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HumAn: A Cat Dissection Tutorial

Sean P. Pierel
University of Rhode Island, spie129@my.uri.edu

HumAn: Cat Dissection Companion

By Sean Pierel
Edited by Dr. William Johnson II

Introduction

HumAn: Cat Dissection Companion is designed you help any human anatomy lab teaching assistant with performing the necessary cat dissections in coordination with Dr. William C. Johnson's human anatomy course curriculum. This written tutorial should be used in combination with the HumAn: Cat Dissection Video Tutorials available through Dr. Johnson's supplemental course website via www.coursesites.com, powered by Blackboard. The video tutorials offer a first hand perspective of how Dr. Johnson performs each dissection.

This written companion will outline each dissection through various steps as well as to offer helpful tips. Please recognize that structures that don't need specific dissection instructions may have been omitted here but should be reviewed with the students, such as in the case of the skull which is taught with prosthetic models. Human anatomy students are also welcome to use these resources as study tools to help them learn the structures observed in lab because, as Dr. Johnson says, repetition is your friend!

Dissection 1: Lab 2 *Muscles of the Thorax and Neck*

I. **Skin Removal**

Insert the blunt end of the probe into the cut found in the skin where dye was injected into the cat; on the ventral side and in the cervical region. Push the probe caudally to lift the skin, withdraw the probe, and then carefully cut the skin with scissors without going deep. Continue this process along the cat's ventral midline to the area of the umbilicus. From the end of this incision in the abdominal region, cut the skin on the left side toward the vertebral column. Note: if the cat is female, leave the mammary glands attached to the skin.

Cut the skin that has been lifted away from the arm around the elbow. Also cut from the cervical region cranially toward the middle of the mandible on the right side then continue to cut along the mandible on the left side but turning dorsally to reach the ear, wrapping the cut around the ear toward the midline of the dorsal side. Lift the skin away from muscles by inserting your fingers and when all the skin is reflected continue to step II. Tip: Try to leave superficial fascia in tact because it is always feasible to remove tissues later but not always feasible to put them back.

II. **Xiphihumeralis and Begin Pectoralis Minor**

Place the cat on its dorsal surface and observe the four pectoral muscles. Starting with the most caudal of these muscles, **xiphihumeralis** (cat muscle), use the forceps and scalpel to remove superficial fascia and expose the muscle. Tip: Take care here because this muscle is extremely thin and easily damaged. Along the cranial border of **xiphihumeralis** you should see the caudal border of **pectoralis minor**. These two muscles overlap, similar to the way shingles overlap, but the border is relatively straight and can be opened with the straight scissors. Separate **pectoralis minor** and continue to repeat this process to the caudal border of **xiphihumeralis**, which is also relatively straight.

III. **Spinotrapezius and Begin Latissimus Dorsi**

Move onto the cat's dorsal side by removing superficial fascia with the forceps and the scalpel, just enough to expose the muscles. Hold the cat's arm so the scapula rotates ventrally and observe the border of **spinotrapezius** and **latissimus dorsi**. Carefully separate the two with the scalpel. As you continue to remove fascia and adipose tissue, in a caudal direction, you will find the other edge of **latissimus dorsi**. This border can be cut with straight scissors and the fascia deep to the muscle can be cleared but the complete separation of this muscle won't be completed until step XI.

IV. **Pectoantebrachialis**

Move back to the ventral side of the cat and try to grab the fascia along the cranial border of **pectoantebrachialis**. Pulling on this area should allow you to cut along the muscle's cranial border with the scalpel. Separate the caudal border of this muscle too but don't go too deep. After both borders have begun to be separated, find where **pectoantebrachialis** meets **clavobrachialis/clavodeltoid** and separate the two. Next clear the fascia deep to **pectoantebrachialis** using the scalpel as a spatula.

V. **Pectoralis Major and Complete Pectoralis Minor**

Note: **Pectoralis major** connects with the arm and **pectoralis minor** does not. Find the margin of **pectoralis major** just distal to the axilla and begin separating the two borders, drawing the scalpel caudally like a spatula. Tip: Only separate the

muscles enough to clearly distinguish between them; you do not have to continue each separation all the way to the sternum.

VI. **Cleidomastoid**

Begin by clearing fascia and adipose tissue from the ventral to dorsal side in order to expose the muscles. The ventral margin of **clavotrapezius** must first be cleared to expose the deeper muscles. Just deep to this border is **cleidomastoid** which, when exposed, can be pulled with the forceps and its ventral border can be cleared with the scalpel. Note: Just deep to **cleidomastoid** is the ventral view of **levator scapulae ventralis** which can be exposed by simply pulling on it with a probe. Also this is when Dr. J recommends, but doesn't require, separating the **external jugular vein** away from the muscles.

VII. **Sternomastoid**

Find the ventral margin of the **sternomastoid** and start to clear it with a scalpel then remove the **mylohyoid** muscle from the cat. Note: The **mylohyoid** is often too damaged when the cat is injected with dye to consistently study and is not part of the course. Clear the fascia deep to **sternomastoid** until the muscle separates away from the oblique margin of **cleidomastoid**.

VIII. **Sternohyoid and sternothyroid**

Note: Take care here as these muscles are often damaged when the cat is injected with dye. Also, you can differentiate between these two muscles because the **sternothyroid** extends cranially to the thyroid cartilage of the larynx where as the **sternohyoid** extends more cranially to the hyoid bone. Both **sternohyoid** and **sternothyroid** are thin muscles and can be separated with a forceps and a probe.

IX. **Clavobrachialis/Clavodeltoid and Clavotrapezius**

Pull on the **clavobrachialis/clavodeltoid** muscle with the forceps to expose its dorsal margin and clear it with the scalpel. Note: Take care not to cut too deep because this is where you will find the **axillary nerve**. Continue to clear this margin in a dorsal-medial direction and you will also finish clearing the caudal margin of **clavotrapezius**. Note: Don't go too deep or you will risk damaging **levator scapulae ventralis**.

X. **Levator Scapulae Ventralis (LSV)**

The medial margin of **LSV** is relatively straight but short and can be cleared by pulling on the muscle and cutting along the border with the scalpel. The lateral margin curves and is easily cleared with curved scissors.

XI. **Complete Latissimus Dorsi and Serratus Ventralis**

Run a probe along the deep side of **latissimus dorsi** up to the end of **spinotrapezius**. Use this probe as a guide to cut straight across **latissimus dorsi**. Reflect the muscle and clear the deep tissues. Deep to this muscle is the **serratus ventralis** muscle witch can be exposed by clearing fascia and adipose tissue away from its surface. Note: Take care not to destroy the **long thoracic nerve** as it runs along the surface of this muscle.

XII. **Rhomboideus Major and Acromiotrapezius,**

Rhomboideus major can be exposed simply by clearing tissue away from its surface with the curved scissors. Along the cats dorsal midline you can find the aponeurosis of **acromiotrapezius**. Extend a probe along the deep side of this aponeurosis and cut its medial border with scissors. Reflect **acromiotrapezius** taking care not to destroy the **spinal accessory nerve (XI)** as it runs along the deep side of the muscle.

XIII. **Rhomboideus Capitis and Rhomboideus Minor**

Rhomboideus capitis and **rhomboideus minor** can be separated with the scalpel and the borders trimmed with the curved scissors. Note: Deep to these two muscles is an alternate view of **serratus ventralis** which can be exposed by clearing tissue on either side of it with a scalpel or probe.

Final Notes

The following structures were not mentioned in these dissection instructions but they do need to be identified during this lab: **acromiodeltoid muscle**, **spinodeltoid muscle**, **thoracodorsal nerve**, **thoracodorsal artery**, and the **cephalic vein**. These structures don't need special dissection and will be accessible after completing the steps for the other structures in this lab. Also, this outline is based off of Dr. Johnson's technique which may not work best for everyone else. Find what works best for your skill level.

Dissection 2: Lab 3 *Thoracic Cavity- Viscera, Nerves, and Vessels*

I. **Open the Thoracic Cavity**

Begin along the midline by inserting the scissors approximately one quarter of an inch to the right of the sternum at the cranial end. Cut in a caudal direction through the costal cartilages to the **diaphragm** but take care not to cut through the **diaphragm**. Dr. J suggests inserting your finger into the thoracic cavity and pushing it toward the **diaphragm** so you will feel it before you get to a point where you might cut it. At the level of the **diaphragm**, cut in a parallel and lateral direction along it's cranial border. This cut should extend diagonally toward the caudal end of the cat otherwise the scissors might be following the curve of a rib which will inhibit the opening of the thoracic cavity. Continue this cut until you reach the vertebral border. When this cut is complete return to the initial position at the cranial end of the sternum and extend the cut toward the **sternohyoid muscle**. Tip: Stay shallow with this cranial cut to avoid damaging vessels that will be studied soon.

Now you are ready to cut through the sternum toward the left vertebral border again following the cranial end of the **diaphragm**, in a parallel lateral direction with a caudal diagonal angle. Note that to complete this cut you will need to cut through the mediastinal ligament so take care to show each lab group this structure before it gets destroyed. Also note that this cut dissects the **xiphihumeralis muscle**. When this cut is complete it is time to cut the ribs. Use bone-cutters to cut each rib on both sides of the vertebral column. Viscera should be moved out of the way while doing this to avoid damaging the organs. Tip: If you are careful, ask one of the students to hold the organs while you use the bone cutters. This will make this step much easier but please avoid injuring yourself and the student helping you.

II. **Thymus Gland**

Tear through the pleura securing the **thymus gland** along the cranio-ventral end of the pericardium with a probe which will loosen the caudal end of the gland. Note to try and avoid damaging the **left internal thoracic** (**mammary**) **artery**, the **right internal thoracic** (**mammary**) **artery**, and the **internal thoracic** (**mammary**) **vein**. Leave the **thymus gland** attached at it's cranial end.

III. **Lungs and Pericardium**

Dr. J recommends instructing the students to perform this step. Be sure to have the students take notice of the differences in the lobes of the **lungs** from the left compared to the right side as well as the **trachea** and how it bifurcates into **primary bronchi** which further divide into **secondary bronchi**. Also instruct the students to make sure they do not cut through the **phrenic nerve** as it runs close to the root of the left **lung**. Next the students can make a small incision at the apex of the **heart** and cut along the ventral surface of the **pericardium** in a cranial direction. The **pericardium** can then be peeled bilaterally toward the dorsal side of the **heart** to expose it but the students should take care not to remove the **pericardium** completely.

IV. **Vessels**

The vessels in this dissection are all relatively easy to expose, that is they can be cleared from the surrounding tissue by scraping around each of them with a probe. Tip: The "Vessels of the Thoracic Cavity" road map on page 78 of Johnson and

Miller's Regional Anatomy Dissector and Laboratory Companion, Second Edition: Revised Printing, is an excellent tool to help learn and to help instruct this part of the lab. Following the vessels in the cat alongside the road map reveals veins in the following order starting at the left side of the cranial end of the thoracic cavity: **left external jugular vein**, a **left internal jugular vein**, a **left subclavian vein**, and a **left vertebrocostocervical trunk** which converge to form the **left brachiocephalic vein**.

The right side is usually in this same conformation of vessels but, in a little less than half of the cats the **right vertebrocostocervical trunk** joins at the **cranial vena cava** rather than the **right brachicoephalic vein**. The two **brachiocephalic veins** join to form the **cranial vena cava** which also recieves the **internal thoracic** (**mammary**) **vein** from the sternum and the **azygos vein** from the dorsal thoracic cavity. Finally the **caudal vena cava** connects to the right atrium from the caudal end of the thoracic cavity.

The **aorta** begins the study of the arteries in this lab and it's third branch, the **brachiocephalic artery**. The first two branches are the **coronary arteries** and won't be observed until lab 4: The Heart. Usually the branches of the **braciocephalic artery** include the right **subclavian artery**, the **right common carotid artery**, and the **left common carotid artery**. Sometimes however there are only two branches in which case the two **common carotid arteries** converge before connecting to the **braciocephalic artery** in what is referred to as the **bicarotid trunk**.

The **left subclavian artery** is the fourth branch off of the **aorta** and it will have four branches studied in this lab. These branches are the **left internal thoracic artery**, the **left vertebral artery**, the **left costocervical artery**, and the **left thyrocervical artery**. Tip: "**VCT**" is a mnemonic to help study the latter three branches as they can be quite small in a cat which poses a challenge to many students as they study them.

V. **Nerves**

Entering the thoracic cavity from the neck on the left side are the **left phrenic** and the **left vagus (X) nerves**. Typically the **vagus (X) nerve** is greater in diameter and more medial to the **phrenic nerve** but because the two are in such close proximity Dr. J recommends using the following trick to discern between the two. The **left common carotid** artery in the lateral area of the neck accompanies the **left vagosympathetic trunk**. Pulling on the **left vagosympathetic trunk** will also pull on the **vagus (X) nerve** in the thoracic cavity while the **phrenic** doesn't move.

Dissection Supplement: Lab 4 *Heart*

I. **Coronal Separation**

Typically a prepared heart will last for an extended amount of time so this procedure is for when a new heart is being dissected although that may not happen every semester. First identify the ventral side by the oblique angle of the **interventricular sulcus** and flip the heart upside down, so the apex is pointing superiorly. As these are calf hearts you will need a large blade to make the necessary coronal cut but begin at the apex and continue to cut towards the heart's cranial end. Ideally the cut will extend into the two atria and can stop once that level is reached. Inspect the heart for the structures the students will be required to study with a probe. Note that when inserting a probe into the various channels of the heart, insert the blunt end in order to avoid tearing at the cardiac muscle tissue.

Dissection 3: Lab 5 *Head and Neck*

I. **Clearing the left side of the face**

Begin by removing the skin of the face using the probe to clear the loose connective tissue away from the **parotid salivary gland**. Tip: Dr. Johnson likes to make a note to the students about how this gland has a texture similar to cauliflower to help them identify this structure more easily. Continue removing the skin over the **masseter muscle** clearing superficial fascia away as needed. When the muscle is exposed you should be able to see the **dorsal facial nerve** (**VII**), **parotid salivary duct**, and **ventral facial nerve** (**VII**) all of which can be more precisely identified by clearing away tissue with the probe as needed.

Caudal to the **parotid salivary gland** you should find two mandibular lymph nodes. The student's will not be responsible for these two structures so they should be removed in order to better observe the other structures in that area. Ventral to the **parotid salivary gland** is now the **mandibular** (**submaxillary**) **salivary gland**. Tip: Dr. Johnson comments how this gland resembles a gumdrop without sugar or a candy dot. The **mandibular salivary duct** runs deep to the **digastric muscle** and superficial to the **sublingual salivary gland**. Note that both of these glands are controlled by the **ventral facial nerve** (**VII**) and the **sublingual salivary ducts** will not be observed as they empty into the oral cavity, on the interior side of the tongue.

II. **Digastric Muscle, Mandibular Salivary Duct, and Sublingual Salivary Gland**

Moving on to the cervical region and medial to the **mandibular salivary gland** is the **digastric muscle**. This muscle can be exposed by clearing fascia away from it's medial and lateral borders with he probe. When it is completely exposed, extend the probe along it's deep surface and transect the muscle but take care not to cut too deep as there are structures immediately deep to the muscle. The **mandibular salivary duct** should now be exposed and deep to it is the **sublingual salivary gland**. Tip: Dr. Johnson helps students identify this small gland by pointing out the similar shape it has to that of a end of a Bic pen. There is also a mnemonic for the three salivary glands that student's usually find helpful; PMS. Wow, so that's what that stands for.

III. **Begin Vessels and Tympanic Bulla**

Adjacent to the **sublingual salivary gland** are the **left sublingual** (**lingual**) **artery** and the **hypoglossal nerve** (**XII**) extending together towards the tongue. Follow the the **left sublingual** (**lingual**) **artery** back toward the cervical region and you will observe how it branches from the **left external carotid artery**. Now follow the **left external carotid artery** cranially to see the **left external maxillary artery** as it branches deep to the **sublingual salivary gland**. By reflecting the **digastric muscle** away from the **left external carotid artery** you will expose the **tympanic bulla**, a landmark of the **temporal bone**.

IV. **Thyroid Gland and Vessels Continued**

Next transect the **sternohyoid** and **sternothyroid muscles** and reflect them towards their origin and insertions. This will expose the **thyroid gland**. Tip: The **thyroid gland** in cats is separated into two separate lobes which is unlike in humans where there is an isthmus connecting the two lobes. Dr. Johnson also likes to point out the resemblance that the **thyroid gland** of a cat has to rice peel-offs.

Lateral and dorsal to this gland is the **left common carotid artery**. The following branches of this artery begin at the caudal end of the neck and progress cranially. The first medial branch is the **left cranial thyroid artery** which serves the cranial end of the **thyroid gland**. In close proximity to the **left cranial thyroid artery** is a lateral branch off of the **left common carotid artery** and it is the **left muscular artery** which serves the muscles of the neck. Moving cranially is the branch that serves the cranial end of the larynx and is named the **left cranial laryngeal artery**. The **left common carotid artery** ends then where it bifurcates to form the **left internal carotid artery**, which the students will not be responsible for because it is too small, and the **left external carotid artery**.

V. **Complete Vessels and Nerves**

In the area of the cranial end of the **left common carotid artery** there is a relatively large lymph node, lateral to the larynx, that should be removed. Then at the base of the digastric muscle and where the **hypoglossal nerve** (**XII**) comes from is the **left spinal accessory nerve** (**XI**). Some of the cats will have a visible **left internal jugular vein** running with the **left common carotid artery** and eventually joining the **left external jugular vein**. Note: The **left** and **right internal jugular veins** are the only vessels of significance that drain blood from the cranium and they exit the skull by the jugular foramen. You will also observe the **vagosympathetic trunk** running with the **left common carotid artery** and the **left internal jugular vein**, collectively forming the **carotid sheath**. The **vagosympathetic trunk** splits into the **vagus nerve** (**X**) and the **sympathetic trunk** at about the level of the **left brachiocephalic vein** and students should be instructed not to separate them cranially to that point.

Final Notes

The **hyoid bone** and the structures of the larynx were not discussed in this dissection guide but they are important parts of this lab. Be sure to review the **epiglottic cartilage**, the **arytenoid cartilage**, the **cricoid cartilage**, and the **thyroid cartilage** with either a prepared sheep larynx or a human model larynx.

Dissection 4: Lab 7 *Upper Limb*

I. Muscles, Nerves, and Vessels of the Arm and Shoulder

The first step in this dissection is to separate the **lateral head** of the **triceps brachii** and transect it. To do so, separate it along its caudal border from the **long head** of the **triceps brachii** and elevate it from the deeper structures by clearing away fascia deep to it with the probe. Then extend the probe along its deep surface and is the probe as a guide to transect the **lateral head** but take care not to cut the **radial nerve** which is along this deep surface where it meets with the **brachialis muscle**. Reflect the **lateral head** of the **triceps** in order to observe the **brachialis muscle** and the **radial nerve**. Tip: The **radial nerve** bifurcates into a superficial branch serving the **brachioradialis muscle** and a deep branch that serves the extensor muscles in the forearm. Notice that along the cranial border of the **lateral head** of the **triceps brachii** is the **cephalic vein**.

The **medial head** of the **triceps brachii** can now be identified by clearing the surrounding fascia with a probe. Also observe the shiny **perimysium** along the distal portion of the **long head** of the **triceps brachii**. Reflect the distal portion of the transected **lateral head** of the **triceps brachii** to observe a relatively small triangular muscle, the **anconeous**. Similarly but at the proximal portion of the **lateral head** of the **triceps brachii** you will see the **caudal humeral circumflex artery** as it emerges from the heads of the **triceps brachii**.

Next transect the **spinodeltoid muscle** to expose the small and triangular **teres minor muscle** as well as part of the **infraspinatus muscle**. The **subscaular artery** emerges from the **teres major** and the **infraspinatus** usually around the area of the caudal border of the **spinodeltoid muscle**. Continue in a dorsal-cranio direction and reflect the **acromiotrapezius muscle** to expose the **supraspinatus muscle**. Then cut this muscle into cranial and caudal halves. Reflect the cranial half, cutting it away from the **supraspinous fossa** of the **scapula** until you expose the **suprascapular artery** and **suprascapular nerve** as they emerge from the **suprascapular notch**. Finally laterally rotate the **scapula** in order to observe the **transverse scapular artery** and the **suprascapular nerve** as they emerge from the **subscapularis muscle**, which is on the deep side of the **scapula**.

Dissection 5: Lab 8 *Upper Limbs: Arm and Forearm*

I. **Transect Epitrochlearis and Pectoral Muscles**

The beginning of this dissection has the potential to cause damage to the structures that the students will be responsible for in this lab. Use caution when doing these first two cuts to try and avoid damage. Separate the caudal margin of the **epitrochlearis muscle** (cat only) then separate the cranial margin of this muscle with a probe in order to separate it from the underlying nerves. When you can see that there aren't any nerves attached to the deep side of the muscle, extend the probe underneath the muscle and use straight scissors to transect it. Extend the blunt end of the probe deep to the pectoral muscles at the level of the caudal margin of the **pectoantebrachialis muscle**. Carefully use the straight scissors to cut towards the sternum using the probe as a guide to prevent damaging deep structures.

II. **Axilla**

To start clearing the axilla, remove the **bacilic vein** and the superficial branch of the **ulnar nerve**. Note that the students will discuss the **bacilic vein** in lecture but these two structures can interfere with observing the brachial plexus so they are removed. The nerves and vessels within the axilla can be cleared using the forceps and probe in order to separate them from fascia and any adipose tissue that might be blocking them from clear view.

During this process, Dr. Johnson likes to point out that the **ulnar**, **median**, and **musculocutaneous nerves** can be pulled toward the elbow simultaneously and they form what looks like the capital letter "M". Students tend to use that as a useful memory tool to establish an orientation when viewing this area. Also as you clear the axilla, make sure to clearly separate the **caudal humeral circumflex**, **subscapular**, and **thoracodorsal arteries** as well as the **axillary nerve** as these structures are relatively deep and students often need assistance viewing them. Note that the **axillary nerve** dives deep toward the shoulder as opposed to extending toward the elbow and that the **posterior cord** is too deep to be viewed so students will not be responsible for it in lab. Also note that spelling counts specifically as there are names that very closely resemble one another in this lab, i.e. the **mediaN nerve** and the **mediaL cord**.

III. **Arm**

The **biceps brachii muscle** doesn't need specific dissection instructions but a helpful tip to offer the students is to palpate it and move a finger along it in a proximal direction. Eventually there is a hard bump which is the head of the **humerus** and where the **coracobrachialis muscle** can be observed. Another tip is to move the **biceps brachii muscle** with a probe and observe the vessel connected to it, usually at the midpoint. This vessel is the **cranial humeral circumflex artery**. Note that the **epitrochlearis muscle** (cat only) was discussed in step one of this procedure.

IV. **Forearm**

Dr. Johnson recommends preparing the forearm prior to the normal lab time as this process can take too long to try and complete with six cats during the normal lab hours. Begin this preparation by separating the skin from the ventral side of the forearm by inserting the probe deep to it, creating a tunnel. Use straight scissors to cut the skin using the tunnel as a guide and peel the skin dorsally until it is completely removed up to the point of the cats paw. Use the pointed scissors to start lifting the

fascia and transition to the scalpel to start lifting the **brachioradialis muscle** away from the forearm. Take care with this muscle as it is relatively thin and easily damaged.

When the **brachioradialis muscle** is separated try to see the tendon for **extensor carpi rdialis longus muscle**. If you can start separating this muscle at the tendon you will be able to insert the point of a probe into that space and lift the muscle away from the forearm which will expose it's natural border. Follow along this border toward the elbow with the scalpel to clearly and accurately separate this muscle. Now at the proximal end you can pull the **extensor digitorum communis muscle** away from the **extensor carpi radialis brevis muscle** and separate the two using the scalpel.

The remaining extensor muscles are individually compartmentalized in fascia. Use short pointed scissors to pierce the fascia and run the scissors along one edge of the muscle to trim the fascia away. Doing this will also separate the muscles slightly. When the fascia is cleared away, use the probe to separate the muscles further and use the scalpel when necessary. This technique should work for the **extensor digitorum lateralis** (cat only) and **extensor carpi ulnaris muscles**.

Moving on to the ventral side, start by the wrist and try to separate the fascia enough to be able to insert scissors deep to it but superficial to any muscles. Cut the fascia up until the elbow, reflecting and trimming it towards both sides of the forearm. Use the probe to clear the **pronator teres muscle**. Tip: Dr. Johnson likes to mention to students that this muscle resembles a tear drop, being wide at the level of the elbow and tapering off as it extends toward the wrist. Note that the students will not be responsible for the deep muscles in the forearm so the **flexor carpi radialis**, **flexor digitorum superficialis**, and **flexor carpi ulnaris muscles** can be separated with a probe. Deep to the **flexor carpi ulnaris muscle** is **ulnar nerve** and **ulnar artery**. Also, deep to the **flexor carpi radialis muscle** is the **median nerve** and the **radial artery**. Finally the **flexor retinaculum** or **carpal ligament** can be pointed to at the level of the cat's wrist.

Final Notes

This lab has several tools to help the students study. The nerves and vessels have a very useful diagram that the students can use as a roadmap, the extensor muscles have the mnemonic "**B**ig **L**arry **B**ird **C**oach **L**oves **U**mbrellas", and the flexor muscles have the mnemonic "**P**ete **R**ose **S**wings **U**p". Be sure to have the students study the human models during this lab for the muscles, the **axillary**, **radial**, and **ulnar arteries** as well as the **ulnar**, **median**, and **radial nerves**.

Dissection 6: Lab 9 *Abdomen*

I. **Abdominal Wall**

Start by removing the skin on the right side of the abdomen then make a cut through the abdominal wall approximately 1/4 inch to the right side of the **linea alba**. Begin this incision at the diaphragm and extend it caudally to the pelvis. Next cut along the margin of the diaphragm dorsally to the vertebral border and repeat this cut on the left side. At this point the released flap of tissue on the right side can be delaminated to better expose the different muscles. The **external abdominal oblique muscle** is the most superficial and Dr. Johnson likes to point out that its **aponeurosis** forms a bell shape as it covers the **rectus abdominis muscle**. Note that the three abdominal aponeuroses are referred to as the **rectus sheath**.

The following step is much easier with the assistance of a student. Have the student hold the **external abdominal oblique** while you hold the **transverse abdominis muscle**. The tension the two of you apply will start to split the muscles away from each other and you can use the scalpel to prevent tearing. Split the muscles until you can start to observe the **internal abdominal oblique muscle**. To do so you will discover the **aponeurosis** of the **internal abdominal oblique** and may have to trim it away from the muscles. When this is complete you should be able to observe the **aponeurosis** of the **transverse abdominis** along the medial border of that muscle. Note that the muscle fibers of the **internal abdominal oblique** extend in a caudal to cranial direction and at an oblique angle as they approach the midline. The **transverse abdominis** fibres extend cranial to caudal again at an oblique angle directed towards the midline and students can use this tip as a guide on where the separation of the two muscles occurs.

II. **Abdominal Viscera**

The majority of the viscera are directly visible or can be observed after minor clearing of tissue with a probe or forceps. Still, before leaving the students to do their own exploring, separate the greater omentum from the small intestines. This will ensure the students don't tear this structure. It is also a good idea to explain what retroperitoneal means and how it can be observed in the case of the **kidney**. Then the **kidney** can be released from the **peritoneum** and split with a cranial to caudal cut and reflected open. This will allow the students to observe to the **cortex**, the **pyramid** of the **medulla**, and the **calyx** of the **kidney**. Pig **kidneys** should also be available for studying.

Just cranial to the **kidney** you can usually find the **left crus** of the **diaphragm** and cranial to that, in the thoracic cavity, will be the **quadratus lumborum muscle**. This muscle is dorsal to the **psoas major** and **psoas minor** muscles so it is more easily observed cranial to the **diaphragm**. At this level but along the cat's midline is the **central tendon**. To better expose it place a probe in the thoracic cavity and extend it along the surface of the **diaphragm** to the vertebral border. Then left the diaphragm cranially to observe its caudal surface and the probe should be visible through the **central tendon**. As a final tip, point out the **lesser omentum** as it covers the **papillary process** of the **caudate lobe** of the **liver** because this structure will be destroyed in preparation of lab ten.

III. **Nerves**

Adjacent to the **adrenolumbar artery** (lab 10) are the **medial** and **lateral lumbar nerves**. These nerves can be very challenging to uncover and it is feasible

that they won't be found on certain cats. However they do branch from a common origin so if you can find one and trace it proximally you may uncover the other. Next is the **lateral cutaneous nerve** which is usually adjacent to the **deep iliac circumflex artery** (lab 10). Further caudally and more medial is the **external iliac artery** (lab 10) which usually runs with the **genitofemoral nerve**. Note that this nerve is extremely thin in diameter and easily damaged. Finally you will find the **femoral nerve** as it passes within the **psoas major** and **psoas minor muscles**. This nerve is usually quite thick and can typically be exposed by inserting a probe right in the middle of the two muscles although it sometimes resembles the color of the surrounding muscle fibers which can make it challenging to find.

Dissection 7: Lab 10 *Abdominal Vessels*

Note that this lab is devoted to observing vessels and nerves so this dissection consists of clearing away fascia and adipose tissue as needed, which can be done using the probe and forceps as in previous procedures.

I. **Ventral Branches of the Abdominal Aorta**

Place the cat on its right side and reflect the organs to expose the three major ventral branches of the **abdominal aorta**. The **celiac trunk** is the most cranial and it extends ventrally. Caudal but in close proximity to the **celiac trunk** is the **cranial mesenteric artery**. This artery extends ventrally at about a forty five degree angle. The **caudal mesenteric artery** is the most caudal of the ventral branches and can be found just cranial to the two external iliac arteries. This artery often resembles a capital "Y" with its two terminal branches; the **left colic artery** extending cranially and the **cranial rectal artery** extending caudally. Tip: Although the **cranial rectal artery** is the caudal branch off of the **caudal mesenteric artery,** it is named cranial because it serves the cranial end of the **rectum**.

II. **Celiac Trunk**

The most dorsal branch of the **celiac trunk** is the **hepatic artery** which is usually thick and directed obliquely toward the right side. The **left gastric artery** is the next branch and this artery sometimes covers the **hepatic artery** so take care to clearly separate the two. After the **left gastric artery**, what remains of the **celiac trunk** is the **splenic artery** which bifurcates into the **cranial** and **caudal splenic arteries**. Note that the **left gastroepiploic artery** is usually a branch off of the **cranial splenic artery** and although it won't be observed in lab the student's should be aware that it forms an **anastomoses** with the **left gastroepiploic artery**.

III. **"X"**

Place the cat on its back and move it so the edge of the cradle is at the level of the **diaphragm**. Bend the cranial end of the cat dorsally to expose the space between the **liver** and the **stomach**. Reflect the **papillary process** of the **caudate lobe** of the **liver** to the left to observe the **hepatic artery**. Note that to do this you will have to destroy the **lesser omentum** covering this process so the students should observe it beforehand. The **hepatic artery** extends obliquely to the right as it approaches the **liver** and doing so it forms the left side of the "X." The cranial branch on the right side of the "X" is the **cystic artery** and the caudal branch on the right side is the **gastroduodenal artery**. Note that the **left gastric artery** can also be observed in this area as it wraps around the lesser curvature of the **stomach**. Also point out that the **right gastric artery** will not be observed in the lab because it is too small but that the students will need to know that it forms an **anastomoses** with the **left gastric artery** along the lesser curvature of the **stomach**.

IV. **From Stomach to Rectum**

Along the grater curvature of the **stomach**, in the **greater omentum**, is the **right gastroepiploic artery** which is usually parallel to the curvature and just deep to some adipose tissue. At the beginning of the small intestines you will find the **cranial pancreaticoduodenal artery**, usually with the **cranial pancreaticoduodenal vein** (part of the **hepatic portal system**), although you may have to clear out some of the **pancrease** to see it. This artery forms an **anastomoses** with the **caudal**

pancreaticoduodenal artery which can be observed at the caudal end of these two organs. Note that this vessel is a branch off of the **cranial messenteric artery**.

The following arteries are branches off of the **cranial messenteric artery**. As you follow the small intestines toward the **rectum** you will observe many vessels within the **mesenteric ligament** (**mesentery**); these are the **intestinal arteries**, **intestinal veins**, and **lymphatic vessels**. At the **ileocecal** (**ileocolic**) **junction** there is the **ileocecal** (**ileocolic**) **artery** which is sometimes deep to a lymph node. Dr. Johnson suggests for this next artery that you find the middle of the **colon**. Reflect it to the right side but take care not to pull it caudally as that could damage the vessels going to or coming from the **colon**. If you are holding the middle of the **colon** then you should see the **middle colic artery**. Note that this vessel forms an **anastomoses** with the **left colic artery**.

V. **Lateral Branches of the Abdominal Aorta**

Reflect the **gastrointestinal organs** to the right in order to expose the dorsal abdominal wall on the left side. Caudal to the cat's **diaphragm** and cranial to the **kidney** you will find the **left adrenolumbar artery**. This artery extends laterally then caudally until it forms an **anastomoses** with the **left deep iliac circumflex artery**. Caudal to the **left adrenolumbar artery** is the **renal artery** extending to the **kidney**. Caudal from that point you will observe the **gonadal artery** but every cat is either male or female and therefore **gonadal artery** is not an acceptable answer on the lab practical. If the cat is male then it is the **left internal spermatic** (**testicular**) **artery** or, if the cat is a female, it is the **left ovarian artery**. The most caudal lateral branch of the **abdominal aorta** is the **left external iliac artery**.

Note before moving on to the dorsal branches and pelvic vessels. The same five major lateral branches of the **abdominal aorta** exist on the right side. Although there are **veins** that correspond with each **artery** on the right, and that each of these **veins** enters the **caudal vena cava** separately, there is an anomaly on the left. The **gonadal vein** extends cranially and joins the **renal vein** and they enter the **caudal vena cava** as a trunk. This is also true for humans and should be discussed in lab with the aid of lecture slides.

VI. **Dorsal Branches of the Abdominal Aorta, Pelvic Vessels, and Nerves**

Gently pull the **aorta** away from the vertebral column and you should see a number of branches running in a dorsal direction. These are the **lumbar arteries** and they serve the **spinal cord** and the **muscles** of the **dorsal abdominal wall**. After the **aorta** gives rise to the **left external iliac artery** there is a single vessel extending caudally which is the **common iliac artery**. This gives rise to the **left** and **right internal iliac arteries** and becomes the **median sacral artery** after the point where they branch to both sides.

The first branch off of the **left internal iliac artery** is the **left umbilical artery** which serves the **urinary bladder**. Then there is a lateral branch that effectively pulls the **left internal iliac artery** laterally and that is the **left cranial gluteal artery**. This vessel is very close to the **left obturator nerve** which passes through the **obturator foramen** and serves the medial compartment of the thigh. The **left internal iliac artery** then extends medially where it ends as it splits into the **left internal pudendal** (**middle hemorroidal**) **artery**, which serves the **rectum**, and the **left caudal gluteal artery**, which extends laterally and deep. Dorsal to the **left obturator nerve** you should observe the **left lumbosacral cord**. This forms the **sciatic nerve** which serves the posterior compartment of the thigh.

Dissection 8: Lab 11 *Pelvis and Reproductive System*

Male Reproductive System Preparation

I. **Testicles**

Start along the midventral line of the pelvis by cutting through the skin. Take care not to cut the **spermatic cord** which is usually just deep to the skin and bilateral to the midline. Next move to the caudal end and left side of the scrotum to in order to cut along the ventral surface of the scrotum toward the midsternal cut that was just made. At this point the **testicles** should be able to be removed from the scrotum and separated from the surrounding tissue. Note that to complete the study of the **testicles**, the students should observe a bull **testicle** but it should already be prepared and won't require a dissection.

When both **testicles** have been recovered, cut through the cartilage of the pubic symphysis from the cranial to caudal end. Note that this cartilage is only about the width of the scalpel but it shouldn't require a lot of pressure. If the scalpel isn't in line with the cartilage then you will be cutting through the bone and could cut too far laterally causing damage to the **levator ani muscle** so try to avoid this. Then firmly spread the thighs laterally to create more visible space within the pelvis taking care not to tear any of the structures.

II. Penis

Remove the prepuce of the **penis** by cutting toward the **shaft** at the urethral opening. Cut around the prepuce to expose the **glans penis**. Move laterally with a probe teasing the tissue around the **penis** away. This can be done with scissors instead of a probe but be careful as you clear tissue laterally until the **crus** of the **penis** is exposed. Repeat this clearing process on both sides of the **penis** and when it is completely released pull it away from the rectal region. This should allow you to clear around the **bulb** of the **penis** to further expose the **crura** and the **bulbourethral glands**. Observe a wide region along the **urethra** as you clear tissue cranial to the **penis**; this is the **prostate gland**.

Female Reproductive System Preparation

III. Vestibule to Ovaries

Begin by splitting the pelvis in the same process as with the male cats by cutting through the **pubic symphysis** and spreading the thighs laterally. The **vestibule** of the cat is internal (unlike in humans) and it extends from the junction of the **urethra** and **vagina** making it a common urogenital sinus. Use the scissors to cut open the **vestibule** along its right side. When the inside of the **vestibule** is exposed you should be able to extend the tip of a probe into the **urethra**. The **vagina**, on the other hand, is very narrow and will be difficult to identify. At this point the remaining tissue can be cleared with the probe and forceps to expose the necessary structures.

Note that the right side of the cats should not be damaged or cleared from previous labs in order to improve the accuracy of this lab. In particular, as you clear tissue cranially from the **urinary bladder**, **uterine body**, and **uterine horns** (**horns of the uterus**), be careful not to tear the **broad** and **round ligaments** of the **uterus**. Also note that there is a **round ligament** of the **ovary** that the students will not be responsible for. Finally, separate the **infundibulim** from the **ovary** with a probe. Doing so should also expose the **oviduct** (**fallopian tube** or **uterine tube**).

Dissection 9: Lab 12 *Lower Limb*

I. **Lateral side of the Thigh**

Create a tunnel by extending the blunt end of the probe deep to the skin along the medial surface of the thigh. Remove the skin from the thigh and leg down to the ankle being careful not to cut any deep vessels. Reflect the skin toward the vertebral border when the thigh is completely exposed. Next separate the **biceps femoris muscle** from the **caudofemoralis muscle** (cat only) taking care not to cut through the very thin aponeurosis of the **caudofemoralis**. Extend a probe along the deep surface of the **biceps femoris** but superficial to the **sciatic nerve** and transect the **biceps femoris**. Then reflect the **biceps femoris** and clear away the underlying adipose tissue to observe the **tibial nerve** as it goes into the belly of the **gastrocnemius muscle** and the **common peroneal nerve** (**fibular nerve**) which runs out to the lateral side of the knee. In this compartment you can also observe the **semitendinosus**, **semimembranosus**, and **adductor femoris muscles**.

Return to the cranial border of the **caudofemoralis muscle** and you should be able to observe the **gluteus maximus muscle**. Carefully cut along the cranial edge of the **gluteus maximus** to expose the **gluteus medius muscle**. Then, moving ventrally, there is typically a layer of adipose tissue and fascia covering the **tensor fascia latae muscle** and its aponeurosis, called the **fascia latae**. If you can clear this superficial layer of tissue then you can transect the **fascia latae** but don't cut through the tendon of the **caudofemoralis**. When the **fascia latae** has been transected you should be able to reflect the muscle and move onto the medial side of the thigh.

II. Medial side of the Thigh

Extend the probe along the deep surface of the **sartorius muscle** to separate it from the deeper muscles, transect it, then reflect the two divisions. Repeat this with the **gracilis muscle**. When the deep muscles are exposed they can be more clearly separated with a probe. Moving cranially the muscles deep to the **gracilis** are the **semitendinosus**, **semimembranosus**, **adductor femoris**, **adductor longus**, and the **pectineus**. Note that the **adductor femoris muscle** has two heads, **magnus** and **brevis**, but don't separate these two heads because it may mess up the students trying to learn these muscles with the help of Dr. Johnsons mnemonic "**S**ome **S**ailors **A**dmire **A**ttractive **P**arrots."

Deep to the **sartorius muscle** are the quadriceps muscles and you can separate the **vastus medialis muscle** from the **rectus femoris muscle** with a probe. Then do the same on the other side to separate the **rectus femoris** from the **vastus lateralis muscle**. Extend the probe along the deep surface of the **rectus femoris** and transect it to observe the **vastus intermedius muscle** just deep to it. Note that when you reflect the **sartorius** there is a deep muscle near its cranial edge, this is the **iliopsoas muscle**.

III. **Vessels and Nerves**

You should be able to observe the **femoral nerve** as it emerges from the **iliopsoas muscle**. The **saphenous nerve** branches from it and extends down into the leg. The **saphenous nerve** initially runs with the **femoral artery** and **femoral vein** toward the knee. As you follow these vessels distally there is a medial arterial branch, the **muscular artery**, which marks the point where the **femoral artery** and **vein** continue as the **saphenous artery** and **vein**. Return to the most cranial portion of the **femoral artery** and look for the branch that extends medially. This is the **deep femoral artery** and cranial to this branch is the **deep iliac circumflex artery**. Distal

to the **deep femoral artery** there should be a lateral branch off of the **femoral artery** which is the **lateral femoral circumflex artery**.

Reference:

Jonson, W., and Miller, L. (2011). Regional Anatomy Dissector and Laboratory Companion, II Ed. Dubuque, IA: Kendall Hunt.