Anatomy Lecture Notes Section 1: Introduction to Anatomy

What is Human Anatomy?
Human anatomy, including histology and gross anatomy, is the study of the **structures** of the human body. The discipline of human anatomy involves the identification and description of the structures within the human body.

What's in a Name? Answer: Everything.
Due to the fact that most anatomical names come from **Latin** and **Greek**, these words have meaning in their original language, and it is very helpful and interesting to know the 'root' meaning of these words, which is called **etymology**, as it helps in the learning process. Therefore, becoming familiar with the etymology of the anatomical term s is an important component of studying human anatomy.

> For example, the word ***anatomy*** comes from the Greek language, composed of *ana* = up or apart, and *tome* = a cutting. Therefore, the word anatomy means "cutting up or apart". As will become evident, the dissection aspects of anatomy are especially important as we study human anatomy.

In general, anatomy can be divided into **Gross Anatomy** and **Microscopic Anatomy**.

Gross Anatomy
In the health care filed, gross anatomy (macroscopic anatomy) refers to the study of structures that can be seen with the naked eye, such as most bones and muscles. Gross anatomy may involve dissection or noninvasive methods in order to examine regions; the objective is to gain insight about the larger structures of organs and organ systems and how they are interconnected.

Microscopic Anatomy
Microscopic anatomy, also known as histology (histo = tissue; ology = study), is the study of tissues that are too small to been seen with the naked eye, and therefore require the use of various microscopes. Microscopy commonly involves studying tissues and cells that have been prepared by histological techniques in order to provide visual contrast of the different aspects of the specimen under examination.

Sectioning and staining tissues is how the histological slides we will examine are prepared. Typically, tissue is treated with preserving and other agents which allow for the sectioning of tissue, which is cutting tissue into very thin slices. Histological stains, such as hematoxylin and eosin, (H&E) are commonly added to the specimens in order to create and enhance visual contrast. The various stains generate different colors and intensities, based primarily on the chemistry of the tissue and the dye (lipid, protein, acidic, basic, etc.). This yield tissues they can be more easily distinguished when they are examined under a microscope (light or electron).

General Information
As mentioned, in anatomy, there is an emphasis on word roots and meanings. There are also a lot of words to become familiar with, and it becomes crucial to keep up with the enormous vocabulary content in this course. One of the best techniques is associating the root term with something that is already familiar. For example, the prefix *hypo* means below or under and the term ***chondro*** is associated with cartilage (and a part of ribs are made of cartilage). Thus, the term ***hypochondral*** refers to an anatomical region of the body under the ribs. Please note: A hypochondriac (someone who frequently believes they are ill) will often wave their hands around their tummy and declare they are not feeling well!

It will become very useful to relate as many anatomical structures to their root words, in order to better understand their meaning. It is also valuable to be able to relate the concepts we study to everyday life as much as possible.

Another important aspect is to know that grammatical constructs also relate to anatomical terms resulting in similar looking words with different endings which indicate use as nouns and adjectives, etc. (e.g., cranium is the noun and cranial is the adjective). In addition, anatomy uses many diminutives – a way of modifying a word to convey smallness, or another quality of the object, or to convey a sense of endearment. A great example of this is organ and organelle. Organelle is almost of way of saying "teeny tiny little organ". Note: Generally the longer the word, the smaller the structure!

In anatomy there are often several terms for one structure. In the past it was common to name structures after the "discoverer's" name, these are called "**eponyms**". Currently, the more preferred terminology is that which is descriptive rather than named with an eponym. The descriptive name often describes function, location, shape, etc. However, it is important that students become familiar with both the eponym and the descriptive anatomical terminology.

Here is an example. Compare ***Eustacian tube*** with ***auditory tube***; an Italian *Eustacia* was cited as the first to described this anatomical structure, but this name gives no indication as to its role or location. However, it is likely that the word *auditory* suggests a role for this structure in sound or a location that has something to do with the ear.

There are many examples, here are a few more that we will encounter:

- **Achilles tendon** = calcaneal tendon of the heel.
- **Bowman's capsule** = glomerular capsule of the nephron in the kidney.
- **Cowper's gland** = bulbourethral gland of the male reproductive system.
- **Fallopian tubes** = uterine tubes of the female reproductive system.
- **Graafian follicle** = mature follicle of the female gamete or the egg cell.
- **Kupffer cell** = macrophages of the liver.
- **Islets of Langerhans** = pancreatic islets of the pancreas where hormones are made.
- **Meissner's corpuscle** = tactile corpuscle for touch sensation in the dermis of skin.
- **Nissl bodies** = ribosomes within nerve cell bodies.
- **Sphincter of Oddi** = hepatopancreatic sphincter to control the flow of bile and pancreatic juices.
- **Pacinian corpuscle** = lamellated corpuscle for pressure sensation deep in dermis of skin.
- **Node of Ranvier** = myelin-sheath gaps along the length of myelinated axons of neurons.
- **Canal of Schlemm** = scleral venous sinus which drains aqueous humor of the eyeball.

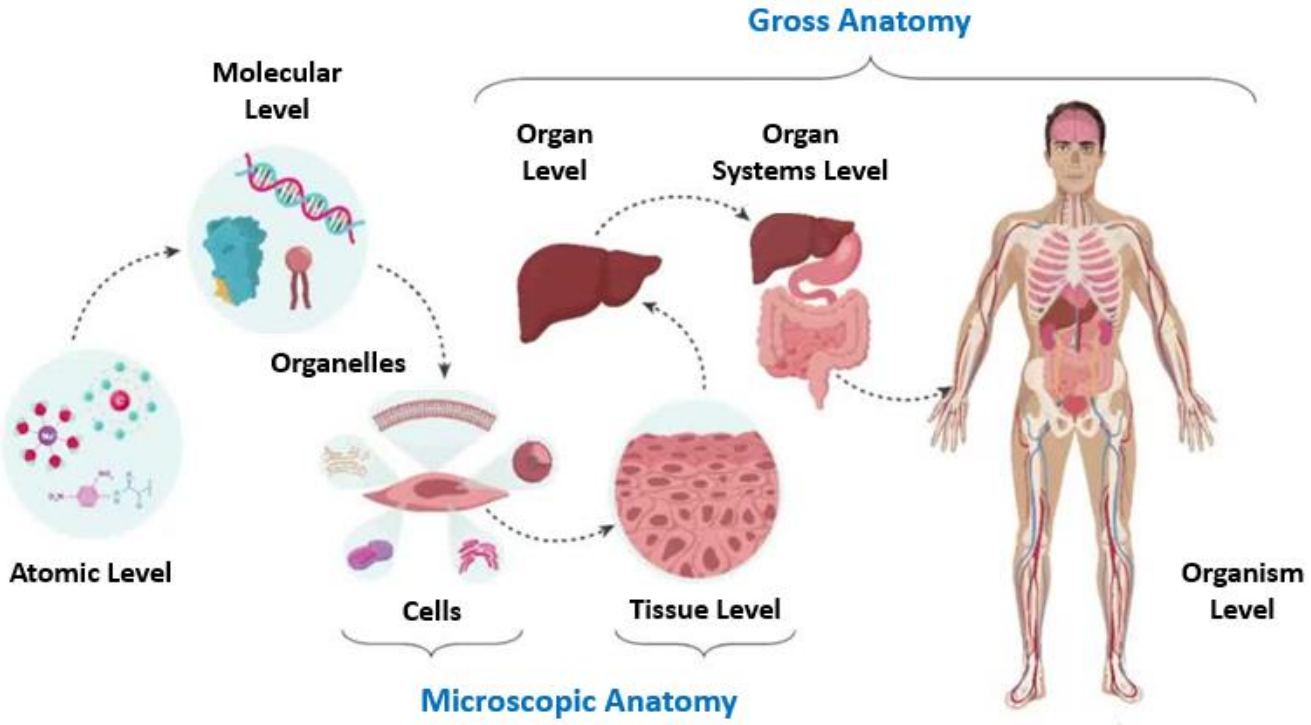
*Note that an eponym is using a proper name and thus the name must be capitalized.

Introduction to the Study of Anatomy

Structure (anatomy) and function (physiology) are closely correlated in the human body. It is important to understand the connection between **form** and **function** when studying anatomy as the form (shape) of a structure is strongly indicative of what it does (function). This approach to the study of anatomy is called "functional anatomy", and it is the approach that we use in this course.

I. Levels of Organization – this describes examining things from the fundamental building blocks and ascending to more complex and larger structures. Below are the levels of organization for human anatomy listed from simplest to most complex.

A. Atoms
B. Molecules
C. Organelles
D. Cells
E. Tissues
F. Organs
G. Organ systems
H. Organism



Any basic anatomy textbook will show this type of order of structures (listed above) and give specific examples of each level. This is also an example of how the course is constructed, we go from micro-structures to macro-structures.

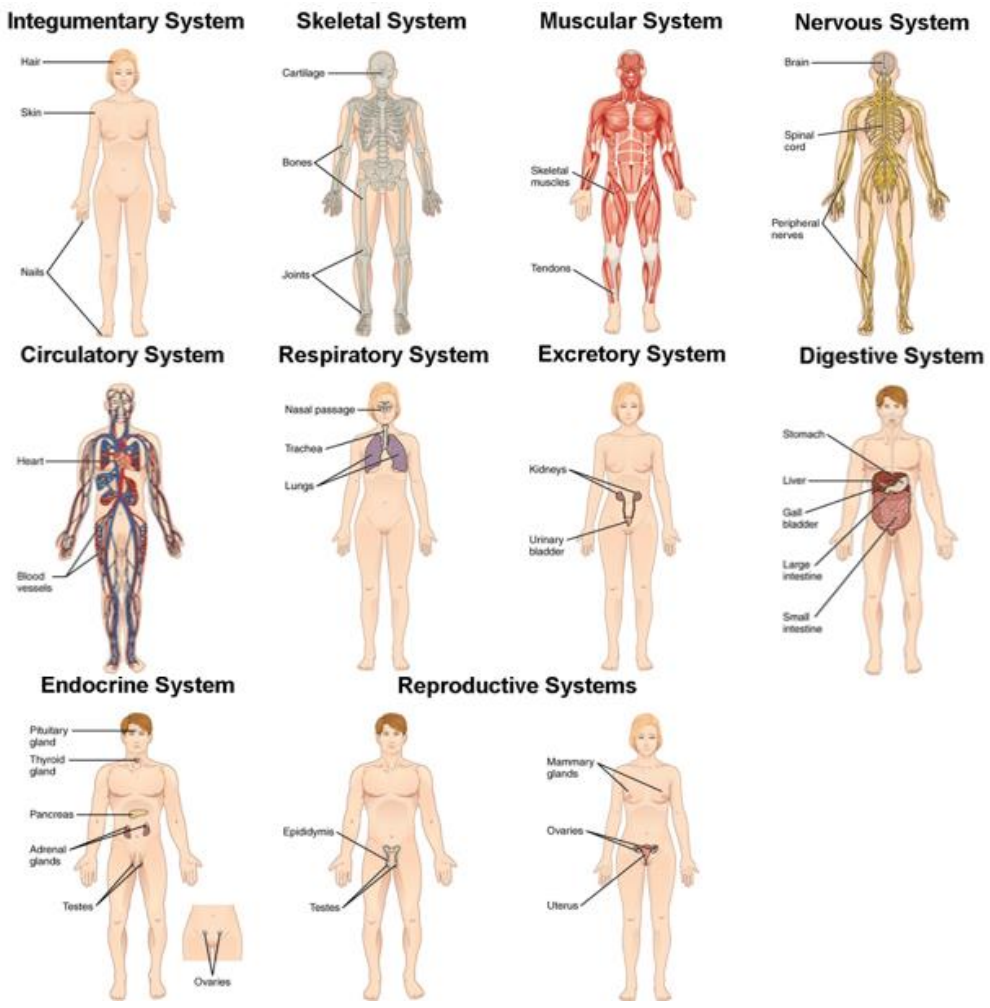
II. Basic Functions of Living Organisms

A. Responsiveness
B. Growth
C. Differentiation
D. Metabolism
E. Movement
F. Reproduction
G. Excretion

Each system we study in human anatomy (see below) will contain various components of these functions. We commence the study of human anatomy with histology - the study of tissues. This micro-anatomy requires the use of microscopes and the identification of not only the four primary tissue, but also the elements (such as cells, fibers and other material) that these tissues are composed of.

III. The Systems Studied in Anatomy

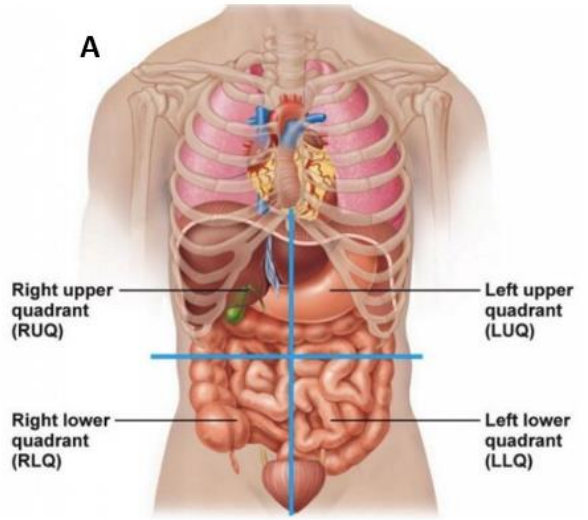
- **A.** Tissues – four primary tissues: Epithelium; Connective; Muscular; Nervous.
- **B.** Integumentary - skin, hair, nails and glands.
- **C.** Skeletal - bones, cartilage, articulations.
- **D.** Muscular - skeletal, cardiac and smooth muscles.
- **E.** Nervous - nerves, glial cells, central nervous system (NS), peripheral NS and autonomic NS. Special Senses - eyes, ears, touch, olfaction, equilibrium and taste.
- **F.** Endocrine – primary and secondary endocrine glands.
- **G.** Cardiovascular - heart, arteries, capillaries, veins. Lymphatic - lymph ducts, nodes, organs, tissues.
- **H.** Respiratory - lungs, bronchial tree.
- **I.** Digestive - mouth, esophagus, stomach, small intestine, colon, liver, pancreas.
- **J.** Urinary - kidney, ureters, urinary bladder, urethra.
- **K.** Reproductive:
    1) Ovary, uterine tube, uterus, vagina.
    2) Testes, epididymis, ductus deferens, glands, urethra, penis.

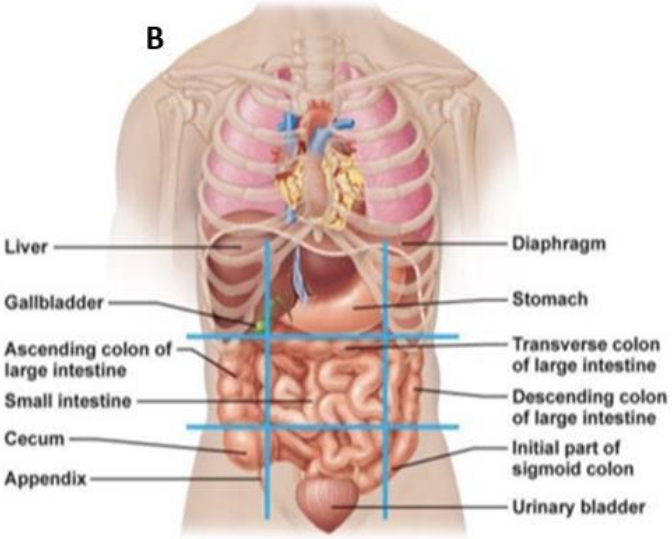


IV. Regions of the Body

A. The four quadrants division

1. Right upper quadrant
2. Left upper quadrant
3. Right lower quadrant
4. Left lower quadrant





See your lab manual and/or any basic anatomy textbook for a diagram of these regions.

B. The descriptive abdominopelvic regions

1. Right and Left hypochondriac
2. Right and left lumbar
3. Right and left iliac (inguinal)
4. Epigastric
5. Umbilical
6. Hypogastric

V. Planes of the Body

A. Frontal (coronal) plane: Divides body into front and back portions.

B. Transverse (cross, horizontal) plane: Divides body into superior and inferior portions.

C. Sagittal (mid and parasagittal) plane: Divides body into left and right portions. Mid-sagittal means equal left and right portions whereas para-sagittal means unequal left and right portions.

Three dimensional (3D) visualization of structures in books can be difficult, especially reconstruction of serial slices of organs or of tissues. Try to think of common items first, like a pencil or an apple, and what would be exposed in a series of slices of the objects or as viewed from different sides or perspectives. The figure to the right is also helpful as it shows the 3 planes of the body as well as the directional terms commonly used in anatomy.

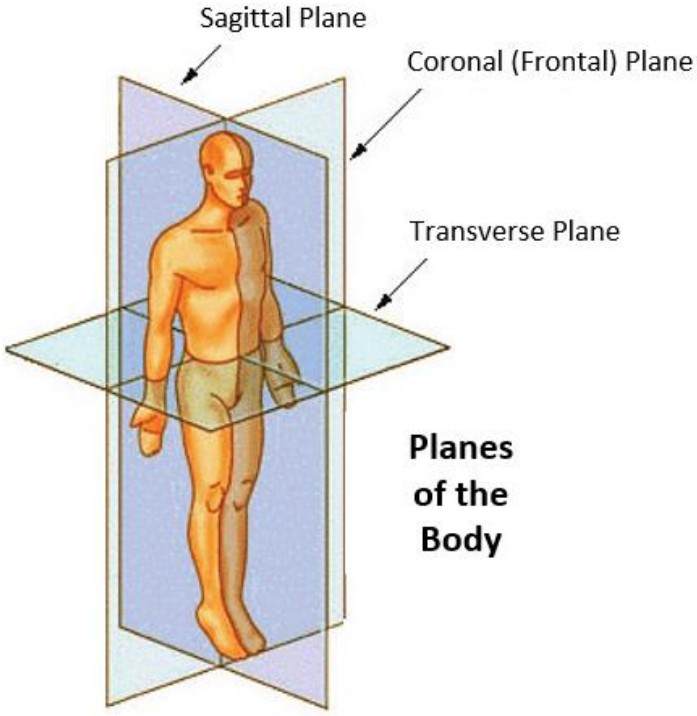
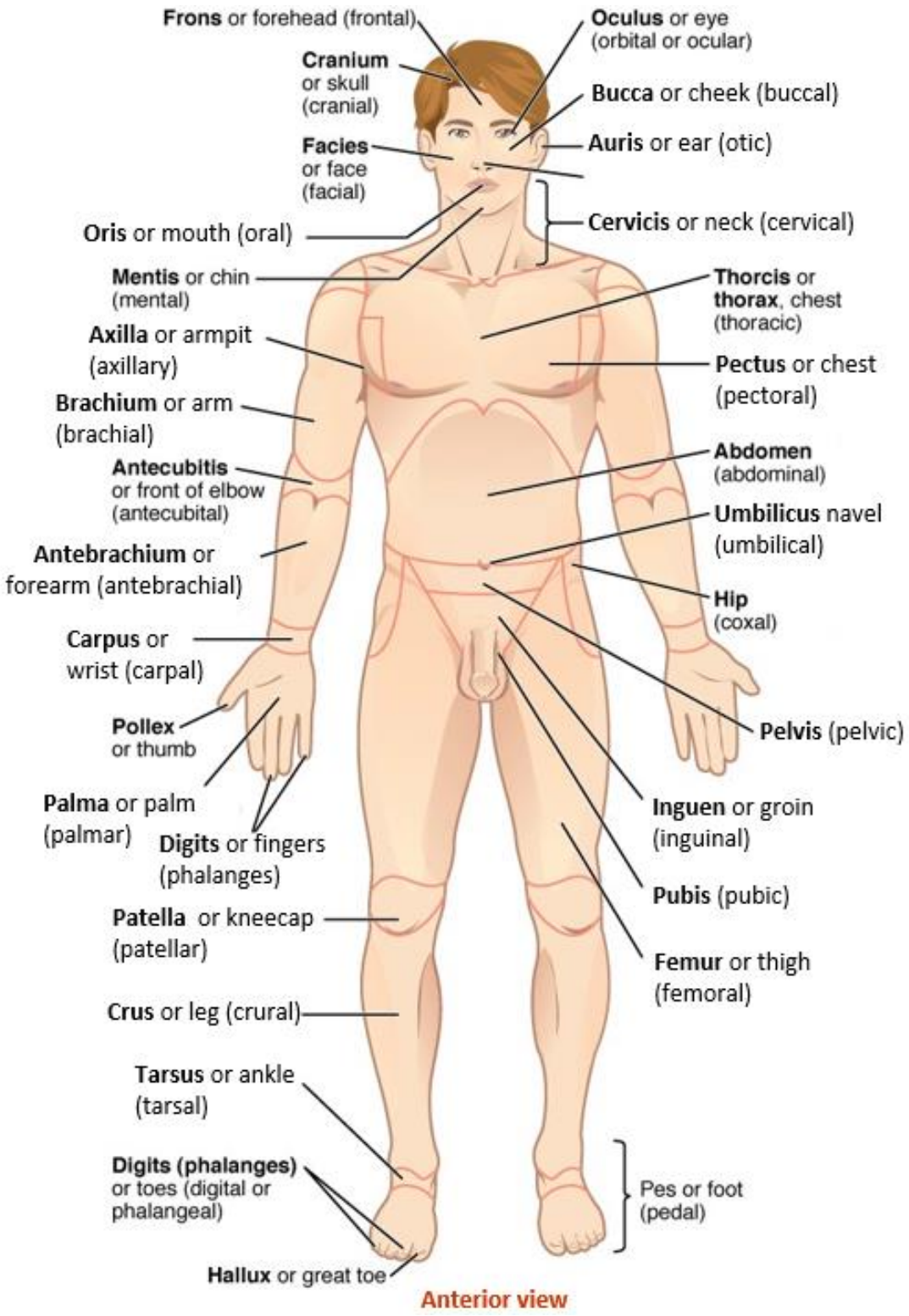
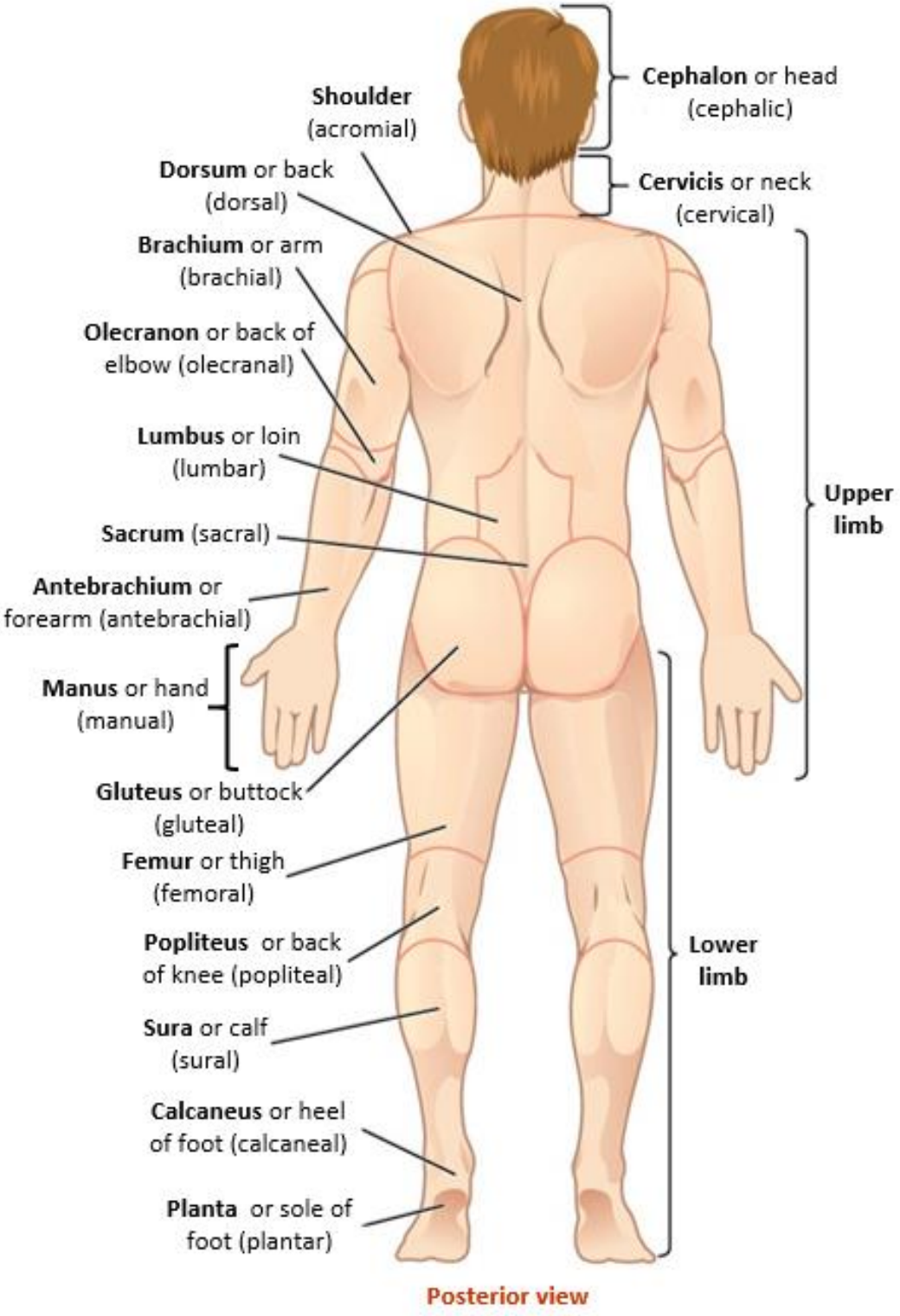


Table 1. Regions of the body described with anatomical landmarks and commonly terminology.

Anatomical Landmarks	**Common Term**
Cranium (Cranial)	Skull
Oris (Oral)	Mouth
Cervicis (Cervical)	Neck
Acromion (Acromial)	Shoulder
Thoracis (Thoracic)	Chest
Abdomen (Abdominal)	Belly
Gluteus (Gluteal)	Buttock
Inguen (Inguinal)	Groin
Pubis	Pubic
Axilla (Axillary)	Armpit
Brachium (Brachial)	Arm
Antecubitis (Antecubital)	Front of elbow
Olecranon	Elbow
Antebrachium	Forearm
Carpus (Carpal)	Wrist
Manus (Manual)	Hand
Pollex	Thumb
Digits (Phalanges)	Fingers
Femur (Femoral)	Thigh
Patella (Patellar)	Knee
Popliteus (Popliteal)	Back of knee
Crus (Crural)	Leg (front)
Sura (Sural)	Calf (back)
Tarsus (Tarsal)	Ankle
Calcaneus (Calcaneal)	Heel
Dorsum	Top of foot
Planta (Plantar)	Sole of foot

Knowledge of the anatomical landmarks for the “layperson’s” terminology is very useful to know.


Frons or forehead (frontal)
Oculus or eye (orbital or ocular)
Cranium or skull (cranial)
Bucca or cheek (buccal)
Facies or face (facial)
Auris or ear (otic)
Cervicis or neck (cervical)
Oris or mouth (oral)
Mentis or chin (mental)
Thorcis or **thorax**, chest (thoracic)
Axilla or armpit (axillary)
Pectus or chest (pectoral)
Brachium or arm (brachial)
Abdomen (abdominal)
Antecubitis or front of elbow (antecubital)
Umbilicus navel (umbilical)
Antebrachium or forearm (antebrachial)
Hip (coxal)
Carpus or wrist (carpal)
Pollex or thumb
Pelvis (pelvic)
Palma or palm (palmar)
Digits or fingers (phalanges)
Inguen or groin (inguinal)
Pubis (pubic)
Patella or kneecap (patellar)
Femur or thigh (femoral)
Crus or leg (crural)
Tarsus or ankle (tarsal)
Digits (phalanges) or toes (digital or phalangeal)
Pes or foot (pedal)
Hallux or great toe
Anterior view



Posterior view

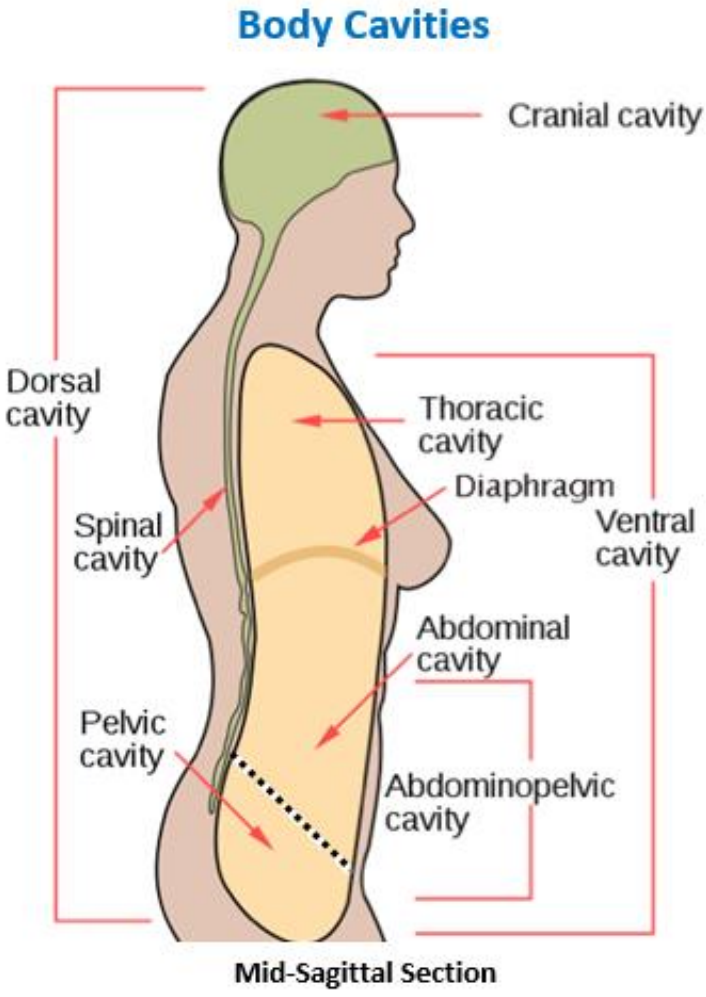
The Body Cavities

Within the human body are cavities which help to contain, compartmentalize and protect the various organs and structures in the body and also allow all structures to be interconnected.

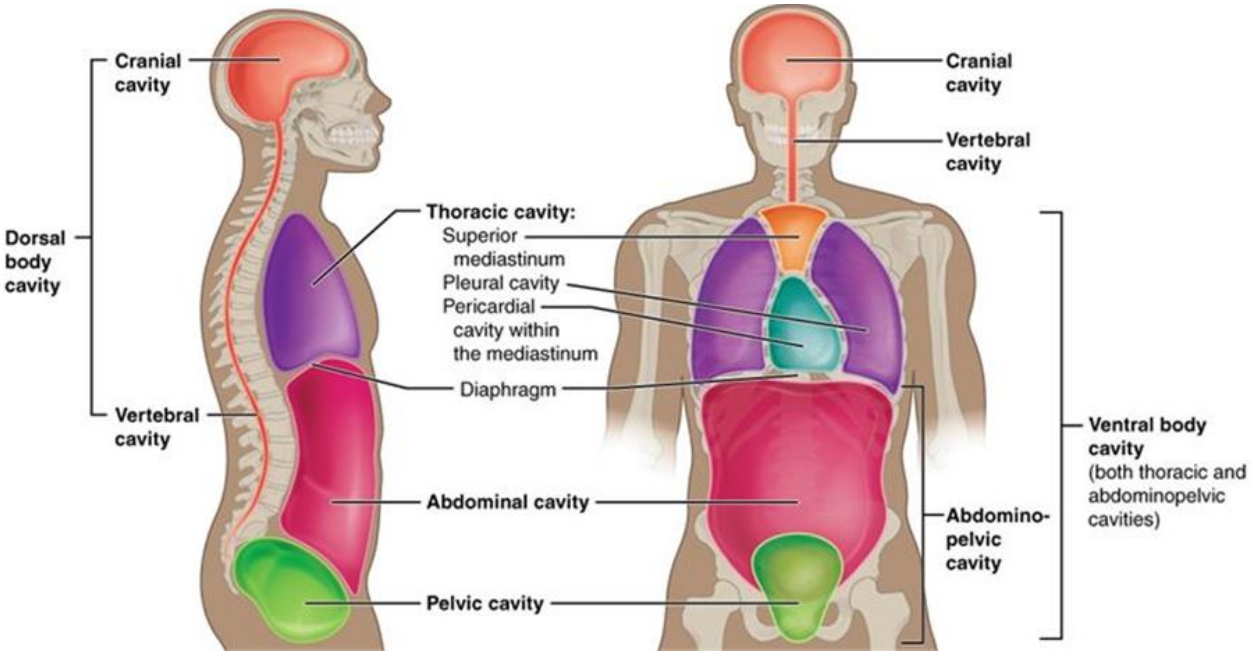
For these body cavities there is correct anatomical terminology. In the human there are several body cavities, with additional more discrete cavities within the larger ones. In general they are 2 large separate body cavities in our bodies:

1) The Dorsal body cavity (in the back), shown in green in the image below. As you can see, the dorsal cavity has two cavities within it, the cranial cavity which is enclosed within the bones of the skull and houses the brain, and the spinal cavity enclosed by the bones of the vertebral column, which contains the spinal cord.

2) The Ventral body cavity (in the front), shown in yellow in the image below. The larger ventral cavity has two man divisions which are separated by the diaphragm (the primary muscle of respiration), which are also body cavities within the ventral body cavity. It contains the thoracic cavity, which is enclosed by the ribcage and contains the lungs (within the pleural cavities), mediastinum (area in between the two lungs) and the heart (within the pericardial cavity). The abdominopelvic cavity contains many large internal organs, including the liver, stomach, intestines, with the bladder and reproductive structures situated within in the bony pelvic basin.



The image below at right provides a more detailed visual of how the thoracic, abdominal, and pelvic cavities are arranged in the ventral cavity.



List Contents in Body Cavity

Dorsal Cavity

- **Cranial cavity** — Brain protected by bones of the skull. Also covered by meningeal layers and bathed in cerebrospinal fluid (CSF).
- **Spinal cavity** — Spinal cord protected by the vertebrae of the spinal column. Further protected by the spinal meninges and CSF.

Ventral Cavity

- **Thoracic cavity**
  - **Pleural cavities** — Two cavities, containing the R and L lungs, surrounded by pleural fluid.
  - **Mediastinum** — The area in between the two lungs, contains the heart, thymus gland, trachea, esophagus, aorta, great veins and nerves.
  - **Pericardial cavity** — Contains the heart, bathed in pericardial fluid.
- **Abdominopelvic (Peritoneal) cavity**
  - **Abdominal cavity** — Stomach, small intestine, liver, gallbladder, pancreas, spleen, and the colon.
  - **Pelvic cavity** — Bladder, rectum, lower colon and reproductive organs.

VI. Anatomical Position

The anatomical position is a very useful way to create a standard frame of reference for the body. This position is used when describing a person's anatomy in order to maintain a standard frame of reference for body orientation

The anatomical position or standard anatomical position, is standing upright, feet together, facing forward, arms at your sides with palms facing forward (anterior). This is called the **supine** position. When the palms are facing posterior, it is called the **prone** position. Again, the anatomical position is used as a universal frame of reference for body orientation in the health care field.

Here is an example of where it is very useful. If a person were to ask: Is the stomach inferior to the diaphragm? The answer will not depend on whether someone is standing on their head or bent over, etc. We can safely assume the description is with reference to the anatomical position. Most often, if the term anatomical position is used, it is referring to a person standing, unless otherwise indicated. When a subject is laying down, then supine refers to laying on their back and prone is laying on their stomach.

Anatomical Position

- **Standing upright**
- **Head and eyes directed straight ahead**
- **Upper limbs at the sides**
- **Upper limbs slightly away from trunk**
- **Palms facing forward**
- **Thumbs pointing away from body**
- **Lower limbs parallel**
- **Feet flat on the ground and facing forward**

VII. Anatomical Directions – terms used to describe specific directions in the body.

A. Superior / Inferior

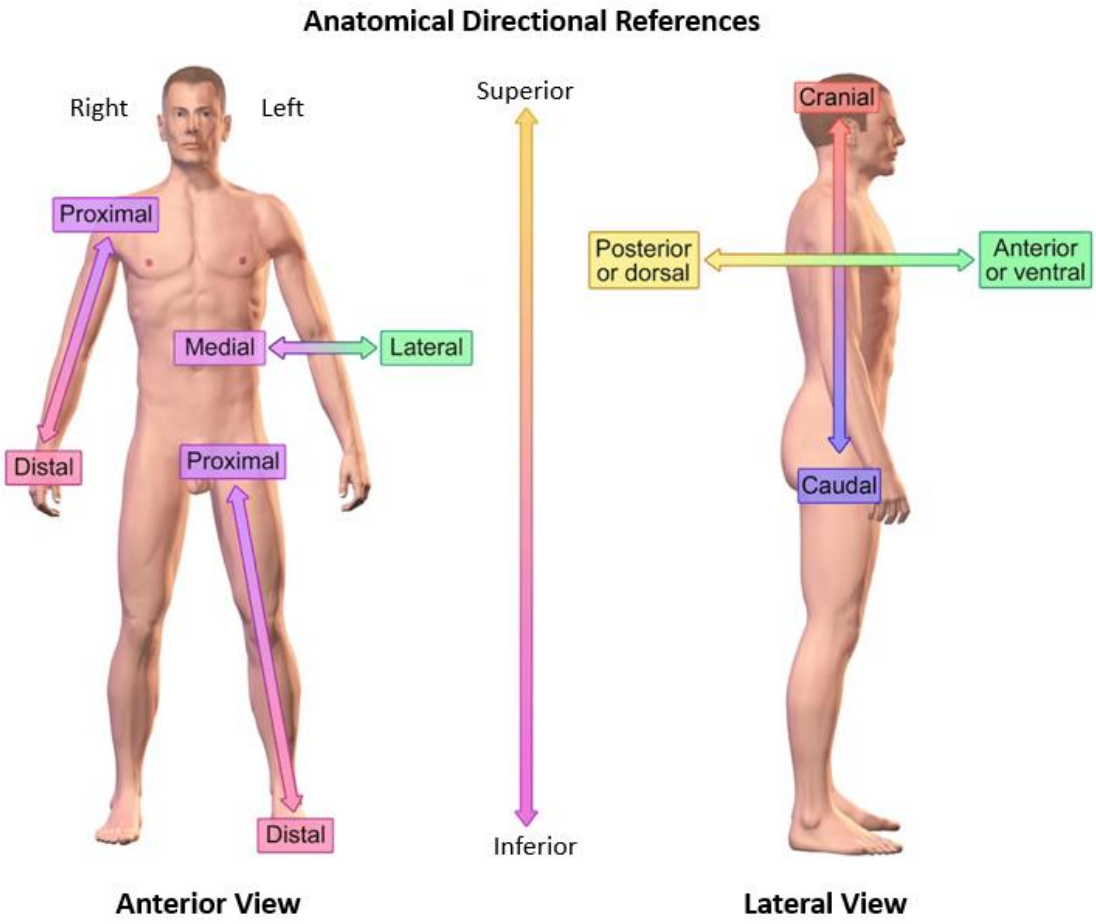
B. Posterior / Anterior

C. Dorsal / Ventral

D. Deep / Superficial

E. Distal / Proximal

F. Lateral / Medial



VIII. Body Cavities

1. **Dorsal cavity** - contains brain and spinal cord (cranial bones and vertebrae).

2. **Ventral cavity** is divided by the diaphragm (skeletal muscle for breathing) into
    a. **Thoracic cavity** which contains:
        i. Mediastinum: Located between the lungs, it contains the esophagus, aorta, nerves, thymus and trachea, and the **pericardial cavity**, containing the heart.

        ii. **Pleura cavity** containing the lungs (1 left and 1 right lung).

    b. **Abdominopelvic cavity**. This cavity is separated by an imaginary plane into
        i. **Abdominal cavity** containing most of the viscera.

        ii. **Pelvic cavity** containing the urinary bladder, female reproductive and rectum.

All of the ventral internal body cavities mentioned above (pericardium, pleura and peritoneum) are lined by a serous membrane. These body cavities are not directly exposed to the outside world (unlike the respiratory tract, for example) and need a moist and slippery surface in order to reduce the friction of two surfaces moving across each other.

Review of the Cell

Can you guess, approximately, how many cells are in the human body?

The human body is made up of … trillions of cells, from 50 to 60 trillion to be more exact. These cells can vary dramatically in size, shape and function. If we stop to think about how amazing this is, we will be very impressed with ourselves. These trillions of cells act as a well-coordinated community that functions as a whole organism. When we are in balanced good health these cells do not compete with or destroy each other – on the contrary, they cooperate and focus on specific tasks that their environment calls for. If cells are competing and destroying each other, using resources but providing no function or even obstructing the function of other cells, this is indicative of a disease state! The focus of this course is the functional anatomy of a healthy, balanced body.

Of the trillions of cells, there are *only about 200 different types of cells* in the human body. For example hepatocytes are found in the liver, neurons help make up nervous tissue, osteocytes are found in bone tissue, adipocytes are found in fat (adipose) tissue, and so on. Within the human body, most cells have some basic properties in common and we will quickly review them.

I. Cell Structure

A. Cell Membrane Functions as almost everything!

1. It creates the cell boundary, separating the inside of the cell from the outside.
2. Allows for adhesion and attachments to other membranes.
3. Has receptors for hormones, neurotransmitters and other signals for communication.
4. Has identifying markers to indicate function to other cells.

B. Special Features on cells may include:

1. Cilia - these are hair-like structures that arise from the exposed (apical) end of some cells. Their role is for the movement of substances across surface of the cell, e.g., mucous.
2. Microvilli - extensions of cell membrane, to increase the surface area of cell for exchange, e.g. to increase the rate of absorption.
3. Flagellum - a whip-like structure for the movement of the entire cell, e.g., spermatozoa.

II. Cell Membrane Permeability – what substances can move across the plasma membrane of a cell?

The Degree of Permeability Varies:

1. Impermeable - this type of membrane restricts the passage of all molecules.
2. Selectively permeable - this cell membrane lets certain molecules through but not others.
3. Highly permeable - lets almost anything through the cell membrane.

III. Cell Attachments and Junctions

A. Tight junction - near free surface (apical end) of epithelium, water tight seal.
B. Desmosome - lightly tacks cells together, usually deep to the surface (basal end).
C. Hemidesmosomes - tethers cell to basemen membrane where cells are anchored.
D. Gap junction - physical opening between two cells, permits direct communication of ions, etc.

IV. Cell Names

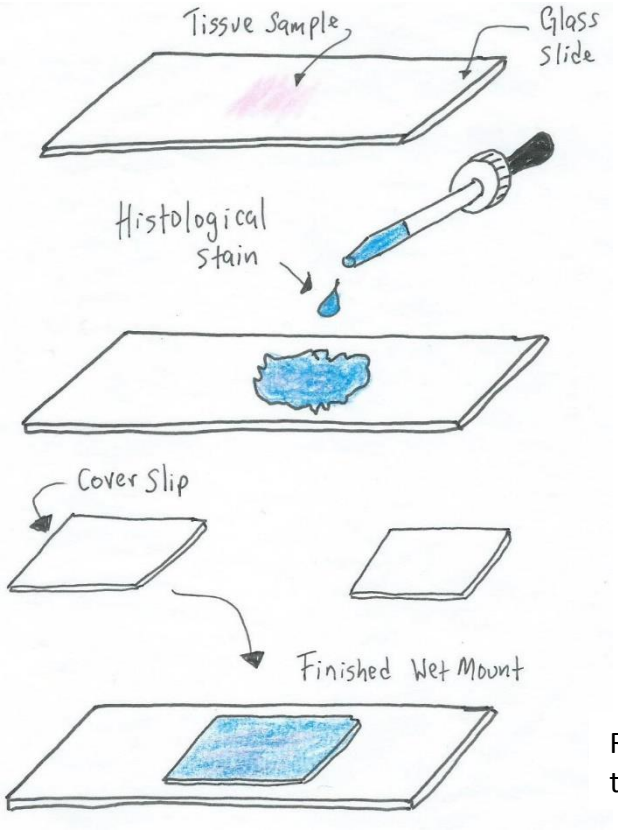
The names of cells often indicate their location and function. In general the term -cyte means a mature cell that resides in and maintains that tissue (e.g., a chondrocyte, in cartilage). Hepatocytes are found in the liver, neurons are for nervous system communication and adipocytes are found in adipose tissue, where they store triglycerides (fat). Various cells types can also have special endings, for example the suffix (ending) blast indicates a cell that makes or builds something (e.g., a fibroblast makes fibers). The suffix -clast means those which breakdown structures (e.g., an osteoclast breaks down bone matrix).

Cells are the unit of life and it is assumed you are already familiar with the basic concepts of cell structure. The first lab session is designed to reacquaint you with major cell structures and introduce you to microscopy. Knowing how to use the microscope to examine cells, tissues and organs is a powerful skill and that is another important goal of the first lab sessions of anatomy that are called ***Microscopy***.

Summary of Objectives for Introduction to Anatomy

1. To understand the language of anatomy and its specialized terminology.
2. To introduce levels of organization, body regions, the anatomical and directional terminology that will be used during the course.
3. To introduce the body cavities and lining membranes that will be seen during the course.
4. To define cytology and introduce the basic concepts involved in cellular organization.
5. To become familiar with the names of some cells and the tissues they form.

Diagrammatic overview of a very basic histological technique practiced in our first anatomy lab. Wet mount preparation of epithelial cheek cells.



Ready for viewing under the microscope!