Introduction to Human Anatomy and physiology
An Overview of Anatomy

- Anatomy - The study of the *structure* of the human body
- Physiology - The study of body *function*
An Overview of Anatomy

- Anatomical terminology
  - Based on ancient Greek or Latin
  - Provides standard nomenclature worldwide

- Branches of anatomy
  - Gross anatomy
  - Microscopic anatomy (histology)
  - Comparative anatomy
Gross Anatomy

- Large, easily observable body parts and structures
Microscopic Anatomy

- Structures only observable with a microscope
Comparative Anatomy

- Using other mammals with similar anatomical structures to learn about the human body
Physiology – How the body and its parts work or function

*** Structure determines function! ***

- Heart
- Lungs
- Bones
- Kidney

The Neuromuscular Junction

1. Vesicle of acetylcholine
2. Ca²⁺
3. Voltage-gated Na⁺ channel
4. Acetylcholine receptor site
5. Acetylcholinesterase
6. Neurotransmitter-gated channel
7. Motor end plate
The Beginnings of Medicine

- **Hippocrates (375 BCE)**
  - ancient Greek physician who lived during Greece’s Classical period and is traditionally regarded as the father of medicine.
  - He has been revered for his ethical standards in medical practice, mainly for the **Hippocratic Oath**.

- **Hippocratic Oath**
  - an oath stating the obligations and proper conduct of doctors, formerly taken by those beginning medical practice. Parts of the oath are still used in most medical schools.
Modern Hippocratic Oath

- I swear to fulfill, to the best of my ability and judgment, this covenant:

I will respect the hard-won scientific gains of those physicians in whose steps I walk, and gladly share such knowledge as is mine with those who are to follow.

I will apply, for the benefit of the sick, all measures which are required, avoiding those twin traps of overtreatment and therapeutic nihilism.

I will remember that there is art to medicine as well as science, and that warmth, sympathy, and understanding may outweigh the surgeon's knife or the chemist's drug.

I will not be ashamed to say "I know not," nor will I fail to call in my colleagues when the skills of another are needed for a patient's recovery.

I will respect the privacy of my patients, for their problems are not disclosed to me that the world may know. Most especially must I tread with care in matters of life and death. If it is given me to save a life, all thanks. But it may also be within my power to take a life; this awesome responsibility must be faced with great humbleness and awareness of my own frailty. Above all, I must not play at God.
I will remember that I do not treat a fever chart, a cancerous growth, but a sick human being, whose illness may affect the person's family and economic stability. My responsibility includes these related problems, if I am to care adequately for the sick.

I will prevent disease whenever I can, for prevention is preferable to cure.

I will remember that I remain a member of society, with special obligations to all my fellow human beings, those sound of mind and body as well as the infirm.

If I do not violate this oath, may I enjoy life and art, respected while I live and remembered with affection thereafter. May I always act so as to preserve the finest traditions of my calling and may I long experience the joy of healing those who seek my help.
Beginnings of Medicine, cont.

- Ancient Greeks dissected the human body, but Roman Law forbade it.
- Galen - dissected apes in order to gain insight into the human body, assuming they were comparable.
  - Autopsy – human
  - Necropsy - animal
- Crusades … Pope Boniface VIII - 14th century directive that forbade cutting up of the dead for transport and burial
Is the Catholic Church against human dissection?

The Catholic Church is known to have ordered an autopsy on conjoined twins Joana and Melchiora Ballestero in Hispaniola in 1533 to determine whether they shared a soul. They found that there were two distinct hearts, and hence two souls, based on the ancient Greek philosopher Empedocles, who believed the soul resided in the heart.
Beginnings of Medicine, cont.

▪ Andreas Vesalius (1543)
▪ Renaissance physician who revolutionized the study of biology and the practice of medicine by his careful description of the anatomy of the human body.
▪ Basing his observations on dissections he made himself, he wrote and illustrated the first comprehensive textbook of anatomy.
Beginnings of Medicine, cont.

- Few human cadavers for dissection … why?
- The natural decomposition of the body means that a cadaver is only suitable for dissection in the first three or four days following death. After this the stench became too much for the dissector to bear. In warm or wet weather the cadaver decomposed even faster, which is why medical schools preferred to do dissections in the winter months.
Beginnings of Medicine, cont.

▪ Renaissance Artists - resorted to unauthorized means such as grave robbing, body snatching, and murder.
▪ Britain – dissection remained prohibited until 16th century - only two schools and 10 bodies between them
▪ Murder Act of 1792 – allowed bodies of executed murderers to be used for dissection and education
"The Resurrectionists" are created in the 19th century, an anatomy act of 1832—a thriving black market arose in cadavers and body parts, leading to the creation of the profession of body snatching ("Resurrectionists"), and the infamous Burke and Hare murders in 1828, when 16 people were murdered for their cadavers, to be sold to anatomists. The resulting public outcry led to the passage of this act which increased the legal supply of cadavers for dissection.
Use of Cadavers in Education

- Involuntary donation vs voluntary donation
  - UK – 100% voluntary
  - US - 80% voluntary/ 20% involuntary (criminals, unclaimed bodies)
  - Funeral Home - transport - check for diseases (HIV, Hepatitis)
- Fresh vs preserved.
- Disposal – cremation (given back to family)
- 6 million animals are used for dissection in US High Schools each year. (2016)
Use of Cadavers in Education

- Students Bill of Rights (17 states including PA) - require alternatives to dissection if students request it.

- Upper level students who have experienced human cadaver dissection along with their professors agree that "Studying human anatomy with colorful charts is one thing. Using a scalpel and an actual, recently-living person is an entirely different matter."

- University of New York - developing 3D virtual dissection
Grey’s Anatomy or Gray’s Anatomy ??
Gray was an English anatomist and surgeon. Born in 1827

- when he was 18 he entered as a professional student at St. George’s Hospital, London

- when Gray was only 31, he published the first edition of *Gray’s Anatomy*, which consisted of 750 pages and 363 illustrations. The latest editions of *Gray’s Anatomy* are now nearly 1,700 pages

- Dr. H.V. Vandyke Carter a skilled draughtsman, made the 363 illustrations for *Gray’s Anatomy*. He also helped Gray perform the dissections to get the most accurate representation for the illustrations

- Gray died of smallpox at the young age of 34, which he contracted while looking after a nephew who was suffering from the disease
The Hierarchy of Structural Organization

- **Chemical level** – atoms form molecules
- **Cellular level** – cells and their functional subunits
- **Tissue level** – a group of cells performing a common function
- **Organ level** – a discrete structure made up of more than one tissue
- **Organ system** – organs working together for a common purpose
- **Organismal level** – the result of all simpler levels working in unison
The Hierarchy of Structural Organization

1. Chemical level
   Atoms combine to form molecules.

2. Cellular level
   Cells are made up of molecules.

3. Tissue level
   Tissues consist of similar types of cells.

4. Organ level
   Organs are made up of different types of tissues.

5. Organ system level
   Organ systems consist of different organs that work together closely.

6. Organismal level
   The human organism is made up of many organ systems.

Figure 1.1
Characteristics of Life

Movement – change in position; motion

Responsiveness – reaction to a change

Growth – increase in body size; no change in shape

Reproduction – production of new organisms and new cells

Respiration – obtaining oxygen; removing carbon dioxide; releasing energy from foods
Characteristics of Life

Digestion – breakdown of food substances into simpler forms

Absorption – passage of substances through membranes and into body fluids

Circulation – movement of substances in body fluids

Assimilation – changing of absorbed substances into chemically different forms

Excretion – removal of wastes produced by metabolic reactions
Requirements of organisms

- Life depends on five environmental factors
  - water
  - food
  - oxygen
  - heat
  - pressure
Requirements of Organisms

**Water**
- most abundant substance in body
- required for metabolic processes
- required for transport of substances
- regulates body temperature

**Food**
- provides necessary nutrients
- supplies energy
- supplies raw materials

**Oxygen (Gas)**
- one-fifth of air
- used to release energy from nutrients

**Heat**
- form of energy
- partly controls rate of metabolic reactions

**Pressure**
- application of force on an object
- atmospheric pressure – important for breathing
- hydrostatic pressure – keeps blood flowing
- **Situs Solitus**
  - Left – heart, pancreas, spleen
  - Right – appendix, most of liver, gallbladder
- **Situs Inversus** (1/8,000)
- Reference Man – 22, healthy, 154 lbs
- Reference Woman – 22, healthy, 128 lbs
Homeostasis

- The maintenance of stable conditions for proper body function
- Body’s internal environment remains the same
- Dynamic – Can change over narrow range
  - Interstitial fluid - surrounds body cells (98 – 99 degrees F)
  - Blood Glucose levels

Homeostatic Mechanisms – monitor aspects of the internal environment and corrects any changes

- Receptors - provide information about stimuli
- Control center - tells what a particular value should be (includes a set point)
- Effectors - elicit responses that change conditions in the internal environment
Feedback loops

- Feedback loops can be positive or negative

- A positive feedback loop recognizes a change and amplifies it.
- A negative feedback loop recognizes a change and brings it back to normal
Feedback system – cycle in which the body’s conditions are continually monitored

- Negative Feedback – a change is sensed and the condition is reversed back to normal
  - Ex. Sweating, shivering
- Positive Feedback – change that is sensed is reinforced!
  - Ex. Childbirth
Stimulus
Body temperature rises

Response
Body temperature rises; stimulus ends

Shivering begins

Effectors
Skeletal muscles

Receptors
Temperature-sensitive cells in skin and brain

Information sent along the afferent pathway to control center

Control Center
(thermoregulatory center in brain)

Afferent pathway
Efferent pathway

Effectors
Sweat glands

Sweat glands activated

Stimulus
Body temperature drops below normal.

Response
Body heat is conserved, temperature rises toward normal.

Effectors
Skin blood vessels constrict and sweat glands remain inactive.

Effectors
Muscle activity generates body heat.

Stimulus
Body temperature drops.

Response
Body temperature rises above normal.

Stimulus
Body temperature is raised to set point.

Response
Body heat is lost to surroundings, temperature drops toward normal.

Effectors
Skin blood vessels dilate and sweat glands secrete.

Receptors
Thermoreceptors send signals to control center.

Control center
The hypothalamus detects the deviation from the set point and signals effector organs.

Receptors
Thermoreceptors send signals to control center.

Effectors
Skin blood vessels dilate and sweat glands secrete.
Feedback Systems Control Homeostasis

1 Nervous System
   ▪ Fast Acting with rapid corrections
   ▪ Ex. Vasodilation, vasoconstriction

2 Endocrine System
   ▪ Slower corrections
   ▪ Ex. ADH – Anti-diuretic Hormone – decreases urine output by causing more reabsorption of water by kidneys
Do Now!

▪ In at least 4 lines and in your own words, describe negative feedback.

▪ Explain how positive feedback is different than negative feedback.
Organization of the Human Body

Systemic v. Regional Anatomy

- **Systemic** – study of anatomy by system
- **Regional** – study of anatomy by region
- Most students use a combination of regional and systemic study
Body Cavities and Membranes

- Dorsal body cavity
- Cavity subdivided into the cranial cavity and the vertebral cavity.
  - Cranial cavity houses the brain.
  - Vertebral cavity runs through the vertebral column and encloses the spinal cord
Body Cavities and Membranes

- Ventral body cavity – subdivided into:
  - Thoracic cavity – divided into three parts
    - Two lateral parts each containing a lung surrounded by a pleural cavity
  - Mediastinum – contains the heart surrounded by the pericardial sac
Body Cavities and Membranes

- Ventral body cavity
  - Abdominopelvic cavity – divided into two parts
    - Abdominal cavity – contains the liver, stomach, kidneys, and other organs
    - Pelvic cavity – contains the bladder, some reproductive organs, and rectum
Body Cavities and Membranes

- **Serous cavities** – a slit-like space lined by a serous membrane
  - Pleura, pericardium, and peritoneum
    - Parietal serosa – outer wall of the cavity
    - Visceral serosa covers the visceral organs
Body Cavities and Membranes

- Lung
- Parietal pleura
- Pleural cavity with serous fluid
- Visceral pleura
- Diaphragm

- Wall of body trunk
- Kidney (retroperitoneal)
- Peritoneal cavity (with serous fluid)
- Stomach
- Visceral peritoneum
- Liver
Other Body Cavities

- Oral cavity
- Nasal cavity
- Orbital cavities
- Middle ear cavities
- Synovial cavities
The Integumentary System

- Forms external body covering
- Protects deeper tissues from injury
- Synthesizes vitamin D
- Site of cutaneous receptors
  - (pain, pressure, etc.) and sweat and oil glands
The Skeletal System

- Protects and supports body organs
- Provides a framework for muscles
- Blood cells formed within bones
- Stores minerals
The Muscular System

- Allows manipulation of environment
- Locomotion
- Facial expression
- Maintains posture
- Produces heat
The Nervous System

- Fast-acting control system
- Responds to internal and external changes
The Endocrine System

- Glands secrete hormones that regulate
  - Growth
  - Reproduction
  - Nutrient use
The Cardiovascular System

- Blood vessels transport blood
  - Carries oxygen and carbon dioxide
  - Also carries nutrients and wastes
- Heart pumps blood through blood vessels
The Lymphatic System

- Picks up fluid leaked from blood vessels
- Disposes of debris in the lymphatic system
- Houses white blood cells (lymphocytes)
- Mounts attack against foreign substances in the body
The Respiratory System

- Keeps blood supplied with oxygen
- Removes carbon dioxide
- Gas exchange occurs through walls of air sacs in the lungs
The Digestive System

- Breaks down food into absorbable units
- Indigestible foodstuffs eliminated as feces
The Urinary System

- Eliminates nitrogenous wastes
- Regulates water, electrolyte, and acid-base balance
Reproductive System

- Overall function is to produce offspring
- Testes produce sperm and male sex hormones
- Ovaries produce eggs and female sex hormones
- Mammary glands produce milk
Gross Anatomy – An Introduction

- Anatomical position – a common visual reference point
  - Person stands erect with feet together and eyes forward
  - Palms face anteriorly with the thumbs pointed away from the body
Gross Anatomy – An Introduction

- Regional terms – names of specific body areas
  - Axial region – the main axis of the body
  - Appendicular region – the limbs
- Directional terminology
  - Refers to the body in anatomical position
  - Standardized terms of directions are paired terms

Figure 1.3
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superior</td>
<td>Toward the head end or upper part of a structure or the body; above</td>
<td>The head is superior to the abdomen.</td>
</tr>
<tr>
<td>Inferior</td>
<td>Away from the head end or toward the lower part of a structure or the body; below</td>
<td>The navel is inferior to the chin.</td>
</tr>
<tr>
<td>Anterior</td>
<td>Toward or at the front of the body; in front of</td>
<td>The breastbone is anterior to the spine.</td>
</tr>
<tr>
<td>Posterior</td>
<td>Toward or at the back of the body; behind</td>
<td>The heart is posterior to the breastbone.</td>
</tr>
</tbody>
</table>

*Whereas the terms ventral and anterior are synonymous in humans, this is not the case in four-legged animals. Ventral specifically refers to the “belly” of a vertebrate animal and thus is the inferior surface of four-legged animals. Likewise, although the dorsal and posterior surfaces are the same in humans, the term dorsal specifically refers to an animal's back. Thus, the dorsal surface of four-legged animals is their superior surface.
### Orientation and Directional Terms

<table>
<thead>
<tr>
<th>Term</th>
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<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medial</td>
<td>Toward or at the midline of the body; on the inner side of</td>
<td>The heart is medial to the arm.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><img src="image1" alt="Medial Image" /></td>
</tr>
<tr>
<td>Lateral</td>
<td>Away from the midline of the body; on the outer side of</td>
<td>The arms are lateral to the chest.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><img src="image2" alt="Lateral Image" /></td>
</tr>
<tr>
<td>Proximal</td>
<td>Closer to the origin of the body part or the point of attachment of a limb to the body trunk</td>
<td>The elbow is proximal to the wrist.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><img src="image3" alt="Proximal Image" /></td>
</tr>
<tr>
<td>Distal</td>
<td>Farther from the origin of a body part or the point of attachment of a limb to the body trunk</td>
<td>The knee is distal to the thigh.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><img src="image4" alt="Distal Image" /></td>
</tr>
</tbody>
</table>

Table 1.1 (2 of 3)
# Orientation and Directional Terms

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superficial (external)</td>
<td>Toward or at the body surface</td>
<td>The skin is superficial to the skeletal muscles.</td>
</tr>
<tr>
<td>Deep (internal)</td>
<td>Away from the body surface; more internal</td>
<td>The lungs are deep to the skin.</td>
</tr>
<tr>
<td>Ipsilateral</td>
<td>On the same side</td>
<td>The right hand and right foot are ipsilateral.</td>
</tr>
<tr>
<td>Contralateral</td>
<td>On opposite sides</td>
<td>The right hand and left foot are contralateral.</td>
</tr>
</tbody>
</table>
Body Planes and Sections

- Coronal (frontal) plane - Lies vertically and divides body or organ into anterior and posterior parts
- Sagittal plane - Lies vertically and divides body or organ into left and right parts
Body Planes and Sections

- Transverse plane - runs horizontally and divides body or organ into superior and inferior parts
Body Planes and Sections

- Oblique section through the trunk
Regional Terms

Figure 1.4a

Cephalic
- Frontal
- Orbital
- Nasal
- Oral
- Mental

Cervical

Thoracic
- Sternal
- Axillary
- Mammary

Abdominal
- Umbilical

Pelvic
- Inguinal (groin)

Pubic (genital)

Key:
- Orange = Thorax
- Purple = Abdomen
- Green = Back (Dorsum)

Upper limb
- Acromial
- Brachial (arm)
- Antecubital
- Antebrachial (forearm)
- Carpal (wrist)

Manus (hand)
- Pollex
- Palmar
- Digital

Lower limb
- Coxal (hip)
- Femoral (thigh)
- Patellar
- Crural (leg)
- Fibular or peroneal

Pedal (foot)
- Tarsal (ankle)
- Metatarsal
- Digital
- Hallux

(a) Anterior/Ventral
Regional Terms

Figure 1.4b

Upper limb
- Acromial
- Brachial (arm)

Manus (hand)
- Metacarpal
- Digital

Lower limb
- Femoral (thigh)
- Popliteal
- Sural (calf)
- Fibular or peroneal

Pedal (foot)
- Calcaneal
- Plantar

Cephalic
- Otic
- Occipital (back of head)

Cervical

Back (dorsal)
- Scapular
- Vertebral
- Lumbar
- Sacral
- Gluteal

Perineal (between anus and external genitalia)

(b) Posterior/Dorsal
Abdominal Regions and Quadrants

- Abdominal regions divide the abdomen into nine regions
Abdominal Quadrants

- **Abdominal quadrants** divide the abdomen into four quadrants
  - Right upper and left upper quadrants
  - Right lower and left lower quadrants