Human Anatomy & Physiology General

this course emphasizes the elationship between **anatomy** and **physiology**

More conceptual approach, interactions stressed

→ need some of both to truly understand how the body works

Anatomy [greek: 'to cut up']

the study of parts and their interrelationships

how the body is organized

What are you, What are you made of?

8 or 10 major **organ systems**

dozens of **tissues** and **organs**

a conglomeration of **trillions of cells**

a collection of carefully arranged **atoms** and **molecules** interacting in millions of different ways

provides a **standardized language**

eg "stomach" means different things to different people

nomenclature was standardized in 1895

Physiology

is the study of biological functions

How does your body work?

all functions of the body involve chemical reactions

cells function by manipulating **energy** and **matter**

= **metabolism**

the whole process is regulated by your "**genes**"

as long as you give your body adequate food it can run automatically

Models

biology is very complex

How can we organize and study such complex processes?

→must **simplify** to understand but

the english satirist, Samuel Butler proclaimed that the human body was merely "a pair of pincers set over a bellows and a stewpan and the whole thing fixed upon stilts"

→lose something in the translation

Use ***models*** to understand complex processes

there are many different kinds of models

some very simple, some extremely elaborate

eg. a philosopher's *model* of the human body: "the body is natures way of learning about itself"

Some Examples of Models in Physiology:

1. Major Organs & Organ Systems

need "organs and organ systems" to coordinate and control all this activity

but these systems can mean different things to different people

thinking of the body in terms of Organ Systems can also be an oversimplification

eg. immune system, lymphatic system, integumentary system, neuroendocrine system

even within a system there can be variations:

anatomy texts present the anatomy seen in ~70% of individuals

→ the most common versions

eg. some people completely lack certain organs (palmaris longus in forearm, plantaris in leg)

eg. most have 5 lumbar vertebrae but some have 4 or 6

eg. most have one spleen, but some have 2

eg. most kidneys are supplied by a single renal artery and drained by one ureter, but some have 2 arteries or ureters

2. Levels of structural organization: [Hierarchy of complexity]

What are you?

matter, energy and their interactions can be applied at many levels in biological systems

→a collection of carefully arranged atoms and molecules all continuously interacting and reacting with each other

→a conglomeration of 100 trillion cells, each orchestrating its own sets of activities; metabolism, transport, replication, etc

→clumps and sheets of specialized cells called tissues designed to perform functions such as storage, movement, impulse conduction, support, etc

→organs systems composed of dozens of organs interacting with each other to perform vital function s such as digestion, respiration, excretion, reproduction, etc

moving up scale each level is more complex than one below it

each level includes all those below it

new properties emerge from each level

in terms of energy, each unit is more unstable than the one below it

atoms –smallest structural units of matter (protons, neutrons, electrons)
molecules – interaction of atoms to form compounds
organelles – specialized components of cells performing specific cellular functions
cells – basic unit of life
tissues – groups of cells carrying out a specific function
organs – groups of tissues performing given functions
organ systems – group of interacting organs
organism – total functioning unit

[**population** – association of same species living in same habitat]
[**community** – popyulations osf several different species livng in same place]
[**ecosystem** – highest level of biological organization]
most complex
environment and community and all interactions]

Learn different things by studying at different levels:

eg stomach digests food, ulcers
tissues/cells mucous cells, endocrine cells etc
chemicals enzymes, hormones,

3. Homeostasis

<u>Homeostasis</u>: the ability to maintain a constant internal environment regardless of fluctuations in the external environment

→ boundaries are needed

factors of the internal environment that must be maintained in homeostasis:

→concentration of nutrient molecules
→concentrations of O_2 and CO_2
→concentrations of waste products
→pH
→concentrations of water, salts and other electrolytes
→temperature
→blood volume and pressure

<u>Requires</u>:

receptor → control center → effectors

receptors can be:
complex sense organs
individual cells
receptor molecules on cells

control center can be:
brain

individual organs

effectors can be:
muscles (smooth, skeletal, cardiac)
glands

homeostasis is maintained mainly by process of **negative feedback**

Negative Feedback: when a change in one direction triggers a response in the opposite direction

has **intrinsic** controls and **set points**

examples

In some instances, **positive feedback** works to return body to homeostasis

=a change in one direction stimulates further change in the <u>same</u> direction
(= **cascades**)

but must have an end point

eg. clotting, immune response, labor,

but *uncontrolled* Positive Feedback causes Homeostatic imbalances; disease and even death

4. Categorizing Disorders and Diseases

we learn about "normal" anatomy & physiology in order to understand disease and how it affects the body

disease
= any change from the general state of good health

Kinds of Diseases

a. injury
b. infectious diseases
c. genetic diseases
d. autoimmune diseases
e. degenerative & age related diseases
f. occupational
g. environmental

eg. infectious diseases

any condition that is the result of an infectious agent: viruses, prions, bacteria, fungi, helminths, etc

eg. genetic diseases

some diseases are due to genetic mutations

eg. Hemophilia, Sickle Cell Anemia, etc

studies of incidence of diseases among twins, blood relatives and spouses and among blacks in different economic strata all suggested that inheritance plays a key role in the development course and outcome of certain diseases

poverty, social conditions, economic stress may only be a compounding factor

genetic differences due to race are minimal → 99.9% of the genomes are similar, but…

eg. Native Americans and Hispanics have higher rates of diabetes than blacks

eg. African Americans seem to suffer from: hypertension, heart disease, prostate and breast cancer, asthma, glaucoma, obesity (60% more prevalent) more frequently than caucasians

eg. black women are more likely to suffer from more aggressive forms of breast cancer; are three to four time more likely to develop lupus; and are up to 9 times more likely to develop uterine fibroids than white women

eg. beta blockers help 3/5 whites with hypertension, but only 2/5 blacks

eg. tamoxifin works less well in preventing recurrence of breast cancer in black women than in white women

eg. Nitromed seems promising in treating blacks with heart diseases but has no significant effects for whites

"when it comes to medicine its very foolish to be color blind"

eg. autoimmune diseases

what are normally the body's defenses become out of control cascades

eg. some forms of diabetes, lupus, some kinds of arthritis

eg. errors in diagnosis

10% of hospital deaths in US are due to misdiagnosis (AAS ~96)

most commonly misdiagnosed:

eg. blood clots in lungs → eg misdiagnosed as heart attack

eg. infections and bleeding → diverticulitis
→ eg misdiagnosed as inoperable tumor

highest rates of diagnosis error were in small community hospitals which also perform the fewest autopsies

Fields of Study in Anatomy & Physiology:

gross anatomy
micro anatomy
developmental physiology
pathophysiology
molecular physiology
surface anatomy
cytology
histology
ultrastructure
radiology
etc

The Language of Anatomy

to study the body we need to establish landmarks and common terminology

1. Directional Terms

dorsal/ventral (anterior/posterior)

toward the back vs toward the front of the body

superior/inferior (cephalad/caudad)

toward the head vs toward the feet

proximal/distal

pertaining to the limbs: toward the point of attachment vs away from the point of attachment

medial/lateral

pertaining to the trunk: toward the midline of the body vs away from the midline of the body

2. Anatomical Position & Body surface landmarks

A. General Body Regions:

a. axial region:
head
neck (cervical)
trunk
thorax

abdomen

b. appendicular region
upper limbs
lower limbs

B. Surface Landmarks:

look up the definitions of each of these terms in your text:

head, neck, thorax, abdomen, pelvis, perineum, nasal, orbital, oral, buccal, occipital, cervical, acromial, axillary, thoracic, umbilical, vertebral, lumbar, sacral, gluteal, brachial, antecubital, antebrachial, pelvic, digital, abdominal, pubic, inguinal, perineal, femoral, patellar, popliteal, crural, pedal, calcaneal

3. Body Planes & Sections

sagittal (including mid-sagittal)

divides the body or an organ into right and left portions

frontal (coronal)

divides the body or an organ into front and back portions

transverse (cross)

divides the body or an organ across the long axis

microscope slides: sag, cs, sec, wm, ts

4. Body Cavities

viscera (~body organs) are contained within distinct cavities within the body

dorsal: cranial
spinal

ventral: thoracic
abdominopelvic
abdominal
pelvic

minor cavities: oral cavity
nasal cavity

5. Subdivisions of abdominopelvic cavity:

the abdominopelvic cavity contains most of our internal organs and is therefore conveniently subdivided into smaller areas:

quadrates – divides it into 4 parts

9 regions – divides it into 9 parts

6. Surface examinations:

a. palpation – feeling with firm pressure
For: all bones – good landmarks
many muscles
some veins and arteries
nerves
lymph nodes
glands
some internal organs, eg liver

b. percussion - tapping sharply
For: fluid concentrations
organ densities

c. auscultation - sounds that various organs make
For: breathing
heartbeat
digestive sounds

d. reflexes - condition of nervous system
uses tendon tapping

What Is Life?

Biology is the study of life
but, what exactly is life?

how are living things different from nonliving things

eg. a human from a rock
eg. a a human from a robot
eg. a living human from a corpse

also, how are all living organisms similar

→what do we have in common with

eg. a bacterium
eg. a fish
eg. a frog
eg. an armadillo

So one of the most basic questions is:
What is Life?

a highly organized interaction of matter and energy

can't define in one sentence

must consider several **properties of life** or life functions:

each property taken individually is NOT unique to living things

many nonliving things do one or more of them
eg. viruses don't quite fit

Properties of Life

1. **maintaining boundaries**

   internal versus external environment

2. **movement**

3. **responsiveness**

   functions are regulated within and between cells

4. **assimilation & digestion**

5. **metabolism**

   anabolism & catabolism

6. **excretion**

7. **reproduction**

   survival of genetic information

8. **growth**

Survival needs:

1. **nutrients**

   solids, liquids, gasses

2. **gasseous oxygen, O_2**

   (is actually a nutrient)

   needed for energy reactions in cells

3. **water**

   solvent

   reactant

4. **temperature range near 37º** [~0º - 100º]

   need liquid water

   proteins (enzymes) sensitive to temp

5. **atmospheric pressure near 760mm Hg**

   gas exchange

   air pressure at sea level: about 14 lbs per square inch; winds produce lots of force

   pressure is equivalent to weight of air: a room 12x15x9 ft holds about 170 lbs of air

6. **gravity**

   space science – gravity is essential for normal bone and muscle maintenance and cardiovascular fitness