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?

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

- **cellular organization**: microscopic units of structure, all functions of the body
- **biochemical unity**: all contain similar components: **proteins, lipids, carbohydrates, DNA** etc. These are unique to living materials or those of biological origin.
- **metabolism**: converting chemicals to other forms, assimilation, turnover. Discuss **catabolism** vs. **anabolism** assists in maintenance of **homeostasis**

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

- **responsiveness**: excitability via detection of a change in conditions (stress); detection by cell (i.e. eye, taste) reaction to stress via receptors may cause an action by an **effector** (i.e. muscle/gland).
- **development**: change in form and/or function over lifetime
  - **growth**: increase in size
  - **differentiation**: 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, and has no reflexes, and no heartbeat or respiration without assistance.
## Table 1.1 Characteristics of Animal Life

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

## Table 1.2 Requirements of Organisms

<table>
<thead>
<tr>
<th>Factor</th>
<th>Characteristic</th>
<th>Use</th>
<th>Factor</th>
<th>Characteristic</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>A chemical substance</td>
<td>For metabolic processes, as a medium for metabolic reactions to transport substances, and to regulate body temperature</td>
<td>Oxygen</td>
<td>A chemical substance</td>
<td>To help release energy from food substances</td>
</tr>
<tr>
<td></td>
<td></td>
<td>To supply energy and raw materials for the production of necessary substances and for the regulation of vital reactions</td>
<td>Heat</td>
<td>A form of energy</td>
<td>To help regulate the rates of metabolic reactions</td>
</tr>
<tr>
<td>Food</td>
<td>Various chemical substances</td>
<td></td>
<td>Pressure</td>
<td>A force</td>
<td>Atmospheric pressure for breathing; hydrostatic pressure to help circulate blood</td>
</tr>
</tbody>
</table>
B. Human Organization - A Hierarchy of Structural Complexity

1. Humans are organisms.

- **organism**: single, complete individual

- **organ system**: group of organs; unique purpose
  i.e., circulatory, respiratory, digestive
  reproductive, nervous etc.

- **tissues**: group of similar cells and non-living products serving a specific function.
  may form a discrete region of an organ.
  Four primary classes:
  muscular, nervous, epithelia connective
  histology = study of tissues
cells
study of cells
smallest unit of an organism capable of performing all basic functions of life.

structure =
membrane enclosed nucleus- eukaryotic
at some point in life (reference: RBCs)
few may be multi-nucleate:
i.e., liver, some bone marrow.

If no nuclear membrane- prokaryotic
e.x.: bacteria)

all: gelatinous fluid: cytoplasm

organelles
microscopic cellular structures
carry out individual functions.
i.e., mitochondria, lysosomes, Golgi complex, centrioles etc.

molecules
make up all cellular components;
comprised of atoms, subatomic particles:
protons, neutrons, electrons.

<table>
<thead>
<tr>
<th>Level</th>
<th>Example</th>
<th>Illustration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atom</td>
<td>Hydrogen atom, lithium atom</td>
<td>Figure 2.1</td>
</tr>
<tr>
<td>Molecule</td>
<td>Water molecule, glucose molecule</td>
<td>Figure 2.10</td>
</tr>
<tr>
<td>Macromolecule</td>
<td>Protein molecule, DNA molecule</td>
<td>Figure 2.18</td>
</tr>
<tr>
<td>Organelle</td>
<td>Mitochondrion, Golgi apparatus, nucleus</td>
<td>Figure 3.12</td>
</tr>
<tr>
<td>Cell</td>
<td>Muscle cell, nerve cell</td>
<td>Figure 3.2</td>
</tr>
<tr>
<td>Tissue</td>
<td>Simple squamous epithelium, loose connective tissue</td>
<td>Figure 5.1</td>
</tr>
<tr>
<td>Organ</td>
<td>Skin, femur, heart, kidney</td>
<td>Figure 7.2</td>
</tr>
<tr>
<td>Organ system</td>
<td>Integumentary system, skeletal system, digestive system</td>
<td>Figure 7.17</td>
</tr>
<tr>
<td>Organism</td>
<td>Human</td>
<td>Figure 23.26</td>
</tr>
</tbody>
</table>
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.*

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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 original changes that triggered them.

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**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**

- **Response:** Room temperature changes from normal.
- **Thermostat:** Detects change in room temperature.
- **Heater:** Turns on; air conditioner turns off.
- **Room temperature returns toward set point.**
- **Normal range:** Room temperature.
- **Return to normal:**
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 body but *absorbed*
by bone, teeth, tuberculosis nodules and tumors.
*hollow organs/spaces:* electron opaque substances
  - **angiogram:** injected substances (blood vessel visualization)
  - **mammography:** sometimes, overlap in images

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.*
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* aneurysms, tumors, kidney stones, cerebral hemorrhage.

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

Responsible for all! (except hole 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).

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.
The End

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

This topic will be reviewed during the Lab.