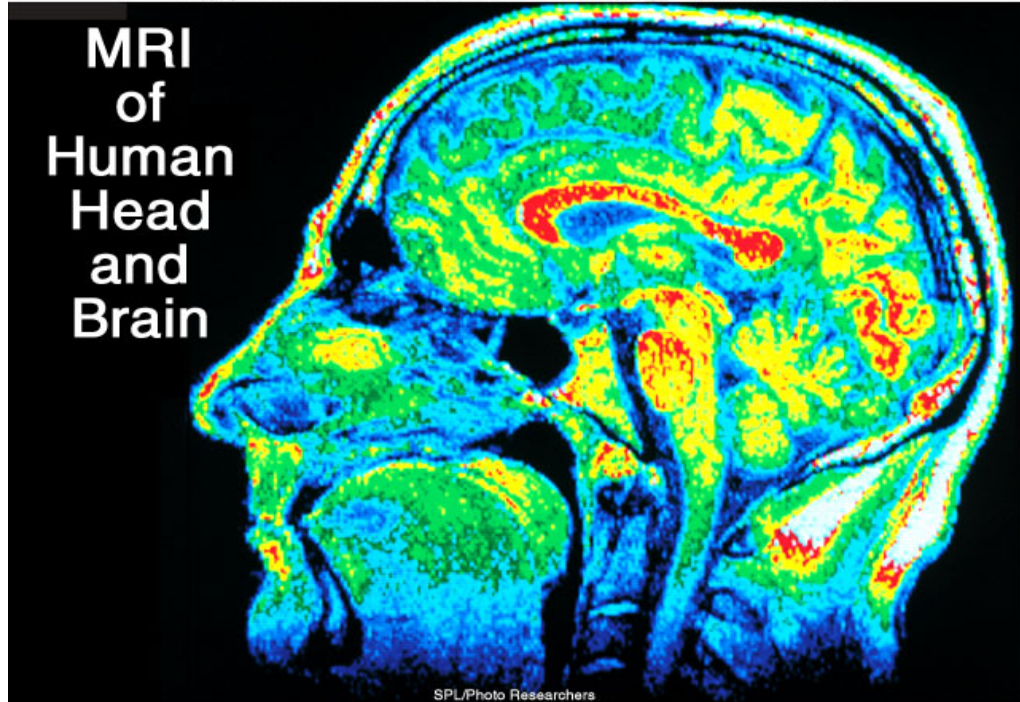
## Ultrasonography Showing Fetus



Copyright Lutheran Hospital/Peter Arnold

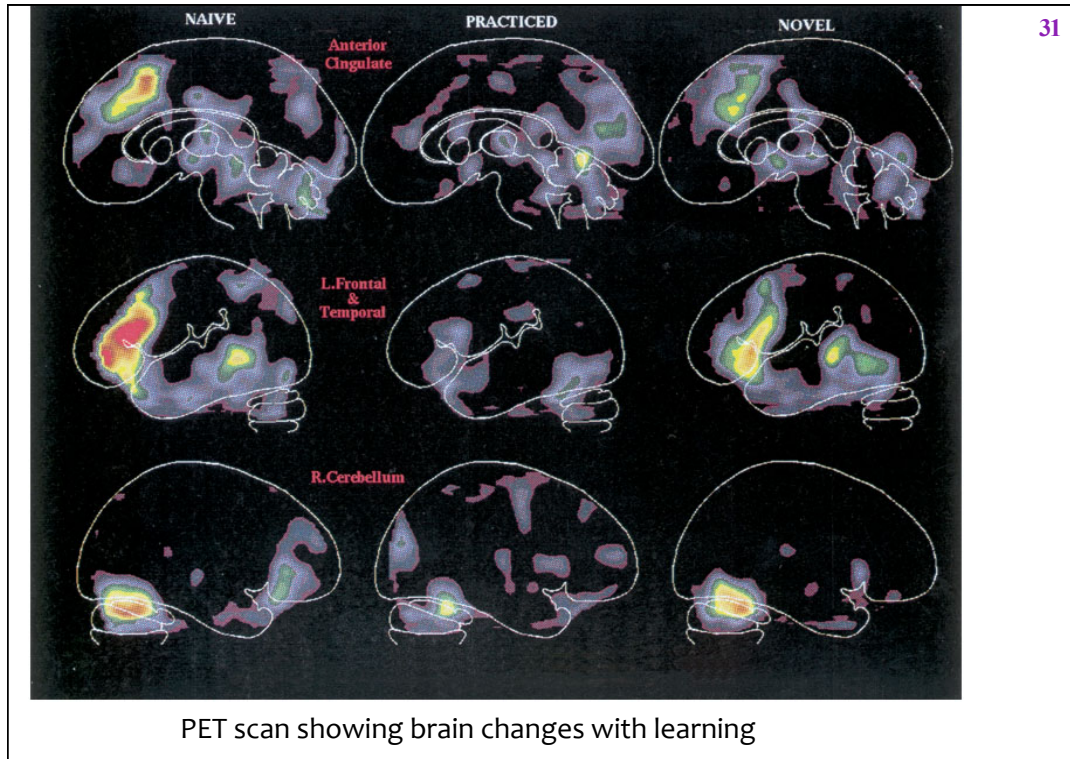
## V. Noninvasive Medical Imaging

- iii. **Computed tomography (CT, formerly, CAT)**  
**scans *thin sections of the body*;**  
 has virtually **eliminated exploratory surgery.**  
 similar to traditional X-rays; uses low intensity X-rays.  
 stacked **slices** used to ***reconstruct 3-D image*** of  
 aneurysms, tumors, kidney stones, and cerebral hemorrhages.
  
- iv. **Magnetic Resonance Imaging (MRI, formerly NMR)**  
 creates a magnetic field in which the patient's hydrogen  
 atoms align, releasing energy and producing an image.  
**better than CT in analyzing the nervous system and  
 other soft tissues.**



## V. Noninvasive Medical Imaging

- v. **Positron Emission Tomography (PET)**  
assesses the **metabolic rates of tissues**, and  
is an example of nuclear medicine:  
radioactive glucose injections:  
positron emissions collide with electrons and release  
gamma rays, translated via computer to various colors  
reflecting **degree of metabolic activity**.



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**VI. Language of Anatomy**  
 (see Labbook: Terminology)

**Responsible for all!** (except whole body transverse sections)

The following are simply a few *review examples*.

**I. Anatomical Position**

A. **Anatomical position** is a standing position in which the subject is erect, face forward, eyes ahead, arms down to the sides, with palms up.

B. The forearm is **supine** when palms face forward (**anterior**), and **prone** when they face to the rear (**posterior**).

## VI. Language of Anatomy

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(see Lab-book: Terminology)

### **Responsible for all!** (except whole body transverse sections)

The following are simply a few *review examples*.

#### II. Anatomical Planes

- A. A **sagittal** plane divides the person in anatomical position into right and left halves.  
**Midsagittal** passes through the midline, while **parasagittal** is off to one side.
- B. A **frontal** or **coronal** plane divides the standing body into front and back.
- C. A **transverse** or **cross-sectional plane** divides the body into top and body sections, perpendicular to the long axis.

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# The End

**Anatomical terminology will be included  
on both Lecture and Lab tests.**

**This topic may be reviewed during the Lab**