Objectives:
By the end of this lab you will:
1. be able to describe the ANATOMICAL POSITION and understand its importance.
2. know the Directional Terms (the terms used to describe the location of organs) and how to apply them in humans and 4 legged animals
3. know the various body Planes and Sections
4. know the names of the Body Cavities and the major organs in each.
5. know the locations of the Abdominopelvic Quadrants and which organs are located in each
6. know the names of the Serous membranes that cover the surfaces of organs in the ventral body cavity.

You are NOT required to know:
1. Surface Anatomy
2. Regional divisions of the Abdominopelvic Cavity (page 8)

Materials:
1. Torso Models of human
2. Dissected fetal pigs with labelled organs
3. Sectioned organs: brain & kidney
4. Video Tape: demonstrates all directional terms

Procedure:
Work your way through Exercise 1 following their descriptions & instructions. Work with your lab partners by quizzing each other. I have listed the specific terms, etc. that I want for you to learn by Major Sectional Headings. When you finish the lab turn to the Review at the end of the book and complete the appropriate sections.

-ANATOMICAL POSITION - Know the definition and why it is useful.

-SURFACE ANATOMY: Omit
I will not test on these terms, but you should become familiar with them.

-BODY ORIENTATION AND DIRECTION (the DIRECTIONAL TERMS)
For each of the following terms know the definition and be able to apply it correctly. Practice on your lab partner. [VIDEO TAPE]
-SUPERIOR - INFERIOR
-ANTERIOR - POSTERIOR
-CAUDAL - CEPHALAD (cranial)
-DORSAL - VENTRAL
-MEDIAL - LATERAL
-PROXIMAL - DISTAL (apply only to the extremities)
-SUPERFICIAL - DEEP

-BODY PLANES and SECTIONS
Know the terms and be able to apply them. Be able to recognize the plane of section of the materials on display [kidney & brain].
-SAGITAL
-MIDSAGITAL VS PARASAGITAL
-FRONTAL (CORONAL)
-TRANSVERSE (HORIZONTAL)
-OBLIQUE
-BODY CAVITIES

Be able to identify the cavities in [MODELS and FETAL PIGS]. Know the major organs found in each cavity. You can combine this activity with Exercise 2.

**BODY CAVITIES**

<table>
<thead>
<tr>
<th>DORSAL</th>
<th>ORGANS</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRANIAL</td>
<td>brain</td>
</tr>
<tr>
<td>SPINAL</td>
<td>spinal cord</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>VENTRAL</th>
<th>ORGANS</th>
</tr>
</thead>
<tbody>
<tr>
<td>THORACIC</td>
<td></td>
</tr>
<tr>
<td>PLEURAL</td>
<td>lungs</td>
</tr>
<tr>
<td>MEDIASTINUM*</td>
<td>trachea, esophagus, aorta, vena cava</td>
</tr>
<tr>
<td>PERICARDIAL</td>
<td>heart</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ABDOMINOPELVIC</th>
<th>ORGANS</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABDOMINAL</td>
<td>liver, stomach, pancreas, spleen, small intestine, large intestine (most parts), kidneys, gall bladder</td>
</tr>
</tbody>
</table>

You should know the ABDOMINOPELVIC QUADRANTS in which each organ is found.

-PELVIC

ural bladder, ovaries, uterus

*Note:

1. the mediastinum is a solid mass, not a cavity
2. a sheet of muscle named the DIAPHRAGM completely separates the thorax from the abdomen

-SEROUS MEMBRANES (=SEROSA) - [FETAL PIGS]

Serous Membranes are extremely thin sheets of epithelial tissue & connective tissue that cover all surfaces in the ventral body cavity (looks like Saran wrap). The cells secrete fluids to lubricate the organs so that they may slide easily over each other.

Serous Membranes form 2 layers:

- PARIETAL (lines surface of cavity)
- VISCERAL (covers surface of organ)

Serous membranes in specific locations are given names. For example:

- PLEURA - pleural cavity & lungs
- PERICARDIUM - pericardial cavity & heart
- PERITONEUM - abdominal cavity & its organs
Biology 105 Lab          Exercise 2 - Organ Systems Overview

Objectives.
By the end of this lab you will:
1. know the definition of ORGAN
2. know the ORGAN SYSTEMS in humans
   • know the general function of each organ system (Table 2.1) & below
   • know the major organs that belong in each organ system
3. be able to identify the organs (only those listed below in CAPITAL LETTERS) in both the models & fetal pigs
   For abdominal organs, you should also know the quadrant in which it is found.
Figure D4.1(p728), D4.2(p730), D4.3(p732), D5.2(p739), D6.2(p 744), D7.2(p 790)

Materials:
1. Human torso models
2. dissected fetal pigs

Procedure:
Use the figures and descriptions in the book to learn to identify the various organs in both the models and pigs. Use the list below; the book includes many more structures than we require. Quiz each other thoroughly on identification, organ system, and system function. Complete the Review section in the back of the book.

<table>
<thead>
<tr>
<th>SYSTEM</th>
<th>SOME OF THE MAJOR ORGANS</th>
<th>PRIMARY FUNCTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integumentary</td>
<td>SKIN</td>
<td>Protect against damage, infection &amp; dessication.</td>
</tr>
<tr>
<td>Skeletal</td>
<td>BONES, cartilages</td>
<td>Support &amp; protect body</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Aid movement.</td>
</tr>
<tr>
<td>Muscular</td>
<td>MUSCLES on the skeleton</td>
<td>Move skeleton.</td>
</tr>
<tr>
<td>Nervous</td>
<td>BRAIN, SPINAL CORD, nerves, sensory receptors(ex: eyes)</td>
<td>Detect environmental change.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Coordinate body's activities. Homeostasis.</td>
</tr>
<tr>
<td>Endocrine</td>
<td>glands that secrete hormones; (examples: PANCREAS, THYMUS, THYROID)</td>
<td>Coordinates body's activities. Homeostasis.</td>
</tr>
<tr>
<td>Cardiovascular</td>
<td>HEART, blood &amp; blood vessels (ex: aorta &amp; vena cava)</td>
<td>Transport nutrients, waste &amp; hormones. WBCs fight infection.</td>
</tr>
<tr>
<td>Lymphatic</td>
<td>lymph vessels and nodes, tonsils, THYMUS, Spleen</td>
<td>Returns tissue fluids to blood. Part of Immune Sys.</td>
</tr>
<tr>
<td>Respiratory</td>
<td>pharynx, LARYNX, TRACHEA, bronchi, LUNGS</td>
<td>Acquires oxygen and discards carbon dioxide.</td>
</tr>
<tr>
<td>Digestive</td>
<td>esophagus, STOMACH, SMALL INTESTINE, LARGE INTESTINE, LIVER, GALL BLADDER, PANCREAS</td>
<td>Breakdown food so that it may be absorbed into the blood.</td>
</tr>
<tr>
<td>Urinary</td>
<td>KIDNEYS, ureters, URINARY BLADDER</td>
<td>Removes nitrogenous wastes (ammonia, urea) from blood.</td>
</tr>
<tr>
<td>Reproductive</td>
<td>Female: OVARIES, UTERUS Male: TESTES only in the pig</td>
<td>Produces eggs or sperm. Female houses fetus.</td>
</tr>
</tbody>
</table>

h = find in human only
p = find in pig only
Biology 105 Lab      Exercise 3      Microscope

Objectives
By the end of this lab you will:
1. know the parts of a compound microscope and their functions
2. know the correct procedure for use of a microscope
3. know proper care of the microscope
4. know the effects of increasing magnification on working distance, image brightness, field diameter, and depth of field
5. know the terminology associated with microscopy
6. be able to calculate magnification
7. know the definition of a micrometer, µm (aka micron)
8. be able to prepare a Wet Mount of cheek cells.

Parts of the Microscope and Terms:
Base & Arm
Stage
Light source
Diaphragm
Condensor Lens
Objective Lenses
   Scanning, Low, High, Oil
Ocular Lens

Magnification
Resolution
Field (Field of View)
Working Distance
Depth of Field

Procedure:
We will "walk through" the basic steps in microscope care and use as a class. You should be able to complete the questions when we finish.

Omit the following parts of the exercise:
1. Estimating the Diameter of the Microscope Field

It is important that you leave class feeling confident that you can use the microscope.
If time permits you should make a Wet Mount of cells scraped from the inside of your cheeks. Use the method described in the book.

Complete the questions in the Review Sheet for Exercise 3.
Objectives
By the end of this lab, you will:
1. know the parts of a cell that are visible with the light microscope and be able to identify them on models or under the microscope
2. know the functions of the structures in #1.
3. recognize the names of other cell structures NOT visible with the light microscope and know their function.
4. understand that cells show considerable variation in form and function.
5. know the major stages of the cell cycle and mitosis
6. be able to identify which stage of the cell cycle or mitosis that a cell is in

Procedure:
ANATOMY OF THE COMPOSITE CELL
Learn to recognize those parts of cell that are visible with the light microscope [MODELS AND SLIDES] and know their basic functions (listed below).

-NUCLEUS Contains DNA : controls cell function & reproduction
-NUCLEOLUS Site of ribosome production
-PLASMA MEMBRANE Forms the cell's boundary. It limits movement of material in/out of cell.
-MICROVILLI Folds in the plasma membrane
-CYTOPLASM The region outside the nucleus
-CYTOSOL The fluid portion of the cytoplasm
-ORGANELLES Structures located in the cytoplasm
-VACUOLES & VESICLES Membranous storage sacs in the cytoplasm
-INCLUSIONS Particles stored cytoplasm ex. oil drop
-FLAGELLA & CILIA Hair-like projections of the plasma membrane; they contain protein filaments and are able to move.

-Additional Cytoplasmic Organelles will be covered in lecture (Table 4.1). Since these Organelles are too small to be seen with the light microscope, you can only see them in the electron micrographs in your textbook. The models of the cell in lab may help you to get a sense of their shape in 3 dimensions. You should identify them on the [CELL MODELS] and learn their function. I won't include these on the quiz, but they will be on the final exam.

DIFFERENCES AND SIMILARITIES IN CELL STRUCTURE
Examples of a variety of different cell types are displayed under the DEMO microscopes. Compare the structure of the various cell types. What cell structures are present in all of the cells? Which are absent? What specialized structures are found in some of the cells? Can you guess the function of the cells based upon their cell structure?

-[SIMPLE SQUAMOUS EPITHELIUM] - Lung, plate 26 and Kidney, plate 42
-[SPERM] = plate 47
-[BLOOD SMEAR] = plate 50
-[TEASED SMOOTH MUSCLE]
-[TRACHEA PSEUDOSTRATIFIED CILIATED COLUMNAR] = plate 27 & 28
CELL DIVISION: MITOSIS AND CYTOKINESIS

You should learn
1. the major stages in the life cycle of a cell
2. major cell events characteristic of each stage
3. to recognize the cell stage in photos or under the microscope.

CELL CYCLE = events in a cell's life are divided as follows:
1. INTERPHASE
   - Nucleus is present.
   - DNA is in the form of CHROMATIN = thin, thread-like form that is not visible in the light microscope
   - DNA replicates prior to cell division
   Each replicate is joined at the CENTROMERE

2. CELL DIVISION
   A. MITOSIS* = division of the nucleus that results in formation of 2 nuclei that are identical to each other and the original mother cell*
      1. PROPHASE
         - DNA forms rod-like CHROMOSOMES
         - SPINDLE forms
         - Nuclear membrane disappears
      2. METAPHASE
         - Chromosomes lie on the equator
      3. ANAPHASE
         - Centromeres split and identical Chromosomes are pulled to the opposite ends (poles) of the cell.
      4. TELOPHASE
         - Chromosomes clustered near the poles of the cell uncoil to form Chromatin.
         - Nuclear membranes form around the two clumps of chromatin.
         - Spindles disappear.
   B. CYTOKINESIS = division of the cytoplasm
      - Fibers around the cell's equator shorten, constricting the cell until it divides into two cells.
      - Telophase and Cytokinesis usually occur at the same time.

Study the stages in the photos in the lab manual.
Look at the [WHITEFISH BLASTULA] slide and identify cells in each stage.

Complete the REVIEW SHEET FOR EXERCISE 4

*MEIOSIS is a different type of nuclear division which results in the formation of gametes (egg or sperm) which have half the number of chromosomes as in the original mother cell. You will study this with the Reproductive system in Bio 106.
Objectives
By the end of this lab you will:
1. understand what factors affect the movement of a molecule across a membrane.
2. be able to use this knowledge to predict the outcome of different experimental conditions.
3. be able to define and explain the following:
   - SELECTIVE PERMEABILITY
   - PASSIVE TRANSPORT
   - BROWNIAN MOTION
   - CONCENTRATION GRADIENT
   - DIFFUSION
   - OSMOSIS
   - ISOTONIC SOLUTION
   - HYPOTONIC SOLUTION
   - HEMOLYSIS
   - HYPERTONIC SOLUTION
   - CRENATION
   - DIALYSIS
   - FILTRATION
   - ACTIVE TRANSPORT
   - PUMPS
   - VESICLE FORMATION
   - PHAGOCYTOSIS
   - PINOCYTOSIS

Experiments:
You will do a variety of experiments. Each group is responsible for presenting their results to the class, so don't throw out your materials until the end of class.

Activity - Brownian Movement.

Activity - Diffusion of Dye Through Agar Gel
You will compare the rate of diffusion by molecules of different molecular weight. Which diffuses faster, small or large molecules?

Activity - Diffusion Across a Non-living Membrane
You will test whether Glucose (a simple sugar) can diffuse across the artificial membrane.

Activity - You will set up an Osmometer to show how osmotic pressure is produced when a membrane prevents movement of solute. Be sure that you understand how it works. A concentration gradient is established by using a solute (in this case sucrose) which is unable to cross the membrane. Water crosses the membrane and moves down its concentration gradient (=osmosis).

Activity - Dialysis: the separation of small and large molecules according to differences in their ability to diffuse across a membrane.

Demonstration - Osmosis in Living membranes
Your instructor may demonstrate the effects of placing red blood cells into solutions of different tonicity. See pp 58-59 and Fig. 5a.3.

Activity - Filtration
You will look at the separation of molecules by filtration. What is the source of energy for the moving the materials across the filter paper?

I will describe experimental situations similar to these on your next test. You must be able to interpret what will happen.
Objectives
By the end of this lab you will
1. know the meaning of ORGAN, TISSUE, and HISTOLOGY
2. be able to name the four types of tissues (epithelial, connective, muscle, and nervous)
3. be able to list the structural characteristics, body locations, and general functions of each of the four types of tissues
4. be able to identify the four classes of tissues when presented with microscope slides or photographs
5. know the subcategories of the epithelial and connective tissues and the structural basis for distinguishing each
6. know the locations and functions of each of the subcategories of epithelial and connective tissues

The primary objective is to learn the specifics of EPITHELIAL and CONNECTIVE TISSUES. You should take time to compare the general structure, functions, and locations of the 4 tissue types. Get these in mind BEFORE looking at the details.

EPITHELIAL TISSUE
Know the general structural characteristics of epithelial tissue (pp 67-68). Draw a sketch of epithelial tissue to help you visualize the structure.
Know these terms:
   APICAL SURFACE
   BASEMENT MEMBRANE
   BASAL LAMINA
   RETICULAR LAMINA

Know the classification scheme for EPITHELIAL tissue: based on cell shape and number of layers. How does the structure affect their function?
Know these terms:
   SQUAMOUS
   CUBOIDAL
   COLUMNAR
   SIMPLE
   STRATIFIED
   PSEUDOSTRATIFIED
   TRANSITIONAL

For each type of epithelial tissue you should be able to describe its structure, location in the body, and function. Figure 6.3 a,b,c,d,e,h

You should be able to identify the specific tissue when presented with a tissue on a microscope slide.
NOTE: Each slide will contain a variety of tissues. The label merely tells you that the specified tissue is present. You must use your understanding of the characteristics of each tissue to find the tissue.
   Photomicrographs in the Figure 6.3 are good.
   Other good examples are in the section of your lab manual with the HISTOLOGY ATLAS. You should be able to find most of the epithelial tissues in this section.
   You have the following slides:
   1. SIMPLE SQUAMOUS - oral smear (not a cross section) Figure 3.5, p34
      These are cells scraped from the mouth and spread on the slide. This slide is useful to see the shape of squamous cells from a "top down" view rather than from the side.
   2. SIMPLE SQUAMOUS - section kidney
      This slide shows mostly Simple Cuboidal, but there are ball-like structures called Gomeruli that are covered by simple squamous. Plates 41 & 42 shows a kidney glomerulus.
Plate 26 shows air sacs in lung. Each sac is formed by S.S. epithelium

3. **SIMPLE CUBOIDAL** - Thyroid Gland
   Simple Cuboidal tissue forms spheres around a clear pink material. This slide also has a big patch of Adipose tissue. (Check out the slide of kidney for examples of simple cuboidal, plates 41 & 42)

4. **SIMPLE COLUMNAR** - usually from the intestine
   The simple columnar forms a single layer of cells facing the interior of the gut tube. Usually lots of GOBLET cells.
   Plates 1, 30-36 (low power section of the gut)

5. **PSEUDOSTRATIFIED COLUMNAR CILIATED** - usually from the trachea
   Lots of goblet cells here. Note the 2 layers of nuclei.
   Plates 27 & 28

**CONNECTIVE TISSUE**

Know the general structural characteristics of CONNECTIVE TISSUE.

**CELLS** - Cells are usually far apart and the type of cell varies

Examples of Cell Types: fibroblast, mast, chondrocyte, osteocyte, blood

**EXTRACELLULAR MATRIX** = the material between the cells. It consists of 2 components:
1. **FIBERS** = COLLAGEN (WHITE) or ELASTIC (YELLOW) or RETICULAR
2. **GROUND SUBSTANCE** - its density varies from watery -> gel-like -> solid depending upon the tissue

Connective Tissues are divided into the following classes based upon the cell types and extracellular matrix. You only need to be concerned about those listed in CAPital letters for now. We will cover cartilages and bone in future labs and blood in A&P II.

1. **Proper**
   - Loose
     - AREOLAR
     - ADIPOSE
     - Reticular
   - Dense
     - DENSE REGULAR
     - Dense Irregular

2. **Cartilages**
   - HYALINE
   - Elastic
   - FibroCartilage

3. **Bone (Osseous)**

4. **Blood**

For each type of CONNECTIVE TISSUE (listed in CAPs. above) you should be able to describe its structure, location in the body, and function. Fig. 6.5 b,c,e,f,g

You should be able to identify the specific tissue when presented with a tissue on a microscope slide.

- Use the photomicrographs in Figure 6.5
- Use photos in the histology atlas
- You have the following slides:
  1. AREOLAR
  2. ADIPOSE
  3. **WHITE FIBROUS** = dense regular CT
  4. **HYALINE CARTILAGE**
     Note the LACUNAE

Demo Slides - Use these as extra sources of tissue to study. You should be able to find the tissues listed below on each slide.

1. **CILIATED EPITHELIUM** - TRACHEA = plate 28 & 27
   Includes cartilage, areolar and adipose too

2. **ARTERY, VEIN, NERVE** = plate 21
   simple squamous, smooth muscle

3. **SMALL INTESTINE** = plate 34
simple columnar, areolar, smooth muscle

4. BONE

MUSCLE TISSUE
You should know the major structural/functional characteristics, but we will study the sub-types in a future lab.

NERVOUS TISSUE
You should know its major structural/functional characteristics, but we will study it in detail late in the semester.

Please try to learn characteristics of the tissues and apply them to the slides and photos. Memorizing an image is a poor approach since the slides vary dramatically in quality, stains, and overall appearance.

An excellent way to prepare for this test is to create a Dichotomous Key to the tissues. This is a series of questions to ask in sequence. The answer to the question determines which will be the next question. It is the same process you would use if lost. Each time you come to an intersection or landmark you would ask which way? This is an example of how a key might work:

1. Are cells tightly packed or far apart?
   ANSWER: Tightly packed therefore, not CT, prob. not nervous, could be muscle or epithelium. Ask a question to distinguish between muscle and epithelium
2. Cells long or compact and boxy?
   ANSWER: cells small and boxy - must be epithelium. Which kind?
3. Cells in one layer?
   ANSWER: yes therefore, simple
4. Cells cube, flat or columnar?
   ANSWER: cube. Tissue must be simple cuboidal epithelium

Biology 105 Lab Exercise 8 Classification of Body Membranes
You should know the names of the membranes, their locations in the body, their products, general structure.

There is no lab work on this exercise.

- EPITHELIAL = 1. MUCOUS (MUCOSA) 2. SEROUS (SEROSA) 3. CUTANEOUS
- CONNECTIVE = 1. SYNOVIAL 2. others not listed
Objectives
By the end of this lab you will
1. know the important functions of skin
2. be able to recognize and name the structures listed below
3. be able to describe the structure of the epidermis and dermis
4. know the functions and properties of the the structures in the skin
5. know the basis for skin color
6. know how distribution of sweat glands varies by location

Layers
-EPIDERMIS
  -Cell types: KERATINOCYTES, MELANOCYTES, MERKEL CELLS
  -Strata
    1. BASAL
    2. SPINOSUM
    3. GRANULOSUM
    4. LUCIDUM
    5. CORNEUM
-DERMIS
  1. PAPILLARY Region
     -DERMAL PAPILLAE
     -MEISSNER'S CORPUSCLE
  2. RETICULAR Region
     -Collagen & elastic fibers
     -Blood vessels
     -structures derived from epidermis
     -HAIR
        -FOLLICLES/ROOT/SHAFT
        -ARRECTOR PILI
        -SEBACEOUS GLANDS
        -SEBUM
        -SUDORIFEROUS GLANDS
        -ECCRINE
        -APOCRINE
     -Sensory receptors - Pacinian, Ruffini, bare endings
-HYPODERMIS (SUPERFICIAL FASCIA) - Not skin
  -Blood vessels, nerves, adipose, loose areolar CT

Be sure that you can identify all of the above in slides of the skin or models or by description or function

Do the experiment to plot the distribution of sweat glands.

Materials
Slides:
  SKIN
    PACINIAN CORPUSCLE - Plate 13, p695
    MEISSNER'S CORPUSCLE - Plate 11, p694
    SWEAT GLAND - Fig 7.7
    SEBACEOUS GLAND - Fig 7.7
    SKIN WITH HAIR FOLLICLE - Fig 7.6

Models of the skin
Objectives
By the time you complete this lab you will
1. know the functions of the skeletal system
2. know the 4 classes of bone shape (long, short, flat, irregular) and be able to place bones in these groups
3. be familiar with the bone markings. I won't test you on the names of the bone markings, but you will need to become familiar with the terms before learning the bones next week. Look for the markings as you look at the various bone types.
4. know the parts of the long bone and be able to identify them
5. know the organization of an osteon and be able to identify its parts
6. know how the composition of the extracellular matrix affects bone strength
7. know the types of cartilage and their body locations
8. be able to identify Hyaline Cartilage and Bone tissue

Bone Markings
Examine a variety of bones and find examples of the markings. What is the importance of the markings? I will not quiz you on this, however, you will use these terms when studying the bones next week and the muscles after that. Study them before next week.

Classification of Bones
Examine bones and fit them into the following groups:
LONG, SHORT, FLAT, IRREGULAR - shape categories
SESAMOID - small bones within tendons
WORMIAN - small cranial bones

Gross Anatomy of a Long Bone
Examine a bone cut longitudinally. Know the structure, parts, their functions, and be able to ID all the parts listed. * indicates structures not found in dry bones. Use a fresh bone if available.

DIAPHRYSIS
EPHYSYSIS
EPHYSEAL PLATE & LINE
MEDULLARY CAVITY
ENDOSTEUM*
YELLOW MARROW*
RED MARROW*
PERIOSTEUM*
SHARPEY'S FIBERS*
ARTICULAR CARTILAGE*

Chemical Composition of Bone
Check the display. What is the effect of removing the mineral matrix? of removing the fibers?

Microscopic Structure (Histology) of Bone
There are 2 histological types of bone each with its own arrangement of OSTEOCYTES in an extracellular matrix:

1. SPONGY BONE
   TRABECULAE
2. COMPACT BONE
   HAVERSIAN SYSTEM = OSTEON
   CENTRAL CANAL
   LAMELLAE
   LACUNAE
OSTEOCYTE
CANALICULI
Chemical Composition of the extracellular matrix
- Protein fibers
- Minerals = Calcium + Phosphate salts

**Cartilages of the Skeleton**
Know the types and their locations in the skeleton. Be able to identify Hyaline cartilage in slides.

Types:
- HYALINE
- FIBROCARTILAGE
- ELASTIC

Locations

Materials
- Slides: BONE, HYALINE CARTILAGE, DENSE FIBROUS CT
- Variety of bones to classify by shape
- Bones that have been cut longitudinally
- Models of bone
- Skeletons to locate bone types and cartilages
Biology 105 Lab  Exercise 10  Axial Skeleton

Bone Handout

-Objectives 1 - 4
-Your major goal is to learn the names of the bones in the axial skeleton and the markings that are listed on the Bone Handout.
-You should be able to recognize most bones when presented alone.
-You should know which bones articulate with each bone.
-You should be able to tell which side of the body some bones belong to when presented alone. You should be able to do this for Femur, Tibia, Humerus, Ulna, and Os Coxae.
-You should be able to recognize which region of the vertebral column a vertebra is from.
-You should know how many vertebrae belong in each region of the vertebral column.
-The exam will be all practical questions.

Materials - boxes of bones and skulls
sagitally sectioned skull

Biology 105 Lab  Exercise 12  Fetal Skeleton

Objectives 1 & 2

-You should be able to identify the 4 major fontanels.

Materials - fetal skull

Biology 105 Lab  Exercise 11  Appendicular Skeleton

Bone Handout

-Objectives 1 - 5
-Your major goal is to learn the names of the bones in the appendicular skeleton and their markings as listed on the Bone Handout.
-You should be able to recognize most bones when presented alone.
-For most bones, you should be able to recognize whether the bone is from the right or left side.
-You should know which bones articulate with each bone and how the joint is formed.
-You should know the differences between the male and female pelvis.
-NOTE that an understanding of the markings and the joints is essential for understanding the attachments and actions of the skeletal muscle. Your hard work now will benefit you later!
-Objectives 1 & 2
  
  We will omit the section on body movements until the lab in which we name the muscles.

-Your major goal is to understand the 2 classification schemes for joints and recognize examples. Each joint can be assigned to both a functional and structural class.

-Functional classes (by degree of movement):
  1. SYNARTHROSIS = no movement
  2. AMPHIARTHROSIS = slight movement
  3. DIARTHROSIS = free movement

-Structural classes:
  1. FIBROUS
      =fibrous CT joins bones
      -Functional class = Synarthroses
      -types:
          -Sutures - eg. skull
          -Syndesmosis - eg. tibia-fibula
  2. CARTILAGINOUS
      =pad of cartilage joins bones
      -Functional class = Amphiarthrosis
      -types:
          -SYMPHYSIS
            =fibrocartilage joins 2 bones
            -eg. pubic symphysis
          -SYNCHONDROSIS
            =Hyaline cartilage joins 2 bones
            -eg. ribs-sternum; epiphysis-diaphysis
  3. SYNOVIAL
      =Joint enclosed by JOINT CAPSULE filled with SYNOVIAL FLUID
      -Functional class = Diarthrosis
      -All the movable joints are of this type
      -Structure
        -ARTICULAR CARTILAGE = hyaline cartilage
        -ARTICULAR CAPSULE = fibrous CT
        -SYNOVIAL MEMBRANE (makes synovial fluid) lines the articular capsule
        -LIGAMENTS
          -Sometimes BURSA & Fibrocartilaginous pads (MENISCUS)
      -Type of movement at a synovial joint is determined by shape of the articulating surfaces and the arrangement of the ligments and muscles.
      -Types of Synovial Joints = classification by the shape of the articulating surfaces. Know some examples of each.
        -GLIDING
        -HINGE
        -PIVOT
        -CONDYLOID
        -SADDLE
        -BALL & SOCKET
      -The types of movements are shown on pages 123-125. We will study these with the skeletal muscles.
Objectives
By the end of lab you should be able to do the following:

1. understand the organization of muscle tissues.
   - State the 3 types of muscle tissues and their locations in the body.
   - Be able to describe the structural characteristics of each muscle type.
   - Be able to identify the type of muscle on histological slides. This material is covered in Exercise 6 (pp 62-64).

2. Describe the internal organization of individual skeletal muscle cells (= MYOFIBER = FIBER).
   - Identify the parts of the cell and be able to identify them in models of the cell:
     NUCLEUS, SARCOLEMMA, MYOFIBRIL, SARCOPLASMATIC RETICULUM, MYOFILAMENTS (THICK & THIN FILAMENTS), Z-LINE
   - Understand the arrangement of contractile MYOFILAMENTS (ACTIN & MYOSIN) within the SARCOMERE and how they interact to bring about movement.

3. Describe the arrangement of muscle cells (fibers) into whole muscles and the specific connective tissue layers that envelop them and form the tendons.
   ENDOMYSIUM (enclose fibers), PERIMYSIUM (enclose FASCICLES), EPIMYSIUM (enclose whole muscles), DEEP FASCIA, TENDONS, APONEUROSES

4. Describe the interactions of skeletal muscle with MOTORNEURONS.
   - Know the organization of the NEUROMUSCULAR JUNCTION and be able to identify the parts on a model:
     AXONAL TERMINAL, SYNAPTIC VESICLES filled with NEUROTRANSMITTER = ACETYLCHOLINE, SYNAPTIC CLEFT, MOTOR ENDPLATE, RECEPTORS
   - What is meant by the MOTOR UNIT
   - Be able to recognize the neuromuscular junction in a tissue slide.

Slides:
SKELETAL MUSCLE
SKELETAL MUSCLE TEASED - individual muscle fibers (cells)
CARDIAC MUSCLE
SMOOTH MUSCLE TEASED - individual cells
ARTERY, VEIN, NERVE (look for smooth muscle in wall of arteries)
COLUMNAR EPITHELIUM (segment of G.I. tract wall with smooth muscle)
MOTOR END PLATE - shows motorneuron terminals on skeletal muscle

-We will discuss some muscle physiology, but we won't do the experiments. We will watch a film in which Dr. Potter performs the experiments.

-You should recognize that a muscle cell maintains an electrical voltage across its plasma membrane (=RESTING POTENTIAL) so the inside is about -80 mV inside. The cell is said to be polarized. This voltage is due to the unequal concentrations of Na⁺ and K⁺ ions on either side of the plasma membrane. This unequal ion distribution results from the action of the Na⁺-K⁺ pump and the ability of the membrane to limit flow of Na⁺ and K⁺ ions. When the cell is stimulated (by neurotransmitter or electrical shock) its permeability to Na⁺ and K⁺ ions changes resulting in a sudden change in the cell voltage to about +30 mV (=ACTION POTENTIAL). This voltage change lasts only a few milliseconds before the cell repolarizes and returns to -80 mV inside. The Action Potential triggers the release of Ca²⁺ from the sarcoplasmic reticulum. High levels of Ca²⁺ and ATP make contraction possible. Contraction ends when the Ca²⁺ is pumped back into the sarcoplasmic reticulum.

-Contraction of a single muscle cell in response to a short stimulus is a MUSCLE TWITCH. Duration of the twitch varies with the type of muscle (sub-categories of skeletal muscle, smooth, cardiac) from about 30 mS to several hundred milliseconds. Duration is dependent on the time required to remove Ca²⁺ from the sarcoplasm.

-Individual muscle cells contract in ALL-OR-NONE fashion, ie. they contract with maximum force in response to stimulation. Increasing stimulus strength does not make the cell contract with greater force. The minimum stimulus that elicits contraction is the THRESHOLD STIMULUS. An individual muscle cell does show a slight increase in its contractile strength as it is first used (warms up). This increase in contractile strength is known as TREPPE.

-Sustained stimulation of a muscle at rates of several times per second causes Force of Contraction to increase. This is because the muscle initiates contraction before it has had a chance to relax completely; each stimulus comes before the thick and thin myofilaments have had a chance to slide apart. This is known as WAVE SUMMATION. At very high rates the muscle enters TETANUS. Tetanus occurs because the muscle does not relax at all before the next stimulus forces it to contract. Under physiological conditions, the brain stimulates the muscle at a high enough frequency so that it reaches tetanus and thus produces maximum force.

-Skeletal muscle cells cannot sustain a contraction for long periods of time. The supply of ATP in the cell becomes depleted, and the cell's Na⁺-K⁺ pumps cannot work fast enough to restore the proper distribution of ions across the cell membrane. These conditions result in MUSCLE FATIGUE.

-You should have a basic understanding of how the muscle's strength of contraction is controlled, know the terms, and be familiar with the experiments described in the film (don't worry about the details of the methods). Be able to interpret a myograph similar to those produced in the experiments shown on the film.
Objectives 4 & 5

4. To define origin and insertion of muscles
5. To demonstrate or identify the various body movements as listed on pp 173-175, Exercise 13. You need to be comfortable with these terms in order to understand the descriptions of muscle actions.

In preparation for learning the actions of gross muscles we will discuss the arrangement of muscle with respect to bones and the roles that muscles play in bringing about movement.

- Muscle tendons attach to bone periosteum at the ORIGIN and INSERTION, p173
- You should learn the terms that are used to describe the roles of the muscles that participate in bringing about a particular movement (p 197, Exercise 15).

AGONISTS (PRIME MOVERS) vs ANTAGONISTS
SYNERGISTS & FIXATORS

- You should understand the concept of Origin and Insertion.
- You should understand how muscles are arranged in relationship to a joint and how they cooperate so that they may bring about specific movements. Know the terms on p 197 - prime movers (=agonists), antagonists, synergists, fixators.

- You should be able to identify the muscles listed on the Muscle Handout.
  1. the action of the each muscle as listed on the handout.
  2. the origins and insertions of each muscle. You only need to know the bone, not the specific bone processes.

- The only materials are the models of torso, arms, legs, head.

- You can learn these muscles more easily if you prepare before coming to class. Go through your lab manual and mark/highlight the muscles listed in the handout on the figures. Mark the lab manual page number where you find pictures of the muscles on the Muscle Handout. This will make it easier to go back and forth between the lab manual and the Handout. Many of the muscles can be seen in the figures on pp 200 & 201.
1. You should have an understanding of the organization of the Nervous System and its major divisions. See Figure 11.2 in your textbook.

Nervous System is divided into:

1. CENTRAL NS (CNS)
   =brain & spinal cord
2. PERIPHERAL NS (PNS)
   =nerves & ganglia outside the spinal cord
   -May be divided into:
     1. SENSORY (AFFERENT)
     2. MOTOR (EFFERENT)

Motor systems are divided by the structures they control:

1. SOMATIC division controls skeletal muscle
2. AUTONOMIC division controls smooth muscle, cardiac muscle & glands
   -The ANS coordinates the actions of the organ systems. It adjusts their activity so that they behave in a manner appropriate for the conditions.
   -Each structure is controlled by antagonistic ANS divisions:
     1. SYMPATHETIC ANS (S-ANS) prepares the body for "fight or flight"
     2. PARASYMPATHETIC ANS (P-ANS) puts body into a state appropriate for rest & repose
   -Each structure receives both of these opposing commands to "slow down - speed up". The relative strength of each determines the final response of the organ.

2. You should know what the NEUROGLIA are and their general function. You should recognize the names of the various types and whether they are located in the PNS or CNS. See Figure 17.1 in the lab manual.

   Neuroglia in the CNS = ASTROCYTES, OLIGODENDROCYTES, EPENDYMAL CELLS & MICROGLIA
   Neuroglia in the PNS = SCHWANN CELLS

3. You should know the structures of a NEURON and what these structures do.
   -Can you draw a picture of a myelinated neuron and label all the major structures? See Figure 17.2 in the lab manual.
   -Can you list the important organelles and their functions?
   -Can you identify the structures on models or in tissue slides?
     -Major regions = CELL BODY, DENDRITE, AXON (often called a "fiber")
     -Structures:
       NEUROFIBRILS, NISSL BODIES, AXON HILLOCK, AXON TERMINALS, SYNAPTIC CLEFT

4. You should know what the MYELIN SHEATH is and its importance for neuron function.
   -How does it form? What cells are involved in its formation in the CNS? and PNS?
   -What is a NODE OF RANVIER?
   -What would happen if your myelin were destroyed?
   -You should be able to identify myelin & nodes of Ranvier in slides of myelinated nerves (both in xs and is) and on models of neurons

5. You should have basic understanding of the properties of a neuron's function.
   -Neurons are irritable and conduct a nerve impulse = ACTION POTENTIAL.
     -The Action Potential is an electrical impulse that is produced when the neuron is stimulated. The AP moves down the Axon towards the axon terminal. A short description is given on pp 269 - 271. I won't test you on this.
   -Neurons can communicate with adjacent neurons via a chemical synapse. NEUROTRANSMITTERS are released from vesicles in axon terminal
     -Where is it made? where is it stored?
     -How does neuron receive the chemical signal?
6. Nerve cells are classified according to structure. Each type is found in specific parts of the NS. Know the types and their common locations. **UNIPOLAR, BIPOLAR, MULTIPOLAR**

7. Nerve cells are also classified according to function. Know the functional classes and type of information they carry. **AFFERENT, EFFERENT, and INTERNEURON (ASSOCIATION) NEURONS**

8. A NERVE is a bundle of axons that travel together.
   - Different terms are used to describe axon bundles in the PNS and CNS:
     - NERVES (PNS)
     - TRACTS (CNS)
     - WHITE MATTER = large areas with mostly axons in the CNS
     - Several layers of CT envelop the axons and the blood vessels that travel with them. You should know the parts of a nerve including the specific connective tissue layers.
     - A nerve will carry a mix of myelinated and non-myelinated axons.
     - Nerves are classified by function, i.e. the type of information they carry:
       - Sensory (Afferent), Motor (Efferent) or Mixed (carries both sensory and motor)

9. Clusters of Cell Bodies are called **GANGLIA** in the PNS and **NUCLEUS** in the CNS
   - GREY MATTER = areas in the CNS with mostly cell bodies.

**MATERIALS**

Slides:
- OX SPINAL CORD SMEAR - look for multipolar neurons, only the soma and dendrites are stained Plate 5
- SPINAL CORD (XS) - Look for cut axons in the White Matter (the pale stained region near the outside of the spinal cord. Look for cell bodies of multipolar neurons in the Gray Matter (the darker stained area near the center of the spinal cord). Look for Unipolar cell bodies in the Dorsal Root Ganglion (located outside the spinal cord) Plates 9 & 7
- MEDULLATED (MYELINATED) NERVE FIBERS (XS, LS) - Look for the axons and myelin. Look for fibers that run parallel to each other. The bubbly looking stuff around the fibers is the myelin. The nodes of Ranvier are also visible in this slide. Plates 8 & 10
- NERVE (silver stain)
- PERIPHERAL NERVE

Models:
- Models of the neuron.
Objectives 1 - 7, 9
-Your overall goal is to learn the parts of the brain (external and internal) and their general functions. Know the structures listed on this handout in the following figures:
  Figure 19.2 (a) & (b)
  Figure 19.3

**Figure 19.4**
- You do NOT need to know the parts of the Basal Nuclei (listed on p 205)
- You must be able to identify the parts on **both the human models and the sheep brains.**
- Look at whole sheep brains and sheep brains that have been cut in sagital and frontal sections.

**Cranial Nerves**
- Know both name and number, the function(s) of each (as listed here), and the location.

**Overview of the major brain areas and their function**
The brain forms through growth of tissues that surround the anterior end of the Neural Tube. The growths around each region of these ventricles gives rise to the major regions of the adult brain:
  - Medulla (=Medulla Oblongata)
  - Pons
  - Cerebellum
  - Midbrain (=Mesencephalon)
  - Diencephalon (includes Thalamus & Hypothalamus)
  - Cerebrum (includes the Cerebral Cortex and Basal Nuclei)

These regions can be seen in sagital views of the brain (Fig 19.4). Some regions can be seen in the ventral view (Fig. 19.3 & 19.9). Identify these regions.

Each brain region encloses specific regions of the Neural tube that expand to form several pouches that are called **ventricles.** These spaces are filled with Cerebrospinal Fluid (CSF) and each region is named:
  - Lateral Ventricle (= 1st & 2nd Ventricles), 3rd Ventricle, Cerebral Aqueduct, 4th Ventricle

What do each of these regions do?
**Brain Stem** = Medulla + Pons + Midbrain
  - Carries Axons of sensory pathways from Spinal Cord up to the Thalamus
  - Carries Axons of motor pathways from Cerebrum down to Spinal Cord
  - Site of numerous Ganglia for sensory or motor functions in both the Somatic and ANS

**Thalamus**
  - Receives sensory information from virtually all sensory receptors
  - Acts as a "Gate Keeper" in that it limits which sensory signals are passed on to the Cerebral Cortex.

**Hypothalamus**
  - Control of visceral functions
  - Acts via ANS & Pituitary Gland

**Cerebrum**
- Seat of consciousness, memory, learning
- Interprets sensory input & produces a motor response

Cerebellum
- Aids Cerebrum in the coordination of movements

**A Tour of the major areas of the brain by region.**

**Cerebrum**

**External View (Fig 19.2)**
- Cerebral Cortex is divided into 2 Hemispheres
- Cerebral Cortex is highly folded:
  - GYRUS = ridge; SULCUS = groove; FISSURE = deep sulcus
- Some Fissures are named:
  - LONGITUDINAL FISSURE
  - CENTRAL SULCUS
  - LATERAL SULCUS
- These fissures divide cerebral cortex into Cerebral Lobes:
  - FRONTAL, PARIETAL, TEMPORAL, OCCIPITAL
- Each lobe has specific functions associated with it:
  - Parietal = somatosensory
  - Occipital = vision
  - Temporal = auditory, taste & smell
  - Frontal = motor, planning
- Specific Gyri within each lobe have even more specific functions
  - EX. Post Central Gyrus in the Parietal Lobe receives the direct sensory input from the skin
  - EX. Pre-Central Gyrus in the Frontal Lobe sends out motor commands in axons that travel down the spinal cord.

**Internal View (Fig. 19.4 & 19.5)**
- The Cerebrum consists of the Basal Nuclei, White Matter & Cerebral Cortex.
  - The Basal Nuclei are masses of cell buried deep in the brain anterior to the Thalamus. They are important for control of movement.
  - They're only visible in the sectioned brain.
- The Cerebral Cortex is a thin layer of cells on the surface.
- White Matter consists of Fiber Tracts (bundles of axons) that carry information between cells. (Figs. 19.5 & 19.14)
  - ASSOCIATION TRACTS connect cells with one hemisphere
  - PROJECTION TRACTS connect cerebral cortex to the spinal cord & brain stem. EX = Internal Capsule
  - COMMISSURES join similar areas in the 2 hemispheres: EX = CORPUS CALLOSUM
- The LATERAL VENTRICLES (1st & 2nd Ventricles) are located inside the cerebrum. The SEPTUM PELLUCIDUM is a thin membrane that forms part of the wall of these ventricles.
- Look for these structures in sheep brains sectioned in frontal and horizontal planes.

**Diencephalon = Thalamus & Hypothalamus & Epithalamus**

**Ventral Surface (Fig. 19.3).** Can't see much of these except for the following:
- OLFACTORY BULBS - contain smell receptors
- OPTIC NERVES, OPTIC TRACT & OPTIC CHIASM - vision
- MAMMARY BODIES - small rounded masses
- PITUITARY GLAND & INFUNDIBULUM

**Sagital Section (Fig. 19.4)**
- Only the medial surface of the Thalamus is visible in the Sagital section.
  - The medial surface of the Thalamus forms the wall of the 3rd Ventricle.
- INTERMEDIATE MASS = small commissure between the 2 Thalami
- Hypothalamus (Fig. 19.4) is a wedge shaped region inferior to the thalamus
- INFUNDIBULUM = a thin, stalk that joins the PITUITARY GLAND (=HYPOPHYSIS) to the hypothalamus
- MAMMARY BODIES
- EPITHALAMUS = the region located dorsal & posterior to Thalamus
  - includes the PINEAL GLAND
Cerebellum (Fig. 19.3 & 19.4)
- The Cb sits on the dorsal surface of the Brain Stem
- Divided into 2 hemispheres with a strip called the Vermis in-between (Fig 19.6)
- Similar to Cerebrum in that its gray matter is on the surface, white matter is deep (=ARBOR VITAE) and there are deep nuclei.
- Cb sits on top of the 4th Ventricle (Fig. 19.4)

Brain Stem
External View (Fig. 19.3).
- You should be able to ID the Medulla, Pons, and Midbrain
- If you pull the Cb down away from the Cortex (Fig 19.12), you can see the
  CORPORÆ QUADRIÈGEMINA = SUPERIOR COLICULUS & INFERIOR COLICULUS
  They control reflex turns of the head and eyes to visual (SC) & auditory
  stimuli (IC)
- Sagital section (Fig. 19.4)
  - CEREBRAL AQUEDUCT - Narrow tube connects the 3rd Ventricle to 4th Ventricle
  - Note the SUPERIOR & INFERIOR COLICULI on dorsal surface

The brain & Spinal Cord are enclosed by 3 CT membranes called MENINGES - Fig. 19.7
1. DURA MATER
   - forms "mitten-like" sheath that encloses entire CNS. It is in contact
     with the skull and vertebral arch
   - 2 layers of CT. The 2 layers are in contact with each other except at a
     few places where the inner layer dips down into the deeper fissures.
   - Don't memorize these, just note their existence in Fig. 19.7c
     Falx Cerebri = The Dip Into Longitudinal Fissure
     Tentorium Cerebelli
     Falx Cerebelli
   - Where the 2 layers separate a space is created called a SINUS.
   - The Sinuses are filled with the venous blood which will leave the
     brain via the jugular veins.
   - EX: SAGITAL SINUS (Fig. 19.7)

2. ARACHNOID
   - Cobweb like
   - thin threads join Dura to Pia
   - SUBARACHNOID SPACE = space between Dura & Pia.
   - Contains CSF
   - Blood Vessels run through here.

3. PIA MATER
   - directly on surface of brain & Spinal Cord
   - follows every sulcus

Cerebrospinal Fluid is formed in the Ventricles and travels into the SubArachnoid
Space then into the Sinuses.
- Composition = similar to blood plasma without proteins
  = water, salts, nutrients
- formed by the CHOROID PLEXUS located in the Ventricles
  = leaky blood capillaries
- can be seen as "fuzzy stuff" in the roof of the ventricles
- Path of flow (Fig. 19.8):
  Lateral Ventricle
    --> Interventricular Foramen
    --> 3rd Ventricle
    --> Cerebral Aqueduct
    --> 4th Ventricle
    --> Lateral & Median Aperatures
    --> SubArachnoid Space
    --> ARACHNOID VILLUS = Arachnoid tissue that forms
        a pouch that forms within the
Superior Sagittal Sinus - contains venous blood that will drain into the jugular veins
-You must learn the Cranial Nerves by name and number.
-You must know the function(s) as listed here.
-You must be able to identify cranial nerves 1, 2, 3, 5, 6 on the sheep brains and human models.

<table>
<thead>
<tr>
<th>CRANIAL NERVE</th>
<th>FUNCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. 1. Olfactory</td>
<td>Smell</td>
</tr>
<tr>
<td>II. 2. Optic</td>
<td>Vision</td>
</tr>
</tbody>
</table>
| III. 3. Oculomotor | Controls 4 eye movement muscles  
 Controls lens shape (PS)*  
 Controls iris (PS) |
| IV. 4. Trochlear | Controls eye movement muscle                                             |
| V. 5. Trigeminal | General sensation from face, mucosa of mouth & nose, surface of eye  
 Controls muscles for chewing |
| IV. 6. Abducens | Controls eye movement muscle                                             |
| VII. 7. Facial | Taste anterior 2/3 tongue  
 Controls muscles of facial expression  
 Controls spitting and crying (PS) |
| VIII. 8. Vestibulocochlear | Equilibrium  
 Auditory |
| IX. 9. Glossopharyngeal | Taste posterior 1/3 tongue  
 General sensation pharynx  
 Pressure receptors in carotid artery (for blood pressure control)  
 Controls muscles of pharynx (swallowing) |
| X. 10. Vagus    | Viscera – sensory & motor (PS)  
 Controls heart (PS)  
 Control muscles of pharynx & larynx (voice) |
| XI. 11. Spinal Accessory | Controls sternocleidomastoid & trapezius |
| XII. 12. Hypoglossal | Controls muscles of tongue                                              |

*(PS = parasympathetic)*

Locations where the CN roots enter the brain:
- Diencephalon – 1, 2
- Midbrain – 3, 4
- Pons – 5
- Intersection between pons & medulla – 6, 7, 8
- Medulla – 9, 10, 11 & 12
  (CN 9, 10 & 11 enter along the lateral surface; CN12 enters close to the midline)
Objectives 1, 2, 3, 6, 7, 9, 11
Your goals are (1) understand the gross anatomy of the spinal cord (SpC) and the spinal nerves (2) understand the internal arrangement of the spinal cord

Know the relationship of spinal cord with the vertebral column (Fig. 21.1)
- SpC extends to L2 within Vertebral Arch
  - CONUS MEDULLARIS = tapered end
- Enclosed by the Meninges which extend beyond the SpC
  - Dura & Arachnoid extend to S2.
    - Forms enlarged SubArachnoid Space - site of Lumbar Tap
  - Pia forms a cord (=FILUM TERMINALE) that extends into Coccyx
    - anchors the SpC in place
- 31 pairs of Spinal Nerves exit through Intervertebral Foramina
- Spinal nerves serve (travel to/from) specific regions of the body
- Spinal nerves in the cervical and thoracic levels exit the vertebral column as they exit the SpC
- Spinal nerves that exit the caudal end of the SpC travel within the SubArachnoid Space to the proper level in the SpC before exit. This mass of nerves = CAUDA EQUINA.
- CERVICAL & LUMBAR ENLARGEMENTS.
  - The SpC is larger in these regions since neurons serving the arms & legs enter/exit here.

Know the arrangement of the Spinal Cord as seen in Cross Section (Fig 21.2 & 21.4)
- Shape in x-s is oval with a deep POSTERIOR MEDIAN SULCUS and ANTERIOR MEDIAN FISSURE
- CENTRAL CANAL is extension of the brain's ventricular system
- Divided into Gray Matter and White Matter. Each is highly-organized
  - GRAY MATTER - contains mostly cell bodies
    - DORSAL (POSTERIOR) HORMS
      - Loc. of cell bodies that receive synaptic input from sensory neurons whose axons enter via the DORSAL ROOTS.
      - Recall that the cell body of the sensory neurons is located in the DORSAL ROOT GANGLION located immediately outside the SpC.
    - VENTRAL (ANTERIOR) HORMS
      - Loc. of cell bodies of Motorneurons whose axons exit the SpC. via the VENTRAL ROOTS to join the Spinal Nerve.
  - LATERAL HORMS
    - Found only in the Thoracic & Lumbar levels
    - Loc. of cell bodies of S-ANS Motoneurons whose axons exit via the Ventral Roots.
  - WHITE MATTER
    - Contains mostly myelinated axons that travel up (=Ascending) or down (=Descending) the SpC or cross to the opposite side = TRACTS
    - ASCENDING TRACTS are sensory
    - DESCENDING TRACTS are motor
    - DORSAL, LATERAL & VENTRAL COLUMNS (FUNDICULI) are the regions between the Horns. Each has well-organized tracts which carry specific types of sensory or motor information.
    - You do NOT need to know the names of the specific ascending and descending tracts that are listed in Fig 21.3.

MATERIALS & PROCEDURES - see p 229
- Beef spinal cords for dissection - Pay attention to nerve roots and the meninges
- Spinal cord models
- SLIDES
  - SPINAL CORD-XS You should see white & gray matter, dorsal & ventral roots, the meninges, major landmarks. Plates 9 & 7.
-know the meninges that enclose the spinal cord (Fig. 21.2)
- Could you identify them on a cross section or on the gross cord or in the models?
- Be able to identify the parts of the spinal cord as seen in cross section (Fig. 21.2) and know the general function.
- You should be able to distinguish between white and gray matter.
- Know what type of information (motor vs sensory) is being carried by neurons in each part of the cord or in the spinal roots, etc.
- Where would you find multipolar cell bodies? Unipolar cell bodies?

**The Spinal Nerves (Figures 21.5 & 21.11)**

- Spinal Nerves are "Mixed" i.e. they carry both sensory & motor signals
- Spinal Nerves exit the vertebral column then split (Fig. 21.5) to form:
  1. Ramus Communicans = carries S-ANS axons into ganglia outside the SpC.
  2. DORSAL RAMUS ---> skin & muscle on posterior surface
  3. VENTRAL RAMUS - route depends on SpC. level:
     - T_2-T_12 ---> skin & muscle on anterior surface of trunk
     - All others ----> NERVE PLEXUSes ----> nerves entering the limbs

<table>
<thead>
<tr>
<th>SPINAL NERVE</th>
<th>NERVE PLEXUSes</th>
<th>NERVE</th>
<th>REGION SERVED</th>
</tr>
</thead>
<tbody>
<tr>
<td>C_1-C_5</td>
<td>CERVICAL</td>
<td>PHRENIC N.</td>
<td>neck, shoulder</td>
</tr>
<tr>
<td></td>
<td>PLEXUS</td>
<td></td>
<td>DIAPHRAGM</td>
</tr>
<tr>
<td>C_5-C_8,T_1</td>
<td>BRACHIAL</td>
<td>AXILLARY</td>
<td>arm</td>
</tr>
<tr>
<td></td>
<td>PLEXUS</td>
<td></td>
<td>MEDIAN</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>ULNAR</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>RADIAL</td>
</tr>
<tr>
<td>L_1-L_4</td>
<td>LUMBAR</td>
<td>FEMORAL</td>
<td>anterior thigh</td>
</tr>
<tr>
<td></td>
<td>PLEXUS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L_4,L_5,S_1-S_4</td>
<td>SACRAL</td>
<td>SCIATIC</td>
<td>posterior thigh</td>
</tr>
<tr>
<td></td>
<td>PLEXUS</td>
<td></td>
<td>&amp; all lower leg</td>
</tr>
</tbody>
</table>

-Materials & Procedures
- Model of vertebral column and Spinal Nerves
  - You should be able to identify the spinal nerve plexuses on models and know which spinal nerves contribute to each
  - You should be able to identify these major nerves:
    Phrenic (Fig. 21.6), Femoral (Fig. 21.8), Sciatic (Fig. 21.9)
- Know the pathways described above so you can associate the SpC. level with the nerve plexus, nerves, and the body regions these nerves serve.
The Autonomic Nervous System (Figure 21.10)

- The ANS is a division of the NS for the control of glands, smooth & cardiac muscle. It consists of motorneurons under the control of subconscious regions of the brain.
- Recall that the ANS has 2 subdivisions: Sympathetic and Parasympathetic.
  - Most organs are innervated by both of these subdivisions. Each has an opposing effect on the structure; whereas one speeds up activity in the organ the other slows down its activity. The level of activity in the organ is determined by the balance between the S-ANS & P-ANS.
  - The S-ANS prepares the body for activity eg. "fight or flight" response
    EX: increase heart rate, inhibit GI tract, dilate bronchii, inhibit blood flow to GI tract by increasing vasoconstriction of vessels serving the gut
  - The P-ANS prepares the body for resting and digesting.
    EX: decrease heart rate, increase GI tract activity, constrict bronchii, increase blood flow to GI by decreasing vasoconstriction of these blood vessels.

- The ANS motor pathways consist of 2 motorneurons in series:
  1. PRE-GANGLIONIC MOTORNEURON
     - Cell Body inside SpC.
     - Axon ends on Post-Ganglionic Motorneuron located in a ganglion outside the SpC.
     - Neurotransmitter is Acetylcholine (ACh)
  2. POST-GANGLIONIC MOTORNEURON
     - Cell Body in ganglion
     - Axon end on the Effector organ
     - Neurotransmitter varies:
       S-ANS uses NorEpinephrine (NE)
       P-ANS uses Acetylcholine (ACh)

- The specifics of the structure of the S-ANS and P-ANS differ with regard to the location of the 2 motorneuron cell bodies in the pathway
  - Sympathetic ANS
    - PreGanglionic Cell Bodies found only in T1 - L2
    - PreGanglionic Cell Axons may either
      1. terminate in PARAVERTEBRAL GANGLIA
         - located just outside the SpC.
         - connected together to form the Sympathetic Chain
      2. pass via SPLANCHNIC NERVES to PREVERTEBRAL GANGLIA
         - located near the viscera
  - Parasympathetic ANS
    - PreGanglionic Cell Bodies found only in
      1. CN 3, 7, 9, 10
      2. Sacral regions
    - Ganglion is in the wall of the Effector organ
    - PostGanglionic Cell Axon is short

- Materials & Procedures
  - Dissected fetal pig with spinal cord and nerves exposed. (Figure D2.2, p721)
  - Locate the Sympathetic Chain which lies alongside the SpC.
  - Review the general organization of the ANS. Limit your study to the structures & names listed above.
  - What effect does each division have on the organs? You do NOT need to memorize a table of the effects, just some major examples.
  - What levels of the spinal cord contain each subdivision
  - How does the structure of the ANS pathways compare to that of the somatic motor pathways? Number of motor neurons? transmitter?
-Objectives 1 - 6

**REFLEX** = stereotyped response to a stimulus
- rapid, unchanging, involuntary (can be suppressed)
- control is by simple circuits in the SpC. or brainstem that operate at a subconscious level
- important for response to pain and for control of movement

**Basic anatomy of a Reflex Arc**

```
RECEPTOR ─── SENSORY NEUON ─── INTERNEURON ─── MOTOR NEURON ─── EFFECTOR
```

Fast because few cells are involved. Few synapses.

-Types of Reflexes:
  - Somatic - control of skeletal muscle
    - STRETCH REFLEXES
      - Important for maintaining posture. Goal of reflex is to prevent change in muscle length.
      - Receptor = stretch receptor in muscle
      - EX:
        - PATELLAR - tested by physicians when they stretch the tendon by hitting with a mallet
        - ACHILLES TENDON
      - CROSSED EXTENSOR = FLEXOR (WITHDRAWAL) + EXTENSOR
        - Response to painful stimulus
      - SUPERFICIAL CORD REFLEXES
        - Require intact descending pathways from the brain
        - EX: Plantar Reflex = curling of toes when stroke bottom of foot with blunt object (heel to toe). If descending pathways are damaged (or if in small babies whose axons are not yet myelinated) then toes extend = Babinski's Sign.
  - CORNEAL REFLEX
    - Blink of eye when touch cornea (CN 5)
  - GAG REFLEX
    - Response to touching uvula (CN 9 & 10)
  - Autonomic - control smooth muscle or glands
    - PUPILLARY LIGHT REFLEX
      - Light → pupils to constrict (CN 3)
    - SALIVARY
      - Salivate in response to food

-Procedures
- Do the experiments listed in Exercise 22 and interpret the results. I will give hypothetical results on the quiz and expect that you can interpret them.
Objectives 1 - 8

Your goal is to understand the structure of the eye and how its parts work together to produce an image on the retina. You should also understand the general organization of the retina and the way in which it transmits information to the visual cortex.

Fall Semester: There will be many questions regarding eye structure on the final exam; better know your stuff.

- You should know the 6 extraocular eye muscles and their actions (p 365 and Muscle Handout).
  - Could you predict the effect of cutting the lateral rectus on eye movements?
  - Could you predict the effect of a lesion to CN 4?
- You need to know the structures external to the eye (Fig. 24.1)
  - Where are tears formed? How do they drain?
  - What is the Conjunctiva?
- You must know the anatomy of the eyeball itself (Fig. 24.3 & 24.5)
  - You must be able to identify all the structures in sheep eyes and models.
  - Note that it is composed of 3 concentric layers.
    - What are they called?
    - What is the function of each?
    - Two of the layers show modifications in the anterior part of the eye
      - What are the names of these specializations?
      - What are their functions?
    - What characteristics can you use to be able to identify each structure?
      - Position? Color?
  - What 2 materials fill the inside of the eye? What are they made of?
    - What is glaucoma
  - What is the path of light as it enters the eye and travels to the retina? What structures does it pass through? How is the light affected by the structures?
    - What does the LENS do to the image? Focus, upside down & backward
    - What does the CORNEA do?
    - What does the IRIS do?
  - Where does the OPTIC NERVE leave? What is the OPTIC DISK?
- You must know how the RETINA is organized.
  - What are the layers of the retina?
    - receptor-bipolar-ganglion cell (Fig 24.4 & Plate 15)
    - Be able to recognize these on a slide. How will you know which layer is which?
    - What are the RODS and CONES? What type of light can each detect?
    - How are rods and cones distributed over the surface of the retina, relative to the fovea? Where is each type most tightly packed together?
  - What path is taken by the neural information that leaves the eye?
    - What happens in the optic chiasm? Fig 24.6
    - Where does it go in the brain?
- You must understand the anatomy of the eye and retina in order to understand the visual tests and experiments
  - What is the BLIND SPOT? What structure on the retina corresponds to this?
  - Eye tests
    - What is meant by 20/20 or 20/60?
    - What is meant by EMMETROPIA, HYPEROPIA & MYOPIA? How does each relate to the shape of the eye? (Figure 24.9)
    - What is the Snellen chart?
    - What is ASTIGMATISM?
    - What is Binocular vision? Determine the amount of overlap of the right and left visual fields
    - What 3 events take place when you look from a distant object to a close object (=NEAR TRIAD)?
1. ACCOMODATION = lens thickens (due to ciliary muscle contracts),
pupils constrict, eyes converge
2. CONVERGENCE
3. PUPILS CONSTRINGT
   -What is PRESBYOPIA?
   -What is the pupillary light reflex? Why is it important? What muscles
     are involved?
   -Omit the section on the ophthalmoscope

MATERIALS:
   -Sheep Eyes to dissect
   -Several eye models including models with the extraocular muscles

SLIDES
   -[RETINA] Plate 15
Objectives 1 – 8

Your main objective is to learn the structures of the ear and the role that these structures play in hearing and equilibrium.

-There are 3 Major regions: INNER, MIDDLE & INNER EAR
  -You should be able to identify them on a model.
  -What structures are located within each region? What is their function?
-Outer
  -PINNA, EXTERNAL AUDITORY MEATUS, TYMPANIC MEMBRANE
    -What are their functions?
-Middle
  -What is the function of the AUDITORY (PHARYNGOTYMpanic OR EUSTACHIAN) TUBE?
  -What are the OSSICLES?
    -MALLEUS(HAMMER), INCUS (ANVIL) & STAPES (STIRRUP)
      -What is their function?
      -What membrane is the Malleus attached to?
      -What membrane is the Stapes attached to?
-Inner

The Inner ear is divided into 3 distinct bony compartments (=Bony Labyrinths). Each contains a membranous sac (=Membranous Labyrinth) with receptor cells inside.

1. COCHLEA
   -Spiral shaped bony chamber which houses the Organ of Corti
     -What bone encloses the cochlea?
     -You need to know the internal structure of the Cochlea and be able to ID these in a model or on a slide
     -Subdivided along its length into 3 chambers which are separated by a Membrane:
       1. SCALA VESTIBULI
          -filled with Perilymph
          -OVAL WINDOW = membrane at one end. Stapes attaches to oval window
          *Vestibular Membrane*
       2. SCALA MEDIA (aka Cochlear Duct)
          -contains the Organ of Corti = auditory receptor
          -filled with Endolymph
          *Basilar Membrane*
       3. SCALA TYMPANI
          -filled with Perilymph
          -ROUND WINDOW = membrane at one end.
          *Note: The perilymph in the Scala Vestibulii is continuous with the perilymph in the Scala Tympani*

 -The ORGAN OF CORTI detects sound waves.
  -HAIR CELLS
    -receptor cells
    -arranged in a sheet
    -Hair cell Cilia project into the TECTORIAL MEMBRANE which lies alongside the Vestibular membrane
    -Hair cells release neurotransmitter onto afferent fibers of CN VIII.
  -How does it work?
    -Sound waves travelling down the perilymph --> distortion of the tectorial membrane --> the cilia to bend --> AP in CN VIII
    -Sound waves of different frequency (pitch) cause hair cells in different regions of the Organ of Corti to fire --> perception of pitch
    -Loud sounds cause more hair cells to respond --> perception of loudness
-Materials:
2. VESTIBULE
- contains 2 sacs (=UTRICLE & SACCULE) with receptors for STATIC EQUILIBRIUM = proprioceptive sense of head position
  - Each sac contains a receptor = MACULA (Fig 25.2 & 25.8) Each has:
    - Hair Cells located in 1 part of the wall
    - OTOLITHS = Calcium Carbonate grains that stick to the cilia of the hair cells
- How does it work?
  - Otoliths are pulled toward the earth by gravity --> bend the hair cell cilia --> AP --> CN VIII
  - Change in head position results in change in the AP frequency

3. SEMI-CIRCULAR CANALS (Figures 25.2 & 25.7)
  =3 semi circular tubes which are at right angles to each other. Each lies approx. in the frontal, horizontal & sagittal planes.
  - Each contains receptors for DYNAMIC EQUILIBRIUM
  - The membranous lining of each canal is:
    - filled with endolymph
    - enlarged at one end to form the AMPULLA. The ampulla contains the receptors = CRISTA AMPULLARIS.
    - Hair Cells with cilia covered by a gelatinous mass = cupula
- How does it work?
  - Movement of head causes endolymph to move back & forth --> pushes the cupula --> AP --> CN VIII
  - Why are there 3 semi-circular canals on each side of the head? One for each plane of movement. The brain interprets the information from all 3 canals and constructs a perception of head movement in 3-D space.
  - This system is sensitive only to changes in head movement (hence the term dynamic equilibrium). This is because sustained movement in one direction pushes the endolymph to one end of the canal and receptors stay in the same position and stop firing. Only when the head velocity changes will the receptors be moved.
- The Vestibular inputs to the brain feed into circuits that control posture, head and eye movements.
  - NYSTAGMUS refers to a pattern of eye movements in which the eyes move slowly in one direction (until they can't move any further) then they make a rapid movement (saccade) in the opposite direction.
  - Nystagmus can be induced by rotating the head which causes the endolymph to move.

  Head rotation to the right --> slow eye movements to the left & saccades to the right.
  - If the motion is sustained, endolymph stops moving --> eye movements stop.
  - If the rotation is stopped, endolymph moves in the opposite direction --> slow eye movements to the right & saccades to the left.
  - The visual system and stretch receptors (proprioceptors) also feed into these circuits.
- How do you test the Equilibrium system?
  - test for Nystagmus (Barany)
  - Romberg
  - What is VERTIGO?
- How do you test the Auditory system?
  - Frequency range of hearing - tuning forks or audiometer
    - Normal = 30 - 22,000 Hz
    - Decibel = measure of sound intensity. 0 dB = softest sound detectible by normal person at each frequency. Each 10 dB increase results in doubling of the perceived loudness