

# *Instructor's Manual*

*Scott D. Schaeffer, D.C.*

## **Lab #1: Skeletal System**

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*Estimated lab time: 90 minutes*

### **Objectives**

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After completing this laboratory exercise, students will be able to:

1. Locate and identify the bones (and their features) of the axial skeleton
2. Locate and identify the bones (and their features) of the appendicular skeleton
3. Identify important internal and external features of the skull, including: surface features, sutures, foramina, sinuses, bones of the orbit, and fontanelles (in the fetal skull)
4. Identify the primary and secondary curvatures of the spine and describe the vertebrae that contribute to the distinct regions of the spinal column
5. Identify the regions of the sternum and distinguish between the different classifications of ribs
6. Locate the bones of the pectoral girdle and upper extremity and identify their major surface markings
7. Locate the bones of the pelvic girdle and lower extremity and identify their major surface markings
8. Describe some differences between the female and male bony pelvis
9. Be familiar with some of the more common pathological conditions of the skeletal system

### **Teaching Tips**

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This first lab is the longest lab of the manual. Feel free to split the lab up into two or three separate exercises, perhaps covering the axial skeleton (skull) one day, axial skeleton (vertebrae and ribs) one day, and the appendicular skeleton one day. If your schedule does not permit the extra days, certainly use any combination that fits your curriculum.

An overview of the skeleton is an appropriate starting place for a laboratory exercise with so many bones and features to memorize. Differentiate between the “weighty 80” bones of the axial skeleton and the upper/lower extremities of the appendicular skeleton, including the shoulder (pectoral) and pelvic girdles

A brief overview of landmark terminology, including elevations (projections) and depressions (spaces) is often a good place to start. When students have an idea of “what” the named feature may look like (raised or depressed) it narrows down the options for them as they search for the features in the lab setting.

Also, this may be a good place to briefly introduce osteoporosis and the three common types of arthritis (osteo, rheumatoid, gouty) when discussing the structure of the bones.

## Materials Required

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- Computer with AIA access
- Human skeleton, individual skull models, and individual bone models

## Lab Activity List

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### **Lab Activity 1.1:** Anterior View of the Skull

Briefly review the bones of the skull, referencing which bones are singular and which bones are paired. This is a good place to start emphasizing the importance of specificity; namely “rights” and “lefts.” In addition to the named bones there are various bone features that are also visible from this view. The orbital and nasal cavities may also be reviewed from this angle. The TMJ (temporomandibular joint) may be introduced here as the mandible is the only moveable bone of the skull and the TMJ is a commonly affected/referenced joint in the health care setting.

### **Lab Activity 1.2:** Lateral View of the Skull

When referencing the sutures it is nice to link to some lecture-based ideas such as joint structure (fibrous, immovable) and bone formation (intramembranous ossification). It is also nice to reference the forthcoming fetal fontanelles to help students understand the concept of fetal skull molding during the birth process. This is another good spot to review the TMJ. Have the students place their 2nd distal phalanx in their ear (facing anteriorly) and then elevate, depress, and laterally translate their mandible to feel the joint move beneath their finger.

### **Lab Activity 1.3:** Posterior View of the Skull

There are many palpable features in this view that students may find on themselves or their lab partners including the EOP, mastoid process, and the spinous processes of the vertebrae.

### **Lab Activity 1.4:** Inferior View of the Skull

The inferior view of the skull often seems to be intimidating for students. Try using a pipe cleaner to stick through the foramina so they can be visualized from both the inferior AND superior views. Learning the names of the foramina at the same time as the other bony landmarks helps some of these long, confusing names make more sense. i.e. the stylomastoid foramen is nestled between the styloid process and the mastoid process. This is a good place to remind students of the precarious nature of the occipito-atlantal joint, noting the smooth, shallow occipital condyles and comparing them to the shallow, but grooved lateral mass of atlas.

### **Lab Activity 1.5:** Internal View of the Cranial Cavities

A brief reference to the olfactory filaments from CN I and the cribriform plate ties multiple systems together. It also helps to explain anosmias the frequently result from head trauma. Students also seem to have initial difficulty differentiating between the sella turcica proper and the hypophyseal fossa so a thorough explanation may be in order here. Using various colors of pipe cleaners to thread through the multitude of foramina helps students to view the openings from all angles.

### **Lab Activity 1.6:** Paranasal Sinuses

It may be a good idea to plant the seed for later, referencing the roles of the nasal sinuses in the respiratory system.

### **Lab Activity 1.7:** The Fetal Skull

There are 6 fontanelles in total: one each - anterior and posterior; two each (right/left) - sphenoid (anterolateral) and mastoid (posterolateral).

### **Lab Activity 1.8:** The Vertebral Column

There are 33 segments, developmentally: 7-C, 12-T, 5-L, 5-S, 4-Co. Ultimately the 5 sacral segments fuse into one sacrum and the 4 coccygeal segments fuse into one coccyx, leaving us with 24 moveable segments in the adult plus a fused sacrum and fused coccyx: 7-C, 12-T, 5-L, 1-S, 1-Co. A review of the primary (kyphotic) and secondary (lordotic) curves of the spine may also be introduced here to correspond to the forthcoming Clinical Application in the Lab Manual. Not pictured are the unique atlas (C1) and axis (C2). Note to students that C1 does not contain a body, but rather has two lateral masses. It is also important to note the dens (odontoid process) of C2 when discussing the pivoting action of the C1/C2 articulation. On the sacrum (not pictured) the sacral foramina, transverse ridges (vestigial discs) and sacral crests (median and lateral) may easily be visualized.

**Lab Activity 1.9: The Sternum and Ribs**

Students may easily palpate both the jugular notch and xiphoid process on themselves. Explain how ribs 1-7 have individual cartilage attachments to the sternum while ribs 8-10 share a common cartilage. Ribs 11 and 12 (the floating ribs) may usually be seen nicely on most complete skeleton models. A review of the location of the xiphoid process in relation to the liver is important here since most students will, at some point, be trained in CPR.

**Lab Activity 1.10: The Pectoral (Shoulder) Girdle and Arm**

The sternoclavicular and acromioclavicular joints may be easily visualized here. In fact, the entire clavicle is easily palpated and all major landmarks can be found on the individual student and/or their lab partner. A discussion of the glenohumeral joint is appropriate here as well. A review of the shallow glenoid fossa and discussion about joint instability that results from an increased range of motion can be easily understood here while looking at the anatomy. This is a good place to introduce future systems. The brachial plexus may be visualized here, warranting a discussion about the need for properly fitting crutches with lower extremity injuries. This is also a good time to introduce the rotator cuff and explain how they are named for the fossa that they occupy, i.e. the supraspinatus muscle occupies the supraspinous fossa, etc. A distinction needs to be made between the anatomical and surgical necks. It is also a good time to explain how the long head of the biceps brachii can be found nestled within the intertubercular (bicipital) groove. Medial epicondylitis (golfer's elbow) and lateral epicondylitis (tennis elbow) can help bridge the musculoskeletal systems together. A brief introduction to wrist flexor and wrist extensor muscle origins may enhance student retention. The deltoid tuberosity is a good place to discuss bone remodeling (Wolff's Law) since it is often a broad, roughened landmark. The connection of the olecranon fossa to the olecranon process of the ulna is a great place to discuss the function of hinge joints.

**Lab Activity 1.11: The Forearm and Hand**

This is a good place to discuss radial head dislocations (nursemaid's elbow) and the importance of not swinging children by their arms. Relating the radial head to lecture, as a secondary ossification center, helps to integrate lecture and lab information. The obvious "elbow" is seen as the olecranon process but the other features of the proximal ulna easily relate to corresponding features of the distal humerus. Both styloid processes are easily palpated. It is also good to note to students that the radial head and ulnar head are at opposite epiphyses. Understand that the digits are numbered 1-5 from lateral to medial. A discussion of the interphalangeal joints is appropriate here, especially for allied health majors (PTA, OTA, ATC, etc)...interphalangeal (IP) joint, proximal interphalangeal (PIP) joint, and distal interphalangeal (DIP) joint.

**Lab Activity 1.12: The Pelvic Girdle**

The iliac crest is easily palpable on most students, including the ASIS and PSIS. The sacroiliac (SI) joint is easily seen here as are some ventral sacral landmarks. This is a good time to discuss the differences between the true and false pelvis as well as the pelvic inlet

and outlet. Some sort of compare/contrast exercise is also fun to do at this time between the male and female pelvis. The acetabulum is not easily visualized here but you can easily see the articulation between it and the femoral head. A brief discussion about the similarities and differences between the hip and shoulder joints is appropriate here. Note that the acetabulum is not found only on the ischium but it is easily seen here. A discussion about the diarthrodial sacroiliac joint and amphiarthrodial pubic symphysis is a good time to emphasize the sound structure of the pelvis with its ability to adapt for childbirth. Note the very roughened ischial tuberosities and remind students of the origin of the three hamstring muscles. Posterior sacral features may also be easily visualized from this view. The entire iliac crest with its anterior and posterior borders can once again be visualized from this view. The gluteal lines may be viewed here on the ilium but on most plastic models they are very hard to identify.

**Lab Activity 1.13: The Thigh**

All landmarks of the proximal femoral epiphysis are easily visualized on this view. This is a good place to discuss the increasingly popular hip replacement surgery which is introduced in a Clinical Application within the Lab Guide.

**Lab Activity 1.14: The Leg**

Be sure to remind students that while the femur is discussed on this slide, it is NOT part of the leg as indicated by the slide title. It is a good idea to differentiate between the medial condyle of the femur and the adductor tubercle. At first glance they often seem to be the same to the student. On the posterior view (not visualized here) you can see the popliteal surface of the femur which gets referenced in future chapters (popliteus muscle, popliteal artery and vein, etc). This is a good time to discuss the knee joint, including the cruciate (ACL/PCL) ligaments, the collateral (MCL/LCL) ligaments, and the menisci. Relating the tibial tuberosity to Osgood-Schlatter disease, again discussing secondary ossification centers is often a welcome discussion. In most every lab section you will find at least one student who was diagnosed with this condition during their youth. This is a good time to open students' eyes to the true ankle joint. They are used to the "ankle bones" being the malleoli but now there is the opportunity to present the tibiotalar joint. It is also important to note that the fibula is non-weight bearing.

**Lab Activity 1.15: The Foot**

Understand that the digits are numbered 1-5 from medial to lateral (opposite to those of the upper extremity). A discussion of the interphalangeal joints is once again appropriate here, especially for allied health majors (PTA, OTA, ATC, etc)...interphalangeal (IP) joint, proximal interphalangeal (PIP) joint, and distal interphalangeal (DIP) joint. Reviewing the three arches of the foot is welcomed here (transverse, medial/lateral longitudinal) as well.

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## Lab #2: Muscular System

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*Estimated lab time: 90 minutes*

### Objectives

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After completing this laboratory exercise, students will be able to:

1. Describe the major functions of the muscular system
2. Describe common muscle origins and insertions as well as synergists and antagonists for major muscle groups
3. Provide examples of criteria used when naming muscles
4. Locate and identify the major muscles of the head and neck

5. Locate and identify the major muscles of the chest and back
6. Locate and identify the major muscles of the upper extremity
7. Locate and identify the major muscles of the lower extremity

### Teaching Tips

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This laboratory exercise is designed to introduce the students to anatomical terminology. The best practice is to incorporate as many examples for students to practice on as possible. Have students identify the different regions on themselves and their lab partners. Making this connection to the material personalizes anatomy and physiology. By forming that connection to the material, students are more likely to be successful in the rest of the course. Using figures, models and their own bodies makes this lab fun and a great introduction to the science of anatomy and physiology.

To make the exercise more clinically relevant, explain to the students how clinicians must be able to discuss anatomical positioning of organs and tissues without any confusion. You can even relate horror stories of the wrong organ or limb being removed when instructions weren't clear or someone did not know their "lateral" from "medial."

Set up models of bones (arms, legs) and organs around the lab. Make stations where students can see examples of the different terms and directions. At the end, hold an unannounced oral quiz for the class to see if they can identify directions and regions on selected models or on another student.

Introduce tendons and ligaments here, differentiating between a "sprain" and a "strain." Additional information may be found within the Lab Guide as a Clinical Application.

### Materials Required

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- Computer with AIA access
- Models that show muscles of the head and the neck, trunk, upper limb, and lower limb

### Exercise List

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#### **Lab Activity 2.1:** Muscles of the Head and Neck

These muscles (except the SCM) are considered muscles of facial expression. Not visualized here are the depressor labii inferioris and the triangularis (depressor anguli oris). These muscles may be found by searching within AIA Dissectible Anatomy.

The SCM is a commonly injured muscle with childbirth and whiplash type injuries. Spasm of the SCM is referred to as "wry neck" or "torticollis." The frontalis and occipitalis are also considered to be part of the "epicranium" muscle. The two bellies may be seen here, connected by the connective tissue referred to as the galea aponeurotica.

The masseter and temporalis are considered muscles of "mastication" (chewing muscles). Students may easily feel these muscles contract when palpating them while biting down.

#### **Lab Activity 2.2:** Muscles of the Trunk and Arm

The deltoid, pectoralis major and biceps brachii are all muscles that move the arm. In this view the two origins of the SCM may be seen, the manubrium (sternum) and clavicle. Note that the origin of the serratus anterior appears "serrated" as would be seen when looking at a serrated knife, hence the name.

Removal of the deltoid allows the visualization of both heads of origin of the biceps brachii. Deep to the pectoralis major may be seen the smaller pectoralis minor, which may either assist forced inspiration by elevating the ribs or help to protract the scapula by its

attachment to the coracoid process. Note the orientation of the fibers of the external intercostal muscles. Deep to these would be found the internal intercostals, whose fibers would be oriented perpendicular to the external intercostal fibers. Removal of the biceps brachii allows for visualization of the deep arm muscles. The coracobrachialis may be found acting on the shoulder joint, whereas the brachialis exerts its action on the elbow joint.

**Lab Activity 2.3: Muscles of the Superficial Back**

This view shows a glimpse of the major arm and forearm extensor (triceps brachii). The latissimus dorsi is sometimes referred to as the “swimmer’s muscle” because its actions include extension, adduction, and internal rotation of the humerus – all actions used with a freestyle swimming stroke.

**Lab Activity 2.4: Muscles of the Deep Back**

Remind students that the teres minor is NOT part of the rotator cuff group. Note how the long head of the triceps brachii is seen sliding between the two teres muscles; this helps to easily distinguish the two teres muscles (major/minor).

Note that the two teres muscles (major/minor) connect the scapula to the humerus, whereas the two rhomboids connect the scapula to the vertebral column. Another name for the erector spinae group is the sacrospinalis, referring to the location rather than the function of the group.

**Lab Activity 2.5: Muscles of the Anterior Forearm and Hand**

With the exception of the brachioradialis, the muscles of the anterior forearm generally originate from the medial epicondyle of the humerus. Inflammation of the wrist flexors is known as medial epicondylitis, or “golfer’s elbow.” Note that the palmaris longus tendon may be seen inserting into the palmar aponeurosis whereas the remaining wrist/finger flexors traverse deep to the flexor retinaculum.

The main muscle of the middle layer is the flexor digitorum superficialis, with its tendons of insertion attaching to the middle phalanx of digits 2-5.

The tendons of the deep muscles of the forearm attach to the distal phalanges and allow for flexion of the IP joint (digit 1) and the DIP joints (digits 2-5).

**Lab Activity 2.6: Muscles of the Posterior Forearm and Hand**

The muscles of the posterior forearm generally originate from the lateral epicondyle of the humerus. Inflammation of the wrist extensors is known as lateral epicondylitis, or “tennis elbow.” Not visualized here is the supinator (deep) which is antagonistic to the two pronator muscles on the anterior forearm. The small anconeus muscle may also be seen here at the elbow joint.

**Lab Activity 2.7: Muscles of the Anterior Hip and Thigh**

The iliacus and psoas major have a common tendon of insertion known as the iliopsoas. Together these muscles allow for hip flexion. Since the psoas major originates from the lumbar vertebrae it can also act as a trunk flexor. The much smaller psoas minor may also be seen here with its long, slender tendon overlying the larger psoas major.

The sartorius, sometimes known as the “tailor’s muscle” may be seen traversing the entire anterior thigh, allowing for both hip and knee flexion resulting in a sitting “cross legged” position. The TFL muscle and its relationship to the ITB are easily differentiated here. Of the four quadriceps muscles, only the rectus femoris crosses the hip joint and assists with hip flexion. All four muscles have a common tendon of insertion into the patellar tendon, serving as the powerful leg extensors

**Lab Activity 2.8: Muscles of the Posterior Hip and Thigh**

Note how part of the gluteus medius is found superficially. This is a common site for administering intramuscular injections for allied health majors. Remind students that all three hamstring muscles have a common origin at the ischial tuberosity. This is why



athletes often appear to be holding their buttocks after a hamstring strain. A pulled groin, on the other hand, is usually injury to the gracilis muscle.

Note the large sciatic nerve as it emerges from beneath the piriformis muscle. Piriformis syndrome is a condition that often presents with a sciatica component, involving radiating pain down the posterior thigh and leg.

This view nicely presents the superficial gracilis from the medial view. Anterior to the gracilis you will find some of the anterior thigh muscles referenced earlier, while posterior to the gracilis you will find some of the aforementioned posterior thigh musculature.

#### **Lab Activity 2.9: Muscles of the Leg and Foot**

The tibialis anterior is easily palpated lateral to the anterior border of the tibia. Only the tendon of the extensor hallucis longus may be seen here, poking out between the tibialis anterior and extensor digitorum longus. All muscles will contribute to dorsiflexion of the ankle.

Both the peroneus longus and brevis assist with eversion of the ankle. The tendon of insertion for the brevis connects to the 5th metatarsal while the tendon of the longus traverses the entire plantar surface of the foot, ultimately inserting into the 1st metatarsal. A smaller, peroneus tertius muscle may be found on the dorsolateral aspect of the foot.

The medial and lateral heads of the gastrocnemius, along with the soleus, make up what is known as the triceps surae. The two muscles have a common tendon of insertion into the calcaneus (calcaneal/Achilles) allowing for plantarflexion.

With the removal of the triceps surae, the three deep muscles of the posterior leg may be visualized. Note that the flexor hallucis longus is found on the lateral leg (although the hallux is the medial digit of the foot) and the flexor digitorum longus is the most medial muscle of the deep, posterior leg.

### **Lab #3: Nervous System**

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*Estimated lab time: 90 minutes*

#### **Objectives**

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After completing this laboratory exercise, students will be able to:

1. Locate and identify the major surface features and internal features of the brain
2. Provide examples of functions for the common brain regions
3. Understand the flow of cerebrospinal fluid through the brain and spinal cord
4. Describe and label the cross-sectional anatomy of the spinal cord as well as the meninges that surround the central nervous system
5. Locate and identify the four spinal nerve plexuses and identify the major nerves arising from each
6. Understand the origin of the two divisions of the autonomic nervous system and identify some structures that are unique to each division
7. Be familiar with a few common pathologies of the nervous system

#### **Teaching Tips**

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This laboratory exercise is designed to introduce the students to the general anatomy of the brain and spinal cord as well as the major nerve plexuses and nerves. Attention to the meninges may be used as an opportunity to introduce the students to what is happening during an epidural/spinal tap or during meningitis.

As this is just an overview, it may not be time to dive into the names and functions of the cranial nerves at this time. Reminding students that some cranial nerves are entirely motor, while others are sensory only or perhaps mixed, may be appropriate though. All 31 pairs of spinal nerves are considered mixed.

This may fall more into the lecture category depending on your curriculum, but it may be an appropriate time to discuss the target organs of the motor divisions as well as differences between the sympathetic and parasympathetic division.

### Materials Required

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- Computer with AIA access
- Brain and spinal cord models
- Torso and extremity models with nerve tissue
- Sheep brains (if available)

### Exercise List

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#### **Lab Activity 3.1: External Brain Features**

Correlate the lobes of the cerebrum to the bones of the cranium to help students get oriented to the brain. It may also be good to reference the previously studied cranial floor so students can compare brain structures to where they lie within the skull.

The central sulcus separates the frontal and parietal lobes of the brain. The precentral gyrus of the frontal lobe is the primary somatomotor part of the brain, whereas the postcentral gyrus of the parietal lobe is the primary somatosensory region. The lateral sulcus separates the temporal lobe from the frontal and parietal lobes. The transverse fissure separates the cerebellum from the cerebrum.

#### **Lab Activity 3.2: Internal Brain Features**

Note that the parieto-occipital sulcus cannot be seen from the external view. The septum pellucidum is seen here separating the two lateral ventricles. On this view, just inferior to the fornix is the choroid plexus (in red).

The hollow area around the thalamus and hypothalamus is the third ventricle. Note that the infundibulum connects the hypothalamus to the pituitary gland (actually the neurohypophysis). This connection will be important later when discussing the endocrine system.

Collectively, the superior and inferior colliculi are known as the corpora quadrigemina, containing reflex centers for vision and hearing. Once the student identifies the infundibulum, the mammillary bodies may be seen posteriorly while the optic chiasma may be found anteriorly.

#### **Lab Activity 3.3: Cerebrospinal Fluid**

Flow of CSF (beginning with the lateral ventricle): choroid plexus->lateral ventricles->interventricular foramen (Monro)->third ventricle->cerebral aqueduct (Sylvius)->fourth ventricle->media/lateral apertures->central canal/subarachnoid space->arachnoid villi (granulations)->dural sinuses->internal jugular vein

#### **Lab Activity 3.4: Cranial Nerves**

Reminders – CN III contains parasympathetic fibers; CN V has three divisions: ophthalmic, maxillary, mandibular

Reminders – CN's VII, IX, and X contain parasympathetic fibers; X is the only CN to go beyond the neck, into the thorax and abdomen.

#### **Lab Activity 3.5: Spinal Cord**



The funiculi contain myelinated fibers that both ascend and descend the cord. The dorsal horn contains somatic and visceral sensory cell bodies, the lateral horn contains autonomic motor cell bodies, and the ventral horn contains somatomotor cell bodies.

The dorsal root is made up of entirely sensory fibers with the cell bodies located within the dorsal root ganglion. The ventral root is made of entirely motor fibers. The spinal nerve (at all 31 levels) is mixed and contains both motor and sensory nerve fibers.

#### **Lab Activity 3.6: Meninges**

Remind students of the relationships of the meninges to each other and other structures (i.e. subdural hematoma, epidural injections, CSF in subarachnoid space, etc). The denticulate ligaments help stabilize the cord from side to side, whereas the filum terminale anchors the cord inferiorly.

This view nicely demonstrates the formation known as the cauda equina (horse's tail).

Remember that the spinal cord terminates at approximately the L1/L2 intervertebral disc at a structure known as the conus medullaris. For this reason, spinal taps are performed inferior to this level in an effort to avoid the spinal cord.

#### **Lab Activity 3.7: Cervical Plexus**

The cervical plexus is made from cord levels C1-C4(5). The phrenic nerve is the major nerve supply to the diaphragm.

#### **Lab Activity 3.8: Brachial Plexus**

The brachial plexus is made from cord levels C5-T1. The axillary nerve supplies the muscles of the shoulder. The musculocutaneous nerve supplies the muscles of the anterior arm. The radial nerve supplies most of the posterior arm and forearm musculature. The median and ulnar nerves supply the muscles of the anterior forearm.

#### **Lab Activity 3.9: Intercostal Nerves**

The intercostal nerves are made from the ventral rami of cord levels T1-11 and supply the skin and some musculature of the chest and abdominal wall.

#### **Lab Activity 3.10: Lumbar Plexus**

The lumbar plexus is made from cord levels L1-L4. The femoral nerve supplies the anterior thigh musculature while the obturator nerve supplies the musculature of the medial thigh.

#### **Lab Activity 3.11: Sacral Plexus**

The sacral plexus is made from cord levels L4-S4. The sciatic nerve is made from the union of the common peroneal (fibular) nerve and the tibial nerve. The sciatic nerve is the main supply to the posterior thigh, leg and foot.

#### **Lab Activity 3.12: Autonomic Nervous System**

The PSNS is known as the SLUDD division (salivation, lacrimation, urination, digestion, defecation). It is also known as the craniosacral division and generally opposes most actions of the sympathetic division.

The SNS is known as the "Fight or Flight" division (active with excitement, stress, and embarrassment). It is also known as the thoracolumbar division and generally opposes most actions of the parasympathetic division.

### **Lab #4: Special Senses**

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*Estimated lab time: 90 minutes*

#### **Objectives**

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After completing this laboratory exercise, students will be able to:

1. Identify the external features of the eye

2. Identify the three tunics of the eye and describe the structures found in each
3. Describe the types of humors located within the internal chambers of the eye
4. Identify the extraocular muscles of the eye and recall their cranial nerve innervation
5. Differentiate between emmetropia, myopia, and hyperopia
6. Identify the structures found in the external ear
7. Identify the structures found in the middle ear
8. Identify the structures found in the internal ear
9. Identify the location of the receptors for hearing and equilibrium
10. Locate the olfactory nerve and describe its relationship to the olfactory bulb, olfactory tract, and the receptors within the nasal mucosa
11. Identify the gross features of the external tongue and describe the four primary tastes

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### Teaching Tips

This laboratory exercise is designed to introduce the students to the general anatomy of the eye and ear. Special attention is given to the mechanism of vision which can be used as an opportunity to introduce the students to common visual pathologies.

The remainder of the lab gives the students the opportunity to become familiar with the smell and taste.

General senses generally involve mechanoreceptors (light and deep touch, vibration), baroreceptors (stretch), proprioceptors (body position), nociceptors (pain), thermoreceptors (hot and cold), etc.

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### Materials Required

- Computer with AIA access
- Eye Models
- Ear Models

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### Exercise List

#### **Lab Activity 4.1:** External Features of the Eye

The superior and inferior palpebrae are the eyelids. The lining of the eyelids is known as the conjunctiva; inflammation of which gives you conjunctivitis (pink eye). The sclera is the “white” of the eye, the iris is the colored region and the pupil is the hole in the iris which is responsible for regulating light. The cornea is the clear covering over the anterior surface of the eye.

#### **Lab Activity 4.2:** Layers (Tunics) of the Eye

The fibrous tunic is the tough outer layer of the eye and serves as an attachment point for the extraocular eye muscles. The middle, vascular tunic is the major blood supply to the eye. The inner, neural tunic contains the photoreceptors known as rods and cones. Note to students that the optic disc contains no photoreceptors and therefore is known as the “blind spot.” The attachments of the ciliary muscle to the lens, via the suspensory ligaments, change the shape of the lens when focusing light on the retina. Hardening of the lens which commonly occurs with age is known as “presbyopia.”

#### **Lab Activity 4.3:** The Internal Eye

Aqueous humor is continually produced via the ciliary body and constantly recycled via the canal of Schlemm. An increase in intraocular eye pressure is known as “glaucoma.” The

posterior segment contains vitreous humor which has a jelly-like consistency and is maintained for life. It helps maintain the shape of the eyeball.

Remind students that different prescriptions for eyeglasses/contact lenses are needed to bend (refract) light before it hits the eye in order to help it more accurately focus on the retina. Altering the shape of the cornea through laser surgery serves the same effect, that is, to refract light as it enters the eye.

**Lab Activity 4.4: Extrinsic Eye Muscles**

CN III (oculomotor) – superior rectus, inferior rectus, medial rectus, inferior oblique

CN IV (trochlear) – superior oblique

CN VI (abducens) – lateral rectus

Also visualized here is the “cut” section of the levator palpebrae superioris which attaches to the upper eyelid.

Note how the tendon of the superior oblique muscle wraps around the “trochlea,” hence the name of CN IV which serves as the innervation of the muscle.

**Lab Activity 4.5: Anatomy of the Ear**

Note the three divisions of the ear and their boundaries. “Otitis” is a word meaning “ear inflammation” – adding a qualifier such as “externa,” “media,” or “interna” more specifically indicates the area of inflammation/infection.

There are many additional regions of the external ear to identify, based on the curriculum. Common places for piercings include the lobe, tragus, and helix.

The pearly white tympanic membrane can easily be visualized by students performing an otoscopic exam. Be careful that students look into the E.A.M. before inserting the otoscope to prevent impacting cerumen against the tympanic membrane. Consider viewing an image of the sagittal head (in the respiratory or digestive systems) to show students how the other end of the auditory tube opens into the nasopharynx.

Remind students that the vestibule houses receptors for static balance (maculae), the semicircular canals house the receptors for dynamic balance (crista ampullaris), and the cochlea houses the receptors for hearing (spiral organ of Corti).

**Lab Activity 4.6: The Sense of Smell**

Note to students how the olfactory filaments are found within the holes of the cribriform plate of the ethmoid bone. It is fairly common for anosmias to result after head trauma as the olfactory filaments get sheared from movement of the brain within the cranial vault. Since the receptors for smell are chemoreceptors found within the nasal mucosa, and since taste is approximately 70-80% smell, it is easy to see how a buildup of mucus from, say, a cold can affect one’s ability to both smell and taste appropriately.

**Lab Activity 4.7: The Sense of Taste**

Of the four types of papillae, only the filiform do not contain actual taste buds (chemoreceptors) – they are primarily present to provide friction on the tongue surface. The four major taste sensations are sweet and salty (anterior), sour along sides, bitter (posterior and most sensitive). A fifth taste has also been named and is called umami (savory, meaty).

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## Lab #5: Endocrine System

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*Estimated lab time: 90 minutes*

### Objectives

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After completing this laboratory exercise, students will be able to:

1. Locate the hypothalamus and provide examples of functions of its major hormones
2. Locate the pituitary gland and provide examples of functions of its major hormones, distinguishing between those of the adenohypophysis and neurohypophysis
3. Locate the pineal gland and provide examples of functions of its major hormones
4. Locate the thyroid gland and provide examples of functions of its major hormones
5. Locate the parathyroid gland and provide examples of functions of its major hormones
6. Locate the pancreas and provide examples of functions of its major hormones, distinguishing between endocrine and exocrine secretions
7. Locate the adrenal gland and provide examples of functions of its major hormones, distinguishing between cortical and medullary secretions
8. Locate the male testis and provide examples of functions of its major hormones
9. Locate the female ovary and provide examples of functions of its major hormones

### Teaching Tips

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This laboratory exercise primarily involves anatomical and histological identification. Be sure to emphasize the physiological impact of the hormone when it is released.

Differentiate endocrine versus exocrine secretions as a reminder to students. Endocrine glands secrete hormones directly into the blood (interstitial fluid) whereas exocrine glands secrete their products via a duct. Not all of the endocrine glands of the body are visible on this slide (i.e. thymus). Additionally, some non-traditionally recognized organs also serve an endocrine function as well (i.e. heart, kidney, adipose tissue, placenta).

### Materials Required

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- Computer with AIA access
- Torso models with endocrine tissue (brain with pituitary gland, thyroid gland, pancreas, kidney with adrenal gland)
- Microscopes (if available)
- Slides
  - Pituitary
  - Thyroid
  - Pancreas
  - Adrenal

### Exercise List

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#### **Lab Activity 5.1:** Hypothalamus, Epithalamus, Adenohypophysis, Neurohypophysis

Remind students that the hypothalamus is a neuroendocrine organ that has a major role in overseeing the function of the pituitary gland. The hypothalamus produces both releasing and inhibitory hormones that then affect the function of the anterior pituitary. It also produces oxytocin and antidiuretic hormone which are then stored and secreted by the posterior pituitary.

Note that the release of adenohypophyseal hormones is regulated by the releasing/inhibiting hormones of the hypothalamus which are transported through the hypothalamic-hypophyseal portal system (circulation). The hormones of the neurohypophysis are released as a result of nerve impulses from the hypothalamus which are distributed via the infundibulum. Have the students review the Clinical Application the Lab Guide for a discussion on diabetes insipidus.

#### **Lab Activity 5.2:** Thyroid Gland, Parathyroid Gland

Thyroid hormone is the body's main hormone of metabolism and is synthesized by the follicular cells in response to TSH. Calcitonin stimulates osteoblast activity in response to hypercalcemia. It is much more effective in childhood and adolescence.

PTH is the body's main regulator of blood calcium levels. In response to hypocalcemia it causes osteoclasts to increase activity, increases absorption of calcium from the gut, and increases reabsorption of calcium in the kidneys, all in an effort to raise blood calcium levels.

**Lab Activity 5.3: Thymus Gland**

Thymosin is important for normal T-lymphocyte maturation. T-cells are important in fighting intracellular microorganisms and abnormal (cancer) cells. Thymus functionality starts to decline once we reach adolescence.

**Lab Activity 5.4: Pancreas, Adrenal Glands, Testes, Ovaries**

The pancreas serves both exocrine (acinar cells) and endocrine (islet cells) functions. Insulin is released from the beta cells in response to hyperglycemia whereas glucagon is released from the alpha cells in response to hypoglycemia. Have students review the Clinical Application in the Lab Guide for a discussion on diabetes mellitus.

The adrenal gland is known as our "stress gland." The adrenal medulla is hotwired directly to the sympathetic nervous system and responds to acute stress. The adrenal cortex responds to more chronic stress with the release of cortisol. Aldosterone is released in response to hyponatremia (low blood sodium) and hyperkalemia (high blood potassium) and is chiefly responsible for regulating salt (and therefore water) balance in the body. Testosterone is secreted in response to LH (ICSH – interstitial cells stimulating hormone) from the adenohypophysis and is responsible for the secondary sex characteristics of the male. Inhibin is secreted in response to increased sperm production which is initiated by the secretion of FSH from the adenohypophysis.

Estrogen from the ovaries is responsible for the secondary sexual characteristics of the female and initiates the rebuilding the endometrium after menses. Progesterone, also from the ovaries, helps sustain the uterine lining with pregnancy until the placenta is able to take over secreting the hormone.

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## **Lab #6: Cardiovascular System**

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*Estimated lab time: 90 minutes*

### **Objectives**

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After completing this laboratory exercise, students will be able to:

1. Locate and describe the external anatomy of the heart and its great vessels
2. Locate and describe the organization of the coronary blood vessels
3. Locate and describe the internal anatomy of the heart including the chambers and valves
4. Describe the pattern of systemic and pulmonary blood flow through the heart
5. Locate the major blood vessels of the head and neck
6. Identify the vessels that contribute to the Circle of Willis (cerebral arterial circle)
7. Locate the major blood vessels of the upper extremity
8. Locate the major blood vessels of the abdomen and describe hepatic portal circulation
9. Locate the major vessels of the lower extremity

## Teaching Tips

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This laboratory exercise is a long one, especially if you make it interactive, but it may be broken up into two labs if time allows – one for the heart and one for the vasculature. Students should be encouraged to take the physiological measurements from a lab partner, if possible. They can measure heart rate (pulse), blood pressure, and ECG (if available), and auscultate heart sounds. Have them explain the physiology behind what they are measuring.

Remind students of the three layers of the heart: epi-, myo-, and endocardium; with the endocardium being continuous with the endothelium of the vessels. A review of basic heart orientation is also good here, i.e. apex, base, location within the thorax.

## Materials Required

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- Computer with AIA access
- Models of the heart
- Torso, upper extremity, and lower extremity models with vasculature
- Stethoscope
- Sphygmomanometer
- Preserved sheep heart (if available)

## Exercise List

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### **Lab Activity 6.1:** External Heart Anatomy

Note that the ligamentum arteriosum, the remnant of the ductus arteriosus, is present in this view. Also note the right and left pulmonary arteries are evident branching from the pulmonary trunk.

### **Lab Activity 6.2:** Internal Heart Anatomy

The fossa ovalis, remnant of the foramen ovale is evident in the right atrium. Note also the interventricular septum, reminding students that the interatrial septum cannot be visualized here since it is obscured by the great vessels. Refer students to the Clinical Application in the Lab Guide for a discussion on valvular stenosis and insufficiency.

### **Lab Activity 6.3:** Circulation of Blood Through the Heart

Trace a drop of blood through the entire CV system beginning and ending with the right atrium.

### **Lab Activity 6.4:** Coronary Blood Vessels

This is a good place to discuss myocardial ischemia and infarct, noting especially the LAD – known commonly as the “widowmaker.” There are several animations that students may be directed to in AIA, including “Coronary artery bypass grafts (CABG),” “Percutaneous transluminal coronary angioplasty (PTCA),” and “Directional coronary atherectomy (DCA).” Note that all of the referenced veins eventually work their way around to the posterior, joining into the coronary sinus which then drains into the RA with the SVC and IVC. Note again the location of the coronary sinus and its termination at the RA so the deoxygenated blood can next be delivered to the lungs for oxygenation.

### **Lab Activity 6.5:** Vessels of the Head and Neck

Note that while only three vessels typically emerge from the aortic arch there are four areas to be supplied: right upper extremity, right side of head, left upper extremity, left side of head.



The common carotid artery is a common site for palpating a pulse. The superficial temporal and facial pulses may also frequently be palpated using a light touch. Note the location of the vertebral artery within the transverse foramen of the cervical vertebrae.

Note there is no “common” jugular vein. Both the internal and external jugular veins will drain directly into the subclavian veins. When reviewing the dural sinuses, students will be able to visualize the internal jugular vein as it exits the skull via the jugular foramen.

Note the two major arterial supplies to the brain – internal carotid and vertebral arteries. Refer students to the Lab Guide to visit Clinical Applications explaining the difference between transient ischemic attack (TIA) and cerebrovascular accident (CVA).

Remind students that all of the dural sinuses eventually drain into the internal jugular vein and then exit the skull via the jugular foramen. The dural sinuses are also responsible for collecting “used” cerebrospinal fluid (CSF) as it gets recycled into the sinuses through the arachnoid villi (granulations).

#### **Lab Activity 6.6: Vessels of the Upper Extremity**

Clinical notes: Remind students that these vessels are contiguous. A dislocated humerus could impinge the axillary artery which would then diminish the radial pulse, for example. Several non-labeled arteries can also be seen in this view depending on the curriculum, i.e. humeral circumflex, interosseous, digital... The radial artery is an easily located pulse point and is a common site used in allied health professions. Students should attempt to locate this pulse on themselves (and lab partners if permission is given).

For the most part, students will find that these named veins parallel their arterial counterpart. It is always a good idea to remind students of the direction of flow of blood. For example, while the axillary artery flows next into the brachial artery, the axillary vein flows next into the subclavian vein.

The cephalic vein runs along the lateral border of the forearm and arm before uniting with the axillary vein. The basilic vein runs medially along the forearm and arm before joining the deeper, brachial vein. The median cubital vein is a common site for phlebotomy in the clinical setting.

#### **Lab Activity 6.7: Branches of the Descending Aorta**

The thoracic aorta becomes the abdominal aorta once it passes through the diaphragm.

Remind students that the celiac trunk will quickly divide into the splenic artery, left gastric artery, and common hepatic artery. The “gonadal” artery will ultimately be named based on the sex of the patient – either the ovarian artery for a female or the testicular artery for a male.

Note the vast supply of the inferior mesenteric artery to the large intestine. The relationship of the abdominal organs to the vasculature is easily seen here, as is the branching of the terminal aorta at the common iliac arteries.

#### **Lab Activity 6.8: Veins of the Abdomen**

Note that the right suprarenal vein and right “gonadal” vein both connect directly to the IVC, whereas the left suprarenal vein and left “gonadal” vein both drain into the left renal vein. The superior and inferior mesenteric veins do not drain into the IVC. They are part of the hepatic portal circulation and will be described shortly.

#### **Lab Activity 6.9: Hepatic Portal Circulation**

Hepatic portal circulation is a special circulatory pathway responsible for collecting blood from the digestive organs, pancreas, and spleen, and then delivering the blood to the liver for processing. The inferior mesenteric vein, carrying blood from the colon, joins with the splenic vein, which contains blood from the spleen, pancreas, and stomach. The superior mesenteric vein, with its blood from the small intestine and proximal colon, unites with the splenic vein to form the hepatic portal vein, which then enters the liver from its inferior surface.

**Lab Activity 6.10: Vessels of the Lower Extremity**

Around the level of the L4 vertebra the aorta bifurcates into the left and right common iliac arteries. The internal iliac artery then branches and stays within the pelvic cavity while the external iliac artery continues into the lower extremity in much the same way as the subclavian artery gave rise to the vessels that supplied the upper extremity.

These vessels simply follow the reverse course of their named arterial counterparts. The termination of the great saphenous vein can be seen here entering the femoral vein. The great saphenous vein is important clinically since it is commonly harvested to be used as the vessel graft during CABG procedures. The popliteal artery divides to give the anterior and posterior tibial arteries, the anterior of which may be seen here. The dorsalis pedis artery is an easily located pulse point and is a common site used in allied health professions. Students should attempt to locate this pulse on themselves (and lab partners if permission is given).

The great saphenous vein is the longest vein in the body and originates from the medial aspect of the dorsum of the foot, traversing its way along the entire medial leg and thigh before terminating in the femoral vein. It is a common vessel used as a graft for CABG procedures.

The popliteal artery divides to give the anterior and posterior tibial arteries, the posterior of which may be seen here. The posterior tibial artery, as it passes behind the medial malleolus, is an easily located pulse point and is a common site used in allied health professions. Students should attempt to locate this pulse on themselves (and lab partners if permission is given).

The small saphenous vein originates from the lateral foot and travels up the posterior leg before uniting with the popliteal vein. The posterior tibial and popliteal veins are common sites for deep vein thromboses (DVT) especially in patients with recent surgery or immobilization of the lower extremity.

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**Lab #7: Lymphatic System**

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*Estimated lab time: 60 minutes*

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**Objectives**

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After completing this laboratory exercise, students will be able to:

1. Describe the two primary functions of the lymphatic system
2. Locate and describe the major tissues and glands associated with the lymphatic system
3. Describe the basic pattern of lymphatic drainage
4. Locate and describe the cervical lymph nodes
5. Locate and describe the function of the thymus gland
6. Locate the cisterna chyli and describe its connection to the thoracic duct
7. Identify the spleen and describe its role in the lymphatic system
8. Locate and describe the inguinal lymph nodes

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**Teaching Tips**

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In this laboratory exercise students are made familiar with lymphatic vessels, lymphatic fluid, lymph nodes, and circulation. Explain to them the general function of draining away excess tissue fluid and how it is filtered by the nodes before returning to circulation.

This is a good lab to make clinical correlations. Once the students have understood the basic function of the lymphatic system, ask them to explain why lymph nodes are removed during tumor removal. Or, ask them what happens when the lymphatic duct is blocked.

This is a good time to remind students about the movement of water in the body, from lecture – i.e., plasma, interstitial fluid, intracellular fluid, lymph, etc.

Lymphatic circulation will be discussed in this chapter so this is a good time to differentiate between CV circulation and lymphatic circulation, noting that CV based organs (spleen, bone marrow) have dual functions – namely immune and cardiovascular based. Lymph nodes and vessels, on the other hand, transport and filter only lymph, no blood.

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### Materials Required

- Computer with AIA access
- Models showing the major vessels and nodes of the lymphatic system
- Torso model with spleen
- Microscopic slide of the splenic tissue (if available)

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### Exercise List

#### **Lab Activity 7.1: Lymphatic Circulation**

Lymphatic circulation is a one-way system (towards the heart) as compared to the CV system which is two directional. Lymphatic capillaries are found in almost every place we find CV capillaries, picking up leaked interstitial fluid to be transported back into general circulation

Both the right lymphatic duct and thoracic duct drain into cardiovascular circulation at the subclavian vein where it joins with the internal jugular vein on each respective side. The right lymphatic duct drains the right upper extremity, right chest, and right side of the head and neck. The rest of the body is all drained by the thoracic duct and its tributaries. The cisterna chyli (the origin of the thoracic duct) can usually be found at or around the T12 vertebral level.

#### **Lab Activity 7.2: The Lymph Nodes**

A review of the drainage patterns of the head and neck.

A review of the drainage pattern of the thorax.

A review of some deeper, iliac structures (nodes, vessels, and nerve).

A review of the superficial inguinal lymph nodes.

#### **Lab Activity 7.3: The Tonsils**

A reminder to students that there is no way for a potential pathogen to enter the body through either the respiratory or digestive mucosa without coming in contact with “immune” tissue in the form of tonsils (or M.A.L.T. – mucosa associated lymphatic tissue). Refer students to the Clinical Application in the Lab Guide for a discussion on allergies.

#### **Lab Activity 7.4: The Thymus**

Remind students of the unique properties of the thymus gland. That is, while it is rather large at birth it is fairly non-functional. Thymus function increases throughout childhood and reaches its peak during adolescence, at which time it begins to atrophy, eventually becoming rudimentary in the adult.

#### **Lab Activity 7.5: The Spleen**

The spleen is the largest of the lymphatic organs and is the only one to filter blood, not lymph. The spleen has a dual role, one as a lymphatic organ and the other as a cardiovascular organ responsible for recycling aged red blood cells.

## Lab #8: Respiratory System

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*Estimated lab time: 90 minutes*

### Objectives

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After completing this laboratory exercise, students will be able to:

1. Describe the pathway of air from its entry at the mouth and nose through to the lungs
2. Locate and describe the components of the upper respiratory tract, including the larynx
3. Identify and describe the anatomy of the larynx
4. Locate and describe the components of the lower respiratory tract
5. Locate the primary and secondary bronchi associated with the lower respiratory tract
6. Describe the gross anatomy of the lungs, including their lobes and fissures
7. Describe the relationship of the pleural membranes to the lungs

### Teaching Tips

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This laboratory can be made more interactive with the additional exercise of auscultating lung sounds. A review of vital signs from the CV laboratory would be appropriate here as well. If your laboratory is equipped with a spirometer, the addition of pulmonary function tests (i.e. vital capacity) would be great reinforcement.

Pulmonary ventilation consists of two phases (inspiration/inhalation and expiration/exhalation). External respiration occurs between the oxygenated alveoli (gas) and the deoxygenated pulmonary capillaries (liquid). The CV system is responsible for the transportation of the respiratory gases. Internal respiration occurs between the oxygenated systemic capillaries and the deoxygenated interstitial fluid of the body tissues.

### Materials Required

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- Computer with AIA access
- Sagittal head model
- Torso model with lungs
- Spirometer (if available)

### Exercise List

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#### **Lab Activity 8.1: Upper Respiratory System**

The superior and middle nasal conchae are found on the ethmoid bone while the inferior nasal conchae are independent bones. The hard palate is made from the union of the right and left maxillae (palatine processes) and the right and left palatine bones (horizontal plates).

The nasopharynx is a passageway for air only and is lined with pseudostratified, ciliated columnar epithelium to help filter airborne particulates. Refer students to the Clinical Application in the Lab Guide for a discussion on otitis media since the opening of the auditory tube is evident in this view. The oro- and laryngopharynx are both common passageways for air and food so are modified with a stratified squamous lining to protect against the abrasion of food. The epiglottis serves as the “switching mechanism” to route air into the trachea or food into the esophagus. Passing through the larynx leads us into the lower respiratory system.

#### **Lab Activity 8.2: The Larynx**

The hyoid bone, epiglottis, thyroid cartilage and cricoid cartilage are all singular structures. The arytenoid and corniculate cartilages are paired, as are the vocal cords. The space found between the vocal cords is known as the glottis and is protected when swallowing by the epiglottis.

### **Lab Activity 8.3: Lower Respiratory System**

The trachea (windpipe) travels down to approximately the T5 vertebral level where it splits (bifurcates) at an area known as the carina. The right primary bronchus is shorter, wider, and more vertical than the left, making it a likely place to lodge aspirated foreign material. There is one primary bronchus for each lung (right and left) and a secondary bronchus for each lobe (3-Rt, 2-Lt). There is a tertiary bronchus for each bronchopulmonary segment of the lung (generally 8-10 per lung).

### **Lab Activity 8.4: Gross Anatomy of the Lungs**

Each lung is covered by visceral pleura and contained within the thoracic cavity, surrounded by parietal pleura. The apices of the lungs are found superiorly (subclavicular) whereas the bases of the lungs are found inferiorly, resting on the diaphragm. During physical examinations each lobe must be auscultated for the assessment of adequate breath sounds. In a lab setting with non-allied health majors it may be a good idea to have the “patient” place and hold the stethoscope while the examiner listens. This keeps students from getting in awkward situations when placing their hands on each other’s chest wall. If the course is being taught to allied health majors it would be appropriate for the examiner to place and hold their own instrumentation.

The terminal bronchiole is surrounded by smooth muscle and helps regulate air flow into the alveoli where external respiration takes place. Refer students to the Clinical Application within the Lab Guide for a discussion on the differences between two common respiratory disorders, asthma and emphysema (COPD). Asthma is a problem with the passageways being constricted whereas COPD is an issue with the breakdown and loss of elasticity of the alveoli themselves.

## **Lab #9: Digestive System**

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*Estimated lab time: 90 minutes*

### **Objectives**

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After completing this laboratory exercise, students will be able to:

1. Locate and identify the organs (and their features) that contribute to the alimentary canal
2. Locate and identify the accessory organs (and their features) of the digestive system
3. Provide examples of functions for the organs of the digestive system
4. Identify the organs and their secretions that contribute to the chemical digestion of macronutrients
5. Locate and identify the duct system of the liver, gall bladder, and pancreas
6. Be familiar with some of the more common pathological conditions of the digestive system

### **Teaching Tips**

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This laboratory exercise is a good way to correlate form and function by reviewing histology from the lecture component of class. Make sure the students can explain how the microscopic structure of the digestive tract is just as important as the gross structures.

The GI tract is the one-way passageway for food to move through our bodies, while the accessory organs help digest the foodstuffs along the way with their secretions and mechanical properties.

Ingestion places food and drink into the mouth. Propulsion is the moving of foodstuffs through the GI tract. Students should be aware of the difference between peristalsis (moving along the tract) and segmentation (mixing back and forth of chyme). Mechanical digestion prepares food for enzymatic breakdown by chemical digestion. Absorption is the taking up of nutrients into the blood or lymph so the body has access to them. Finally, defecation is the elimination of solid waste from the bowel.

### Materials Required

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- Computer with AIA access
- Models of the following organs and structures:
  - The oral cavity with salivary glands
  - Stomach
  - Small intestine
  - Large intestine
  - Liver/gallbladder
  - Pancreas

### Exercise List

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#### **Lab Activity 9.1: Head and Neck**

Primary dentition consists of 20 deciduous teeth (central and lateral incisors, canine, 1st and 2nd molars). All 20 primary teeth are replaced by the permanent 32 teeth highlighted in the slide. In some, the 3rd molars (wisdom teeth) never erupt and are referred to as “impacted” wisdom teeth.

#### **Lab Activity 9.2: Salivary Glands**

The three salivary glands secrete “saliva” which contains, among other things, the enzyme salivary amylase which initiates carbohydrate digestion. Stensen’s duct may also be seen here exiting the parotid gland.

Note the location of the parotid gland in relation to the ear (E.A.M.) and the masseter muscle. The word root “oto” refers to ‘ear’ and the parotid gland is named for its relationship to the ear itself. The parotid gland is usually inflamed when one is infected with the mumps, giving the ‘chipmunk cheek’ appearance.

#### **Lab Activity 9.3: Tongue**

The circumvallate papillae are found along the sulcus terminalis while the foliate papillae are found along the sides of the tongue. Both of these papillae contain taste buds, chemoreceptors for taste. Along the surface of the tongue are the chemoreceptors containing fungiform papillae and the foliate papillae which do not contain taste buds, but rather are present to provide friction on the surface of the tongue.

#### **Lab Activity 9.4: Oral Cavity**

The oral cavity is the area found within the teeth and houses the tongue and other labeled structures. The oral vestibule is the area outside the teeth, between the teeth and lips (labial vestibule) and between the teeth and cheek (buccal vestibule). The uvula protrudes off of the posterior aspect of the soft palate and rises, when swallowing, to close off the nasopharynx from the oropharynx, making sure the contents of the mouth move inferiorly towards the esophagus. The epiglottis is the laryngeal structure that is responsible for routing food and drink into the esophagus or air into the trachea (with ventilation).

#### **Lab Activity 9.5: Abdomen**



The lesser omentum may be seen attaching the lesser curvature of the stomach to the undersurface of the liver. The greater omentum is seen coming off of the greater curvature of the stomach and draping over the entire abdomen like an apron. At the top of this image the esophagus is visible in the thoracic cavity before it pierces the diaphragm and attaches to the cardiac region of the stomach at what is known as the cardiac (or lower esophageal) sphincter. Direct students to the Clinical Application in the Lab Guide for a discussion on gastroesophageal reflux disease (GERD) which is often caused by a weakness of this sphincter or even a herniation of part of the stomach into the thoracic cavity (hiatal hernia). Note the extensive greater omentum in this view. This is the area where we commonly store our “belly fat.”

**Lab Activity 9.6: Abdomen (Frontal Section)**

The detail of the stomach is easily visualized here, as is the majority of the small intestine. Since there are no outward, visible identifiers to differentiate the three divisions of the small intestine it is often easier for students to identify the subdivisions in relationship to other organs. The duodenum is easily identified as it emerges from the pylorus, or at the entry point of the biliary apparatus (on the following slide). The ileum is easily identified as it joins with the cecum at the ileocecal valve. Lastly then, the jejunum is the area of the small intestine found between the previous two landmarks. Remind students of the spelling difference between the “ilium” and the “ileum” – one letter can make a big difference.

**Lab Activity 9.7: Pancreatic and Bile Ducts**

The right and left hepatic ducts merge to form the common hepatic duct. The common hepatic duct joins the cystic duct from the gall bladder to become the common bile duct. The common bile duct unites with the main pancreatic duct of the pancreas to form a small, funnel-shaped structure known as the hepatopancreatic ampulla. The hepatopancreatic papilla is the small bump (and opening) seen entering the duodenum, which delivers both bile and pancreatic juice to the duodenum to aid in digestion. Refer students to the Clinical Application in the Lab Guide for a discussion on gall stones (cholelithiasis) and to view some radiographic images of the digestive tract.

**Lab Activity 9.8: Liver (Ant)**

From the anterior view the left and right lobes of the liver are prominent, as is the falciform ligament that separates the two main lobes. Again, the lesser omentum may be seen connecting the undersurface of the liver to the lesser curvature of the stomach. The gall bladder may be visualized just popping out of the undersurface or the right hepatic lobe.

**Lab Activity 9.9: Liver (Inf)**

The undersurface of the liver allows for visualization of all four lobes. The gall bladder, in its entirety may also be seen from this view. Note the small hepatic vein that may be seen draining into the large inferior vena cava. Beside the cystic duct may be seen the hepatic portal vein which is entering the liver, carrying with it the nutrient-rich blood from the gut. Students sometimes have difficulty grasping the idea that a vein is actually “entering” an organ when, up until this point, they are likely to know veins as structures that emerge from organs. Refer students to the Clinical Application in the Lab Guide for a discussion on cirrhosis of the liver.

**Lab Activity 9.10: Large Intestine**

The large intestine, in its entirety, may be seen in this view. Remind students that the “hepatic” flexure and the “splenic” flexure may also be referred to as the “right” and “left” hepatic flexures, respectively. Refer students to the Clinical Application in the Lab Guide for a discussion on colonoscopy and colon cancer.

**Lab Activity 9.11: Abdominal Viscera**

This slide serves as a good review of the abdominal viscera previously discussed. A close-up view of the colon allows for visualization of the pouches (haustra) and the taenia coli

(three longitudinal bands of smooth muscle). The epiploic appendages may be seen as the tiny pockets of fat dangling from the colon – their role is not well understood. Refer students to the Clinical Application in the Lab Guide for a discussion on inflammatory bowel disease and colostomy.

**Lab Activity 9.12: Rectum**

The three transverse folds are evident from this frontal view. They serve to help separate the flatus from the feces as it enters the rectum via the sigmoid colon. The anal columns are also evident here and serve to secrete a lubricating mucus to aid in defecation. Remind students that the internal anal sphincter is made of smooth muscle and is therefore under involuntary control whereas the external anal sphincter is made of voluntary skeletal muscle.

The sagittal view again shows the transverse folds, anal columns, and sphincters. In addition the rectal veins are a bit more evident here. Direct students to the Clinical Application in the Lab Guide for a discussion on hemorrhoids.

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## Lab #10: Urinary System

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*Estimated lab time: 90 minutes*

### Objectives

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After completing this laboratory exercise, students will be able to:

1. Locate and describe the organs of the urinary system
2. Describe the renal artery and its branches within the kidney
3. Describe the internal anatomy of the kidney including structures of the cortex and medulla
4. Describe the structure and function of the renal corpuscle
5. Describe the pathway of urine (filtrate) through the nephron
6. Identify the three openings in the urinary bladder and describe the route of urine
7. Locate the female urethra and describe its relationship to other structures of the perineum
8. Locate the male urethra with its three distinct regions and describe its dual function as both a urinary and reproductive structure
9. Locate the prostate gland and describe its relationship to the male urethra

### Teaching Tips

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This laboratory exercise is designed to familiarize the student with the structure of the kidney and its importance to the formation of urine. Build the lab discussion around first the gross structure of the kidney, then explain how the nephron is the microscopic functional unit of the kidney.

Remind students that while only one “tube” is entering the kidneys (renal artery) there are two exit routes, the renal vein and the ureter. Even while asleep the body is producing metabolic waste and it is important that the kidneys continually filter this waste and cleanse the blood in order to regulate the above mentioned blood characteristics.

## Materials Required

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- Computer with AIA access
- Models of the following organs and structures:
  - Kidney
  - Bladder
  - Urinary tract
- Preserved sheep kidney (if available)

## Exercise List

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### **Lab Activity 10.1: External Kidney Features**

This view illustrates the major structures of the renal hilum except for the renal artery which is not visible here. Remind students that the kidneys are retroperitoneal and in order to see them in this anterior view, the peritoneum has been removed.

### **Lab Activity 10.2: Internal Kidney Features**

Since the major internal landmarks are already labeled in this image it may be a good place to introduce the flow of urine once it leaves the nephron. Refer students to the Clinical Application in the Lab Guide for a discussion on kidney stones (nephroliths), staghorn calculi, IVP studies, and extracorporeal shockwave lithotripsy.

### **Lab Activity 10.3: Blood Supply to the Kidney**

Flow of blood from abdominal aorta to the inferior vena cava: Abdominal aorta->renal a. ->segmental (lobar) a. ->interlobar a. ->arcuate a. ->cortical radiate a. ->afferent arteriole->glomerulus->efferent arteriole->peritubular capillaries->cortical radiate v. ->arcuate v. ->interlobar v. ->renal v. ->IVC (note there are no lobar/segmental veins)

### **Lab Activity 10.4: The Renal Corpuscle**

It is sometimes difficult to get students oriented to all of the structures in this view because several of the passageways are in section. The PCT can only be seen as it exits the capsule. By default, then, the DCT is seen “unattached” to the capsule at the left. Within the DCT may be found the macula densa cells that respond to filtrate flow and osmolality. The afferent arteriole may be recognized by the directional arrow in this image. Additionally, renin-filled juxtaglomerular (JG) cells may be seen around the vessel as they monitor blood pressure. The podocytes are visible on the glomerular surface and help to form the filtration slits that keep larger solutes from being filtered from the blood.

### **Lab Activity 10.5: The Renal Tubule**

The following blood vessels may also be seen in this image: interlobar a/v, arcuate a/v, cortical radiate a/v, afferent arteriole, efferent arteriole, peritubular capillaries, vasa recta

### **Lab Activity 10.6: The Bladder and Urethra**

While there are not many urinary structures found in these views, spelling sometimes is an issue with students confusing the ureter and the urethra. From these sagittal sections only part of the trigone is visible since the orifice of the right ureter is not evident. Some reproductive structures have been highlighted on the list for these two slides since the two systems are so closely related. Refer students to the Clinical Application in the Lab Guide for a discussion on cystoscopy and for a discussion on benign prostatic hypertrophy (BPH).

## Lab #11: The Male and Female Reproductive Systems

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*Estimated lab time: 90 minutes*

## Objectives

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After completing this laboratory exercise, students will be able to:

#### Male Reproductive System

1. Locate and describe the structures of the male external genitalia
2. Locate and describe the accessory glands of the male reproductive system
3. Locate and describe the internal anatomy of the penis and the divisions of the urethra
4. Describe the pathway of sperm through the male reproductive duct system

#### Female Reproductive System

1. Locate and describe the structures of the female external genitalia
2. Locate and describe the structures of the female internal genitalia
3. Describe the pathway of ova through the female reproductive duct system
4. Identify the mammary gland and its associated structures

#### Teaching Tips

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In this laboratory exercise, students will become familiar with the male and female reproductive anatomy. Explain to the students the importance of the pathway of urine flow. Explain to them how the proper insertion of a catheter requires a full understanding of the anatomy.

Remind students that gametes are haploid cells (n or 23 chromosomes) whereas the remaining, somatic cells of the body are diploid cells (2n or 46 chromosomes). Gametes are made via meiosis whereas the somatic cells are made via mitosis. Both male and female gonad function are fairly dormant until puberty. Males do not begin spermatogenesis until the age of puberty whereas females are already born with their supply of oocytes at birth. At puberty the female will begin the maturation process of select ova that she already has “in storage.” Refer students to the Lab Guide for a link to AIA to view several Clinical Animations on conception and fetal development.

#### Materials Required

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- Computer with AIA access
- Torso model with reproductive organs
- Male reproductive system model
- Female reproductive system model

#### Exercise List

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##### **Lab Activity 11.1: Male Reproductive System**

Remind students of the importance of the testes being housed in the scrotum, outside of the pelvic cavity (to keep them cool). Also note that the prepuce is not evident in this view, covering the glans penis. Surgical removal of the prepuce is referred to as “circumcision.” Also visible in this image is the ureter (not to be confused with the vas deferens), the urinary bladder, and the pubic symphysis. Refer students to the Lab Guide for a discussion and link to view a Clinical Animation on vasectomy in AIA.

Of the three glands that contribute to semen production (seminal vesicle, prostate, and bulbourethral (Cowper’s) glands) the bulbourethral gland is not evident in this view. Students should clearly differentiate between the prostatic urethra and the ejaculatory duct. Also found within the spermatic cord, and seen in this view, are the testicular artery and the pampiniform (venous) plexus. For an interactive view of the male reproductive system direct students to the Lab Guide for a link to the 3-D animation in AIA.

**Lab Activity 11.2: Female Reproductive System**

This lateral view allows for a look at the typical, anteverted uterus and its relationship to other pelvic structures. Note that the ovary and the fimbriae of the uterine tubes are not in contact with each other. Refer students to the Clinical Application in the Lab Guide for a discussion on pelvic inflammatory disease (PID). It is a good idea to remind students to visualize the uterus here, in relation to the bony pelvis. Some students incorrectly believe that the uterus is housed in the abdominal cavity since that is where it “appears” in a gravid state. The proximity of the uterus to the urinary bladder also explains why the gravid woman has to urinate so frequently – there just isn’t room for the bladder to expand when encroached upon by the gravid uterus. From the medial view, all three layers of the uterus are evident. Additionally, it is possible to view the position of the cervix and its relationship to the vaginal canal. Refer students to the Clinical Application within the Lab Guide for discussions on endometriosis, Pap smears and cervical cancer. Remind students that the perforated hymen protects the vaginal opening at birth. For an interactive view of the female reproductive system direct students to the Lab Guide for a link to the 3-D animation in AIA.

**Lab Activity 11.3: Mammary Glands**

Remind students that unlike the nipples in baby bottles, with only one opening, the human breast has multiple openings in each nipple for the expression of milk with lactation. While breast size varies greatly among women it is important to remind students that the great disparity in size is generally more of a product of adipose deposition rather than glandular tissue. Even smaller breasted women can generally produce adequate amounts of milk with lactation. Lactation is driven hormonally by demand rather than proportionally to breast size.

Direct students to the Clinical Application within the Lab Guide for discussions on breast examination, mammography, and breast cancer.