MD Program
UNIVERSITY OF TORONTO

Anatomy

UNIT 3: The Cardiorespiratory System

Lab 8

CLICK TO ENTER

Unit 3 Overview

Unit 3 describes the anatomy of the cardiorespiratory system. It will build on your introduction to the thorax in Unit 1, Lab 2. Over the course of three labs, you will have the opportunity to study, through dissection and exploration, i) the anatomy of the heart, internal and external, including the coronary circulation, ii) the skeleton and fascial compartments of the limbs, and the peripheral vascular system, iii) the detailed anatomy of the superior and posterior mediastinum, and iv) a more in depth study of the lungs, pleural cavity and the mechanics of respiration.

The skeleton is quite sensibly divided into an **axial division** and an **appendicular division**. You've already studied the axial division, consisting of the vertebral column (including the bony thorax), and the skull, in Units 1 and 2, respectively. In Unit 3, you will learn the appendicular skeletons of the upper and lower limbs. You are learning the skeleton of the limbs at this point because so much of the language of anatomy (and therefore medicine), including its vasculature, is based on the names of its bones. In Lab 7 you will learn the skeleton of the lower limb. In Lab 8, you will continue with the skeleton of the upper limb.

Note that the anatomy of the musculoskeletal system will be studied in CPC-2, next September, and it is then that you will learn about articulations, muscles and innervation of the limbs. Your current objectives in Unit 3 are to learn the skeleton, fascial compartments and blood supply of the limbs.

PREVIOUS NEXT

Lab 8 Instructions

Lab 8 is spread over two half-days, one in each of Weeks 18 and 19. Each lab session begins with a Lab RAT on Pre-lab Exercise 8A. Arrive 10 minutes early so that you can log into Turning Point. If you encounter problems with the app on your phone, you will then have time to **log in on a computer** and be **ready to start the quiz at 9:00**.

After the Lab RAT, each pair will start with the exercise that corresponds to their pair number (i.e. pair 1 starts with exercise 8.1, pair 2 with 8.2, etc.). Pairs will have 90 minutes to complete the tasks associated with a given station before the TA announces that it is time to rotate to the next station.

	Week 18 9:00-10:30	Week 18 10:30-12:00	Week 19 9:00-10:30	Week 19 10:30-12:00
Ex. 1 The Heart Internal	Pairs 1	Pairs 4	Pairs 3	Pairs 2
Ex. 2 Compartments and BVs	Pairs 2	Pairs 1	Pairs 4	Pairs 3
Ex. 3 The Heart External	Pairs 3	Pairs 2	Pairs 1	Pairs 4
Ex. 4 Bones	Pairs 4	Pairs 3	Pairs 2	Pairs 1

Unit 3: Lab 8

Select an exercise to begin:

LAB INSTRUCTIONS

Lab 8

8A Pre-lab SLM

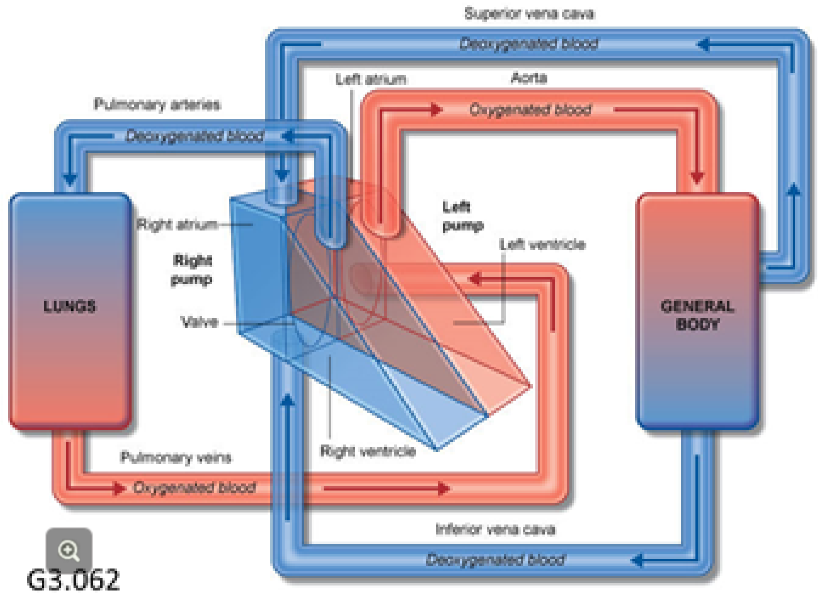
Part 1: Introduction to the Cardiac Cycle

When you have learned the material presented in this exercise, you will be able to:

- describe the skeleton of the heart and its structural and functional importance.
- describe the function of the atrioventricular and semilunar valves during the stages of the cardiac cycle.
- describe the components of the conducting system of the heart and their locations.

If you are unfamiliar with the blood vascular system, the accompanying diagram is a good place to start. It shows that the **right atrium** receives deoxygenated blood from the **systemic circulation** ("general body") via the SVC and the IVC. This blood is pumped from the right atrium to the **right ventricle**, and from there into the **pulmonary circulation**. Gas exchange occurs in the lungs, and oxygenated blood returns to the heart, this time to the **left atrium**.

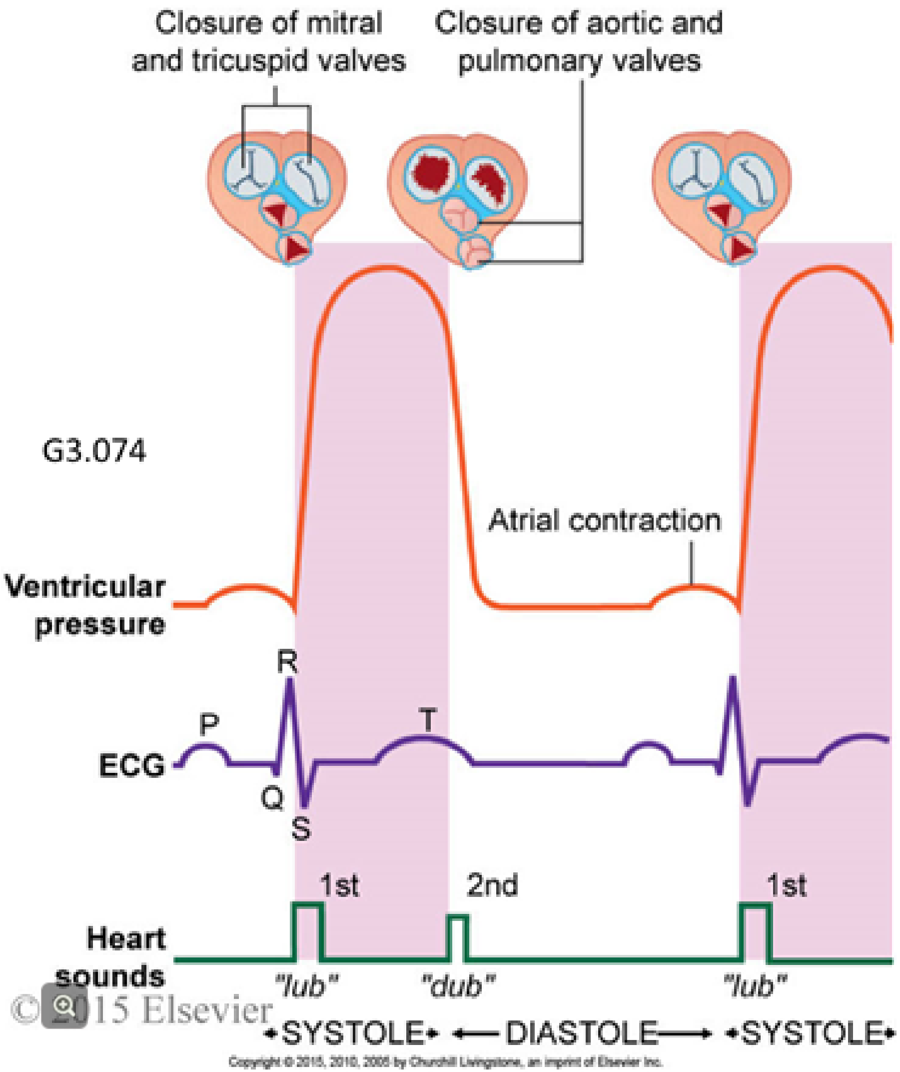
Blood is pumped from the **left atrium** into the **left ventricle**, and from there into the **systemic circulation**. Once again, gas exchange takes place and the peripheral tissues are supplied with oxygen and have carbon dioxide removed. The cycle repeats with blood returning, via the SVC and IVC, to the right atrium.



G3.062

The contraction of the atria occurs simultaneously, followed by the simultaneous contraction of the ventricles. The contraction of the heart is coordinated by specialized myocardial cells that make up the **conducting system of the heart**.

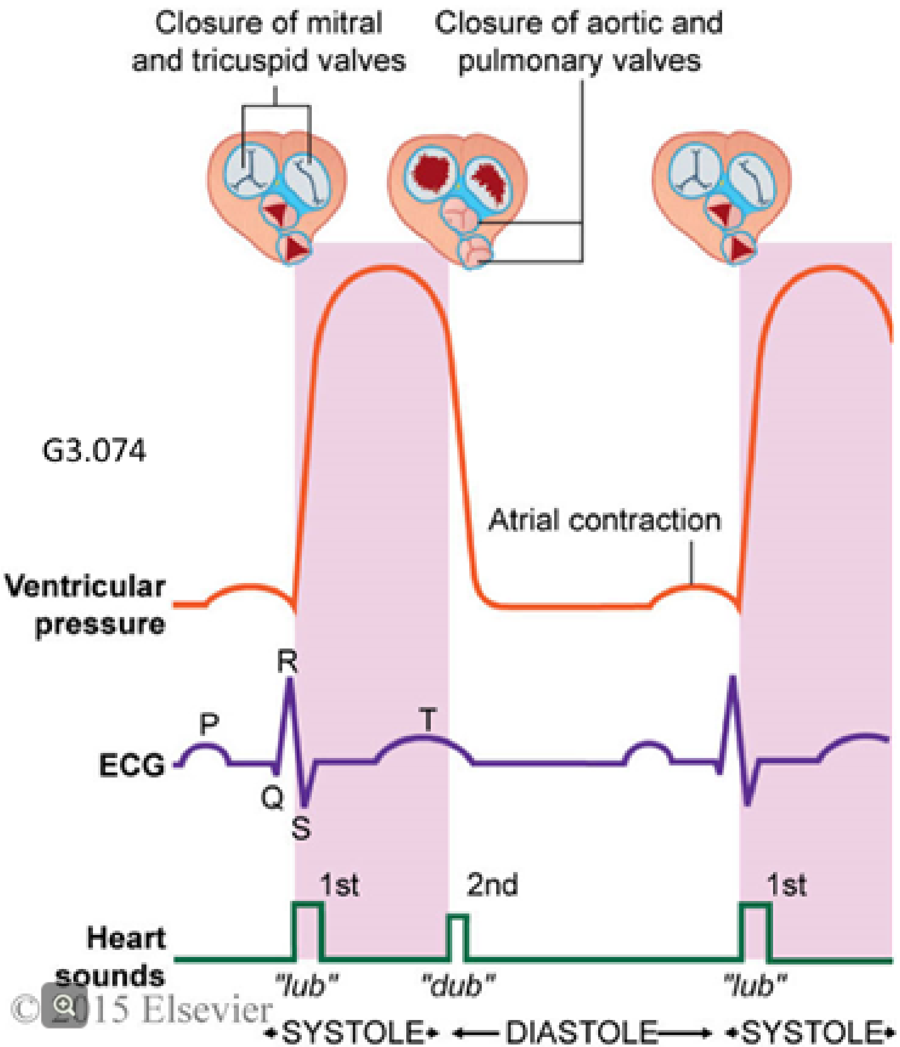
Valves control the movement of blood through the chambers of the heart. The right and left **atrioventricular valves** control the flow of blood from the atria to the ventricles. The **pulmonary and aortic semilunar valves** control the flow of blood out of the right and left ventricles, respectively.



A valve, by definition, permits one-way flow.

The contraction of ventricular myocardium during ventricular systole increases pressure in these chambers. Because of the distinct structure of the valves, this **increased pressure forces the semilunar valves open and the atrioventricular valves closed**.

This ensures the one-way flow of blood during ventricular systole **through the opened semilunar valves** and into their efferent vessels, **the pulmonary trunk and the ascending aorta**. Meanwhile, because the **atrioventricular valves are forced shut** during ventricular systole, the **backflow of blood** into the atria **is prevented**.



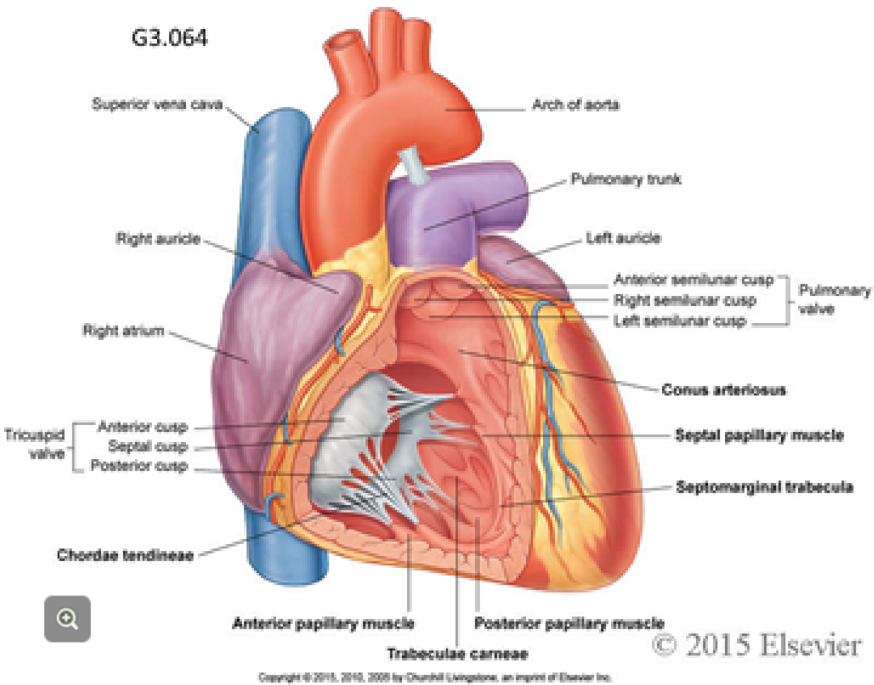
Structure-function relationship of the **atrioventricular valves** during ventricular systole:

Increased ventricular pressure during ventricular systole **forces the atrioventricular valve cusps against each other**, thus closing the valve. The atrioventricular **valve cusps are prevented from inverting**, and thus permitting backflow of blood into the atria, because they are tethered to the ventricular floor by the **chordae tendineae and the papillary muscles**.

The closure of the atrioventricular valve cusps is the cause of the first heart sound, "lub".

Structure-function relationship of the **semilunar valves** during ventricular systole:

The same increase in ventricular pressure during ventricular systole forces the semilunar valve cusps against the wall of the efferent vessel, thus opening the semilunar valves.



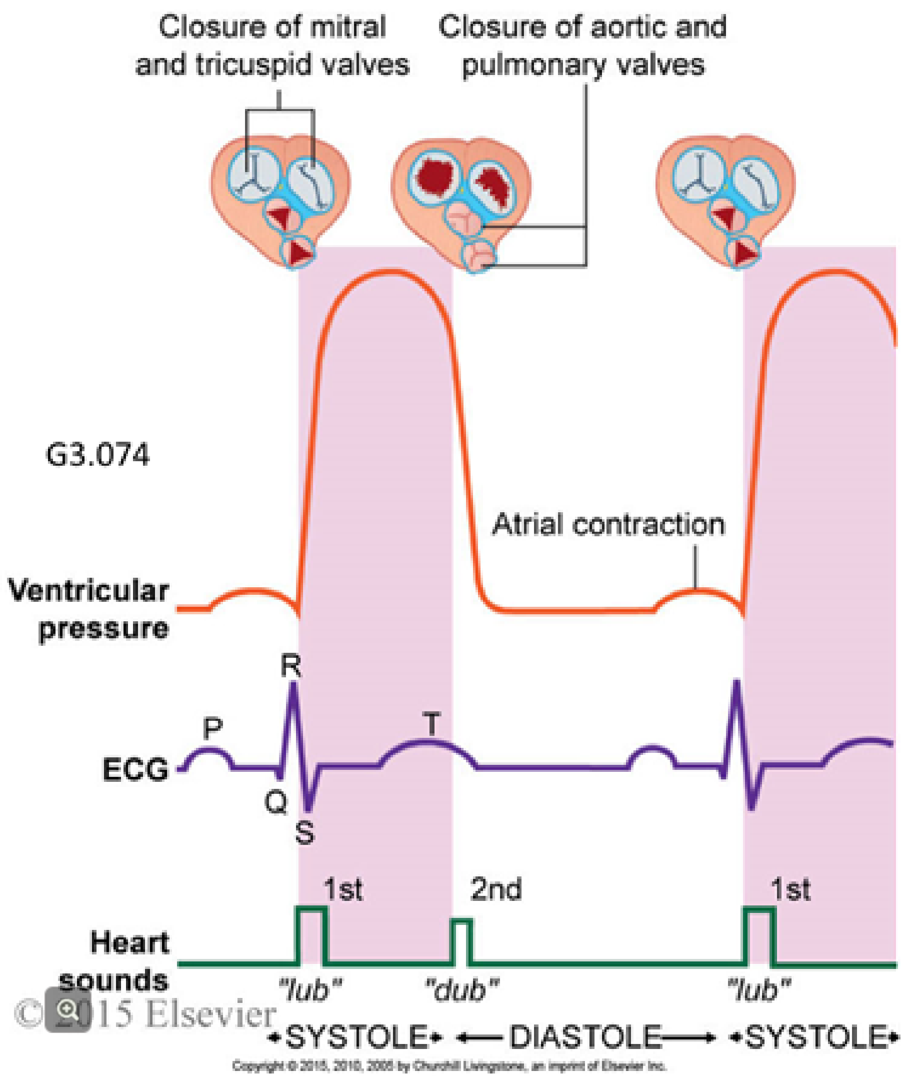
Structure-function relationship of the **atrioventricular valves** during ventricular systole:

Increased ventricular pressure during ventricular systole **forces the atrioventricular valve cusps against each other**, thus closing the valve. The atrioventricular **valve cusps are prevented from inverting**, and thus permitting backflow of blood into the atria, because they are tethered to the ventricular floor by the **chordae tendineae and the papillary muscles**.

The closure of the atrioventricular valve cusps is the cause of the first heart sound, "lub".

Structure-function relationship of the **semilunar valves** during ventricular systole:

The same increase in ventricular pressure during ventricular systole forces the semilunar valve cusps against the wall of the efferent vessel, thus opening the semilunar valves.

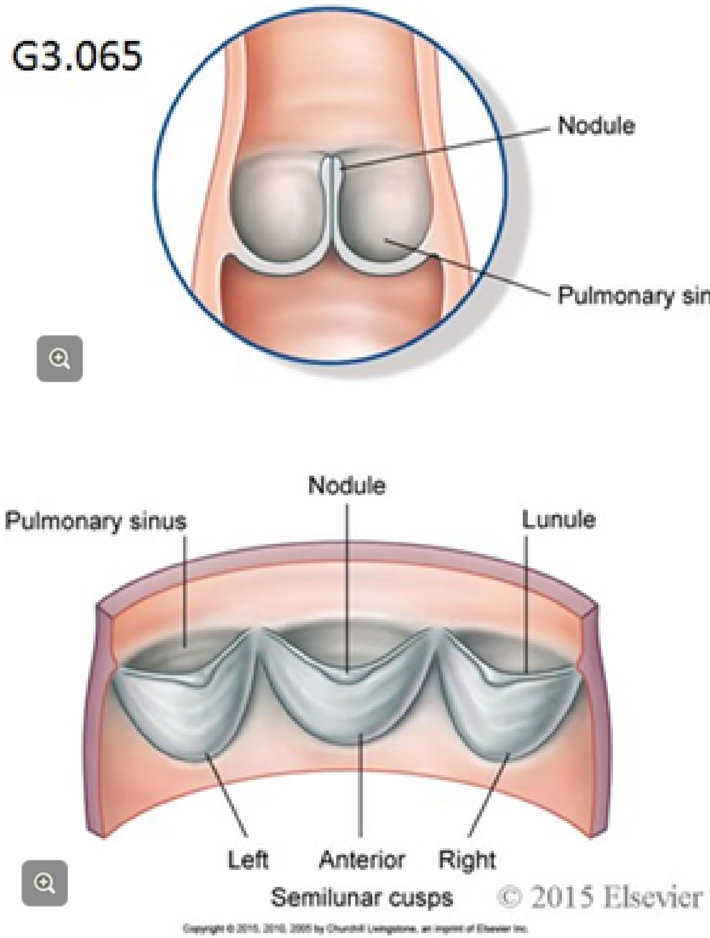


Structure-function relationship of the **semilunar valves** during ventricular diastole:

When the ventricular myocardium **relaxes**, ventricular pressure falls below that of their efferent vessels, the pulmonary trunk and ascending aorta. This **reverses the pressure differential** between these blood filled spaces, favouring the return of blood to the ventricles. However, **blood fills the sinuses of the valve cusps**, forcing them against each other and **closing the valves**. This structure-function relationship prevents the backflow of blood into the ventricles during ventricular diastole.

The closure of the semilunar valve cusps against each other is the cause of the second heart sound, "dub".

Meanwhile, filling of the right and left atria occurs with venous return from the systemic and pulmonary systems, respectively. Contraction of the atrial myocardium forces the atrioventricular valves open and fills the ventricles.



Structure-function relationship of the **semilunar valves** during ventricular diastole:

When the ventricular myocardium **relaxes**, ventricular pressure falls below that of their efferent vessels, the pulmonary trunk and ascending aorta. This **reverses the pressure differential** between these blood filled spaces, favouring the return of blood to the ventricles. However, **blood fills the sinuses of the valve cusps**, forcing them against each other and **closing the valves**. This structure-function relationship prevents the backflow of blood into the ventricles during ventricular diastole.

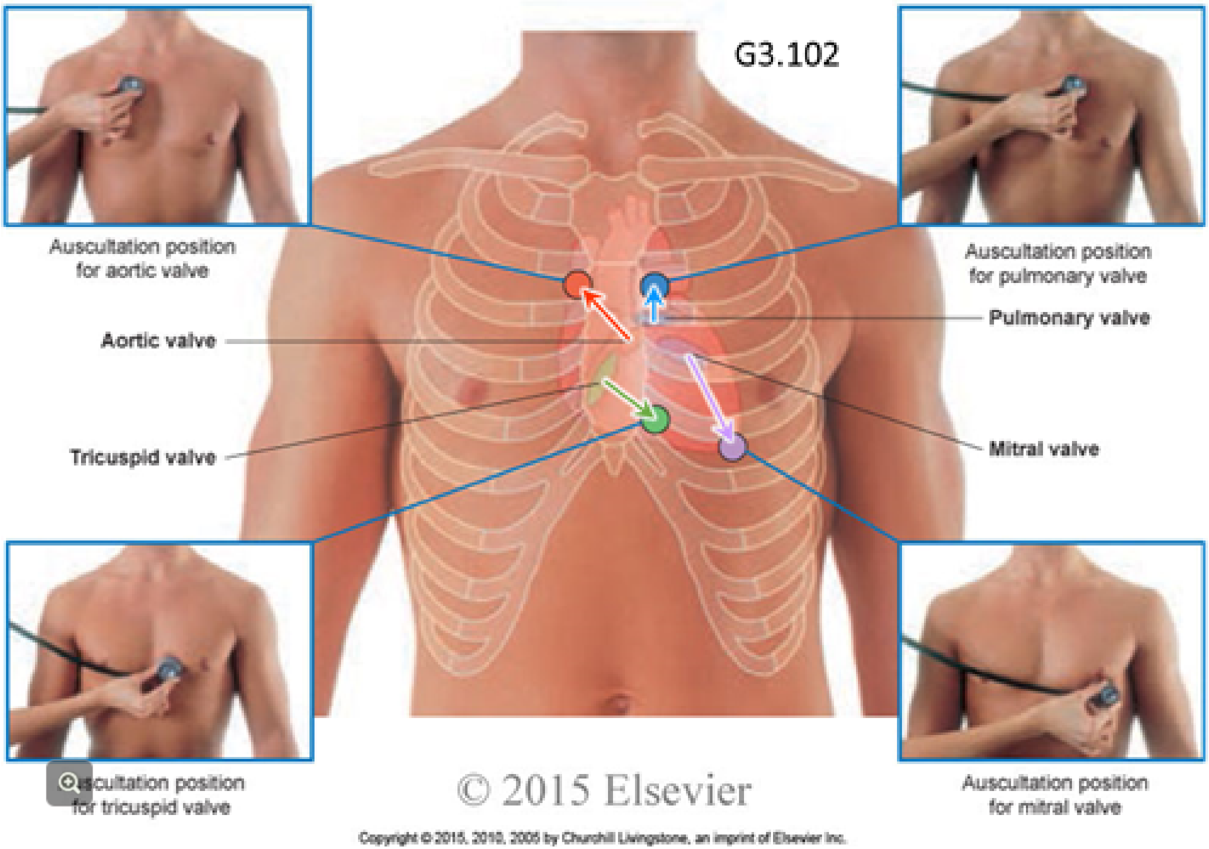
The closure of the semilunar valve cusps against each other is the cause of the second heart sound, "dub".

Meanwhile, filling of the right and left atria occurs with venous return from the systemic and pulmonary systems, respectively. Contraction of the atrial myocardium forces the atrioventricular valves open and fills the ventricles.

I N F O

Auscultation Positions:

Because sound travels in fluid, the sound of a valve closing is carried, and best heard, “downstream”. Thus, the auscultation positions for each valve is located distal to, and not over, the valve being listened to.



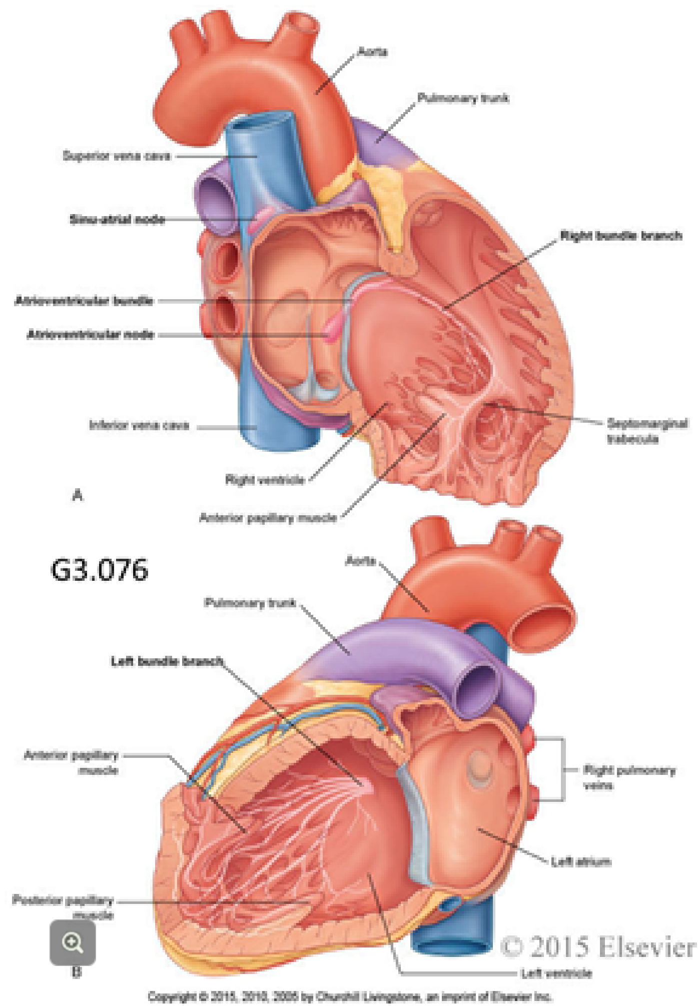
As you learned in the histology eModule on muscle tissue, cardiac muscle is **intrinsically contractile**.; i.e. individual myocardial cells **contract in the absence of neural input**. You'll also recall that electrical impulses travel between adjacent myocardial cells via **gap junctions**.

In order for this intrinsically contractile tissue to do useful work – i.e. to move blood from one chamber to the next – the contraction of the myocardium must be coordinated. This is the function of the the **conducting system of the heart**. It ensures that the two atria contract and empty simultaneously while the ventricles are relaxed, and then that the two ventricles contract and empty simultaneously while the atria are relaxed.

The conducting system of the heart consists of specialized myocardial cells that form the:

- **sinoatrial**, or **SA node**,
- **atrioventricular**, or **AV node**
- **atrioventricular** or **AV bundle**
- **right and left bundle branches**
- **Purkinje fibres**

Signals passing through this system of specialized myocardial cells **coordinates the contraction of the atrial and ventricular myocardium**.

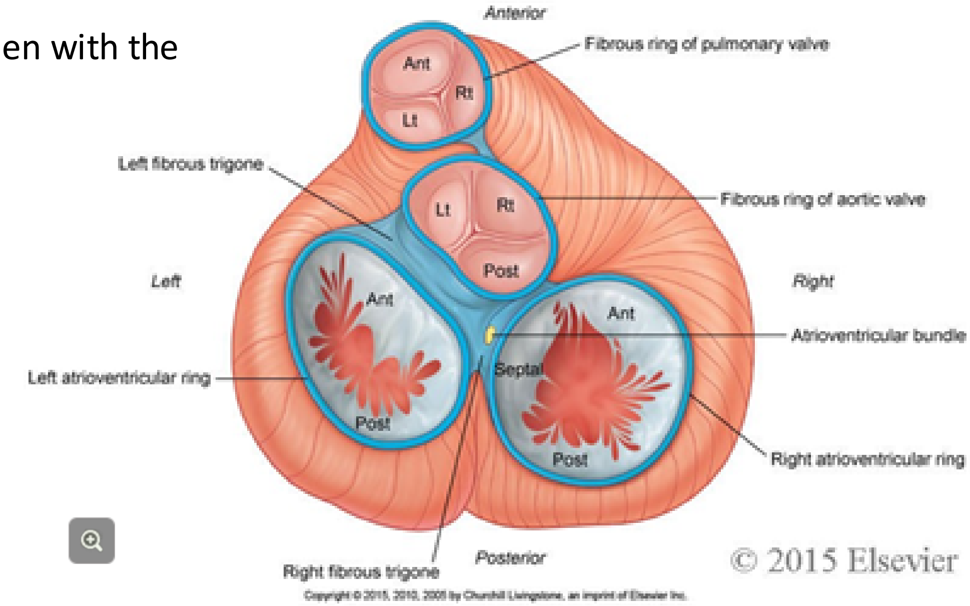


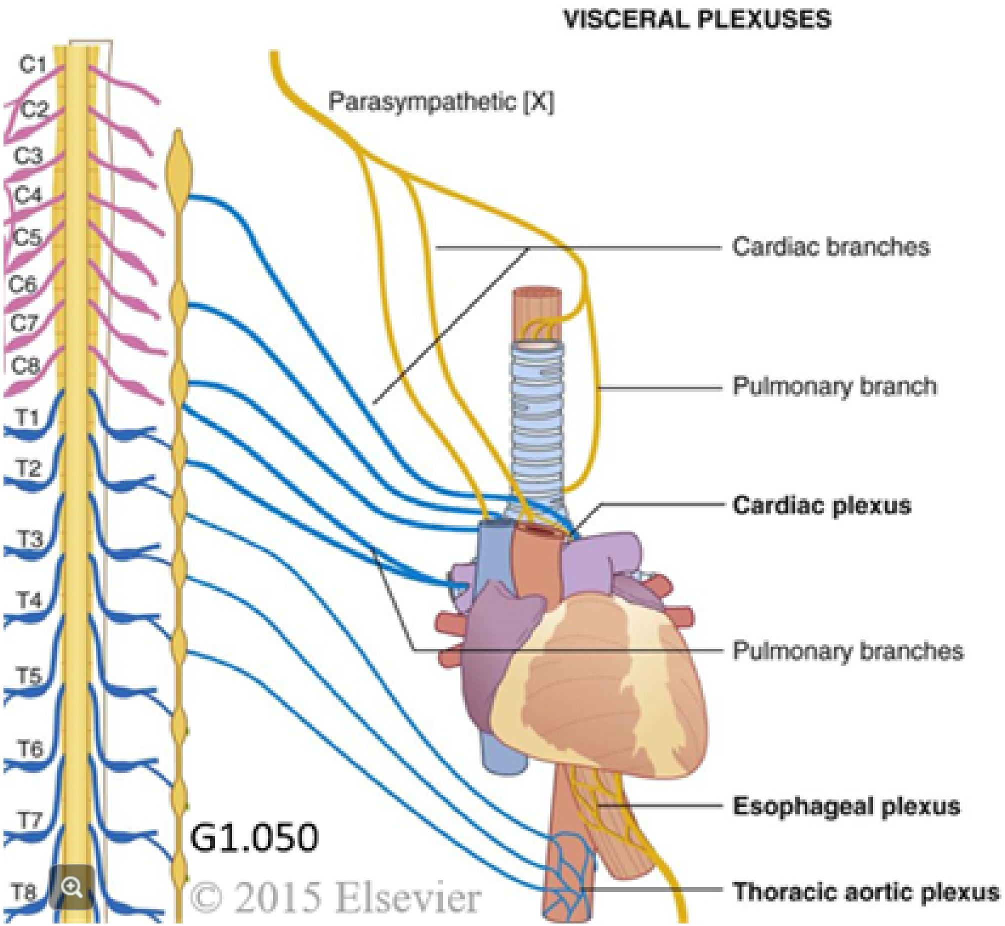
G3.076

However, if myocardial cells are joined by gap junctions, what prevents the spread of electrical signals, and therefore contraction, from the atrial myocardium directly to the ventricular myocardium? Read on….

The fibrous skeleton of the heart is composed of dense connective tissue. It forms fibrous rings around each of the four heart valves. Because dense CT is inextensible, these rings **define the size** of the opening of each valve. The fibrous rings provide **attachment** for the **valve cusps**. They also provides attachment for the **myocardium** of the atrium and that of the ventricles. In addition, it **provides an insulating barrier** between the two, thus **preventing the direct spread of contractile impulses from the myocardium of the atria to that of the ventricles**. Therefore, the contraction of the ventricles must wait for the impulse to arrive from the AV node by way of the AV bundle, which passes through the fibrous skeleton of the heart, as shown below.

The heart valves as seen with the atria removed.



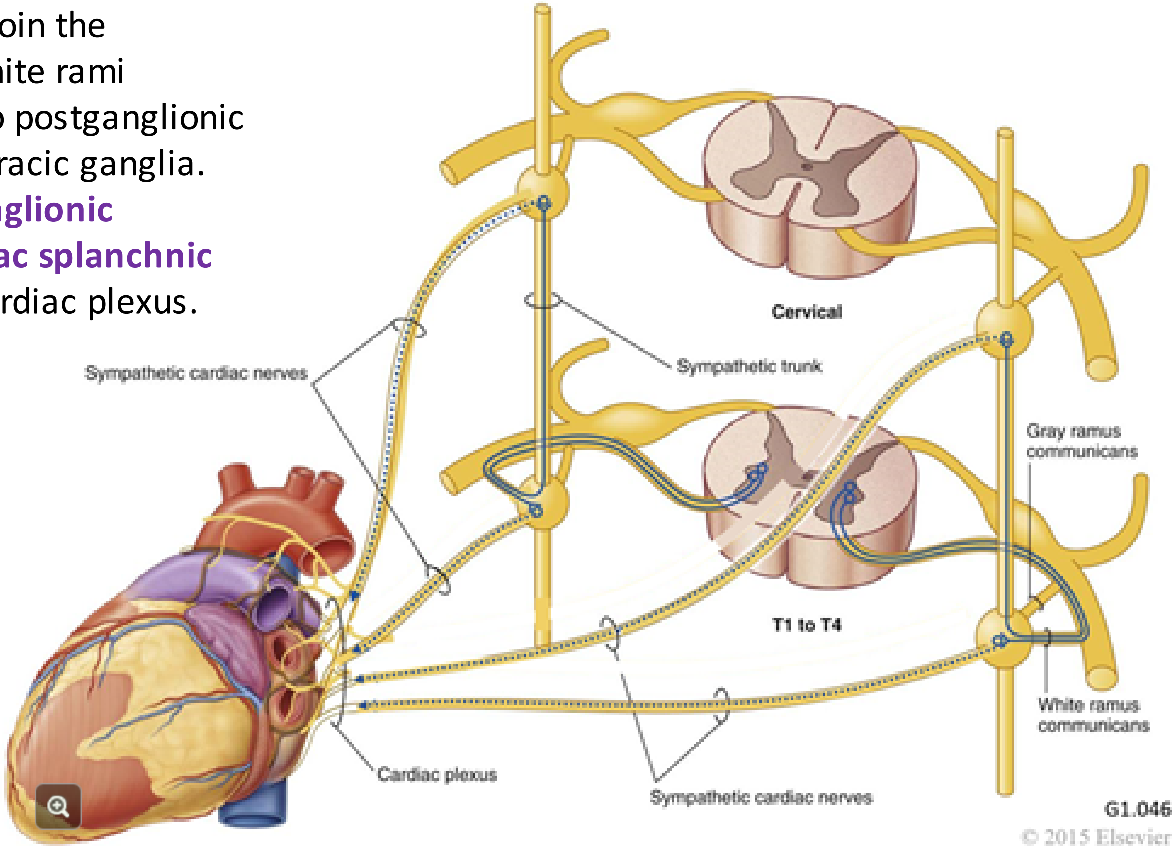


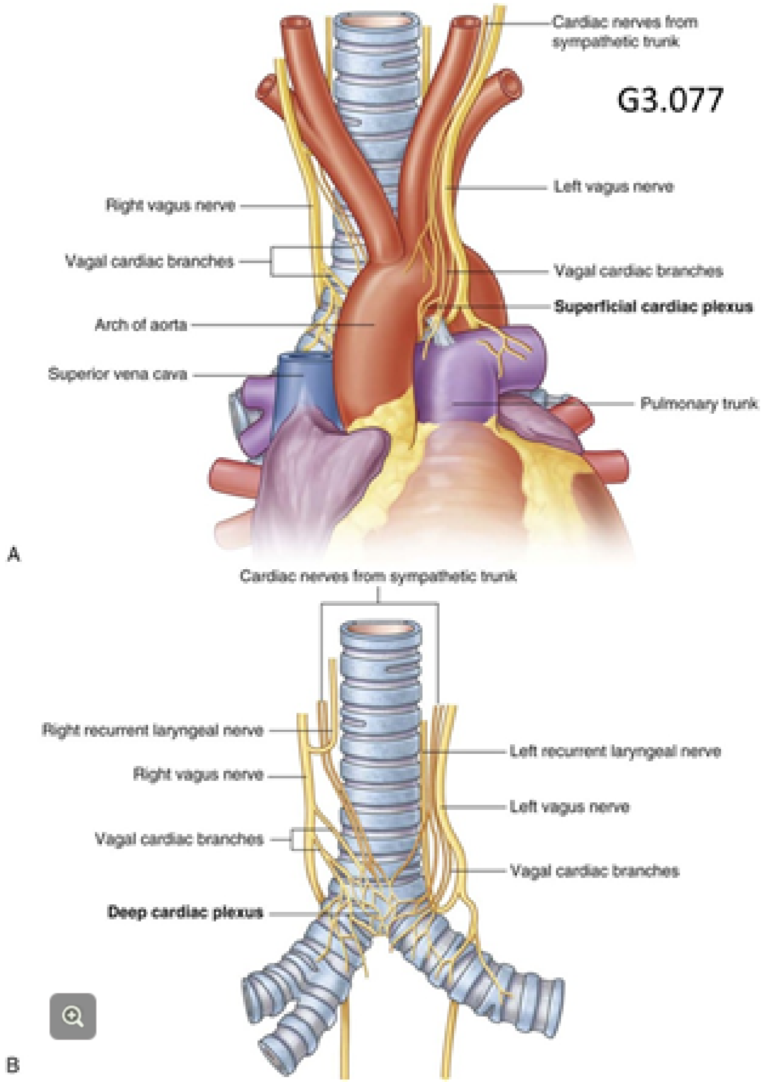
Cardiac myocytes are **intrinsically contractile**; the individual cells contract in the absence of any input. The conducting system **synchronizes this contractile activity**, and therefore ensures that the tissue, and therefore the organ, functions as a coordinated unit to propel blood through the pulmonary and systemic vasculature.

The autonomic nervous system acts as a "volume control"; it regulates the **rate and force** of contraction of the heart, and therefore, **cardiac output**. The sympathetic and parasympathetic divisions of the ANS come together to form the **cardiac plexus.** Nerves arising from the cardiac plexus innervate the components of the conducting system, the myocardium and coronary blood vessels.

Sympathetic activation **increases the rate and force of contraction of the heart**.

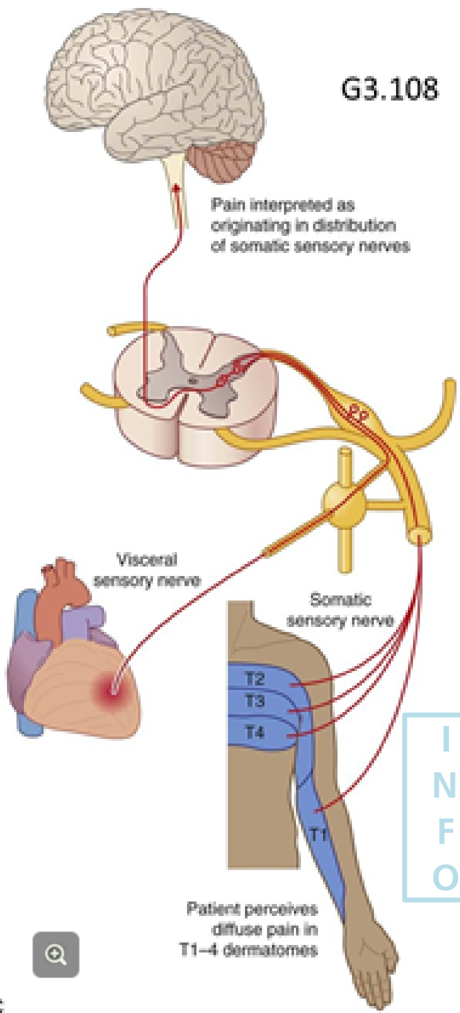
Sympathetic output destined to innervated targets in the face and thorax arises from the upper four or five thoracic spinal levels. Preganglionic fibres destined to innervated the heart join the sympathetic chain through the white rami communicantes and synapse onto postganglionic neurons in cervical and upper thoracic ganglia. Axons arising from these **postganglionic sympathetic neurons** form **cardiac splanchnic nerves** which contribute to the cardiac plexus.





Parasympathetic activation **decreases both heart rate and force of contraction**. In addition, it **constricts coronary arteries**.

Cardiac branches of the vagus nerves join the cardiac plexus. The plexus thus contains a mixture of sympathetic and parasympathetic fibres. It consists of a **superficial part** between the aortic arch and the pulmonary trunk, and a **deep part** between the aortic arch and the tracheal bifurcation. Parasympathetic ganglia containing parasympathetic postganglionic neurons are located both in the plexus and in the walls of the atria.



Sensory fibres from the heart travel with both the vagus nerves and the sympathetic cardiac nerves.

Vagal sensory fibres carry information such as **blood gas and blood pressure** from the aortic body and sinus, respectively. This information returns to the brainstem with the vagus nerves, and **informs cardiac reflex function**.

Sensory fibres traveling with the **sympathetic cardiac nerves carry nociceptive signals** that are interpreted by the CNS as pain. Cardiac nociceptors respond strongly to **ischemia**, as occurs during **myocardial infarction**. These signals travel along sensory fibres in the sympathetic cardiac nerves back to cervical and upper thoracic levels of the sympathetic chain. **Sensory fibres do not synapse in the chain**, but simply pass through on the way back to upper thoracic levels of the spinal cord, from which the sympathetic motor outflow originated. The cell bodies of these sensory fibres are located in **dorsal root ganglia** at these same levels.

INFO

Referred Pain

In the spinal cord, sensory fibres from the heart overlap with sensory fibres reporting nociception from the corresponding dermatomes. The CNS cannot differentiate the sources of the incoming nociceptive signals, and interprets it as coming from body wall. Thus, **cardiac pain refers to the medial arm and upper chest, which are the dermatomes corresponding to the level of sympathetic outflow to the heart**.

Part 2: Introduction to the Upper Limb

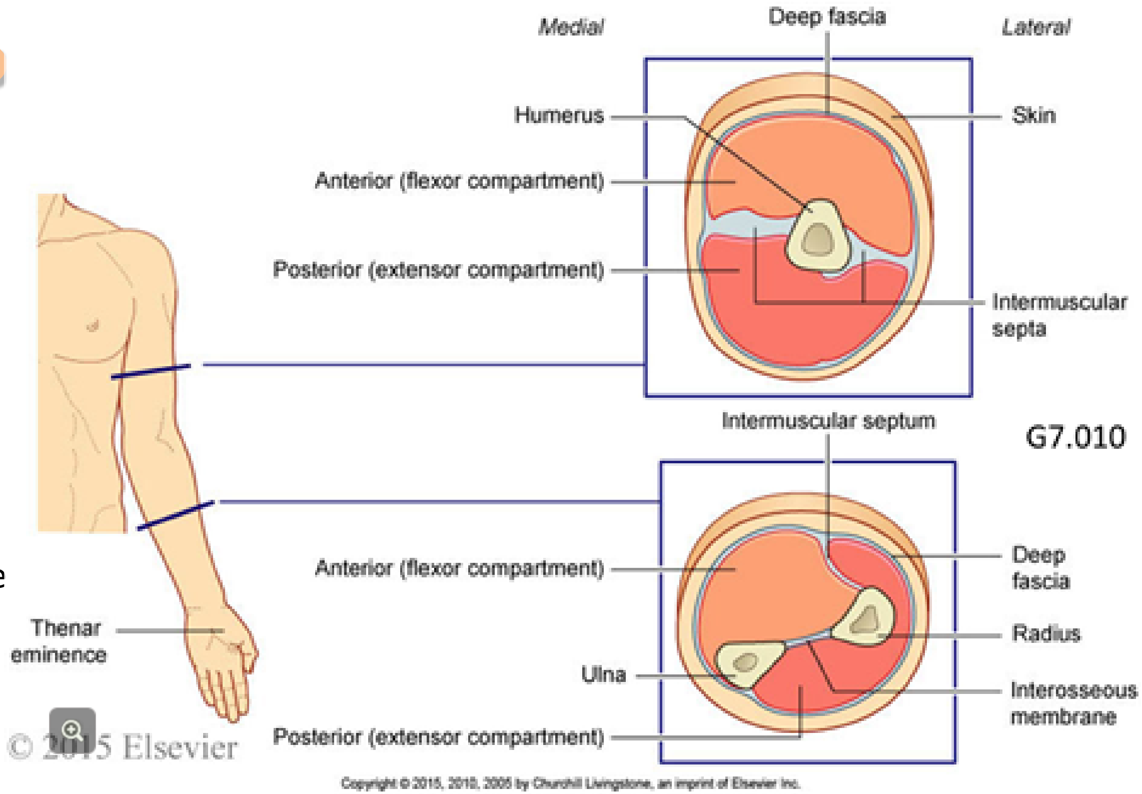
When you have learned the material presented in this exercise, you will be able to describe the:

- deep fascia of the upper limb
- fascial compartments of the upper limb
- superficial veins of the upper limb

As in the rest of the body, deep to the skin of the upper limb is a layer of loose connective tissue (CT) that contains a variable amount of adipose. This is the **superficial fascia** and can also be called the **hypodermis**.

As in the lower limb, the **deep fascia** of the arm forms a sleeve-like structure that encloses its muscles and attaches to bone at joints (shoulder, elbow, wrist, and joints of the hand).

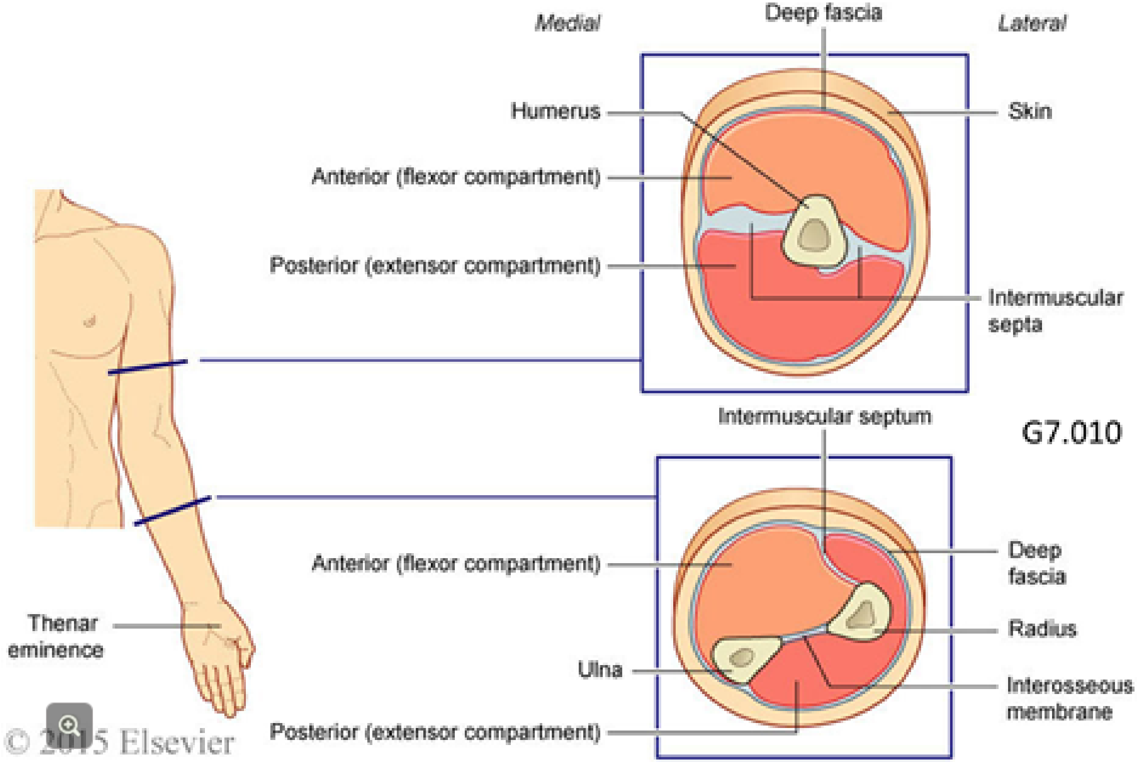
In the upper limb it forms the **brachial fascia** of the arm and the **antebrachial fascia** of the forearm. **Septae** extend from this enveloping fascia to the bones of the limb, creating **compartments** that contain groups of muscles and their nerves, blood vessels and lymphatics. The muscles within a compartment often have common actions and nerve supplies, as you will learn in Unit 5, next September. For now, you will focus on the fascia, fascial compartments and vasculature of the upper limb.



Dense CT intermuscular septae emanating from the **brachial fascia** merge with the periosteum of the humerus to subdivide the arm into **two compartments: anterior** and **posterior**. The muscles in each of these compartments have common actions, with the muscles of the anterior compartment flexing the elbow and the muscles of the posterior compartment extending the elbow.

The radius and ulna are joined by a dense sheet of CT, the **antebrachial interosseous membrane**. In addition, dense CT intermuscular septae emanating from the deep fascia of the forearm, the **antebrachial fascia**, merge with the periosteum of the radius and ulna. These CT structures subdivide the forearm into **two compartments: anterior and posterior**.

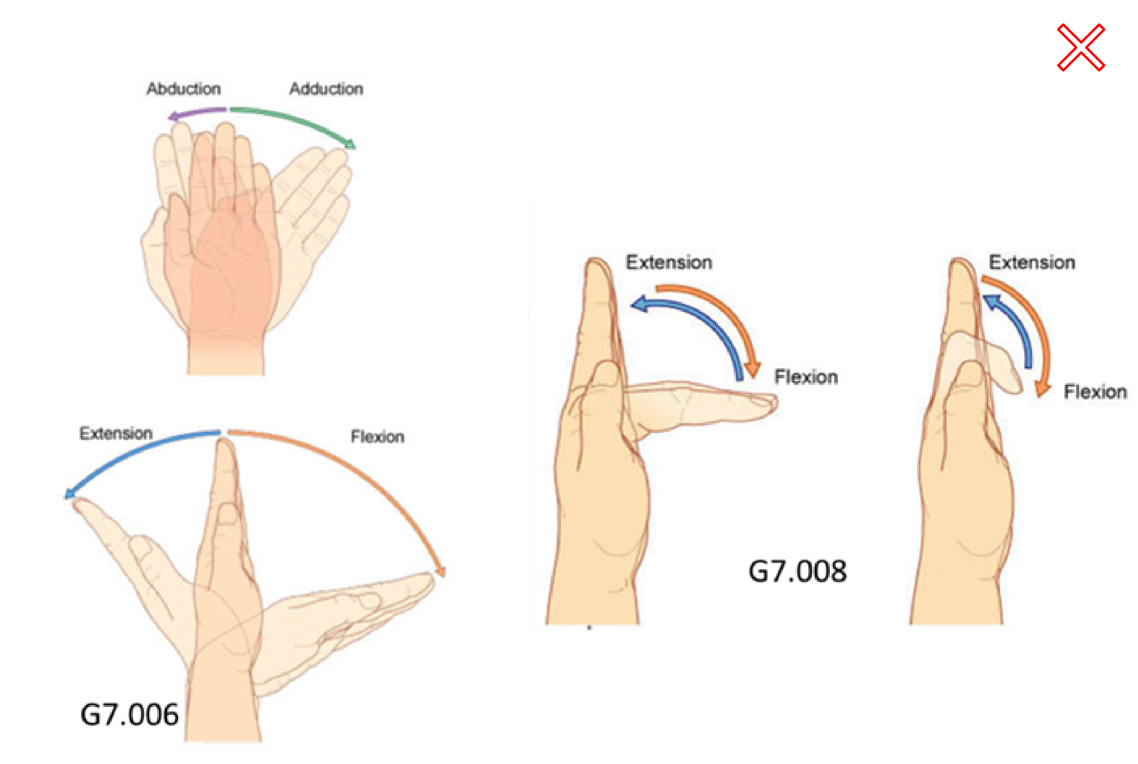
The muscles in each of these compartments have common actions, with the muscles of the anterior compartment **flexing the wrist and joints of the hand** and the muscles of the posterior compartment **extending the wrist and joints of the hand**. Muscles of these compartments work synergistically to adduct and abduct the wrist.



Dense CT intermuscular septae emanating from the **brachial fascia** merge with the periosteum of the humerus to subdivide the arm into **two compartments: anterior** and **posterior**. The muscles in each of these compartments have common actions, with the muscles of the anterior compartment flexing the elbow and the muscles of the posterior compartment extending the elbow.

The radius and ulna are joined by a dense sheet of CT, the **antebrachial interosseous membrane**. In addition, dense CT intermuscular septae emanating from the deep fascia of the forearm, the **antebrachial fascia**, merge with the periosteum of the radius and ulna. These CT structures subdivide the forearm into **two compartments: anterior and posterior**.

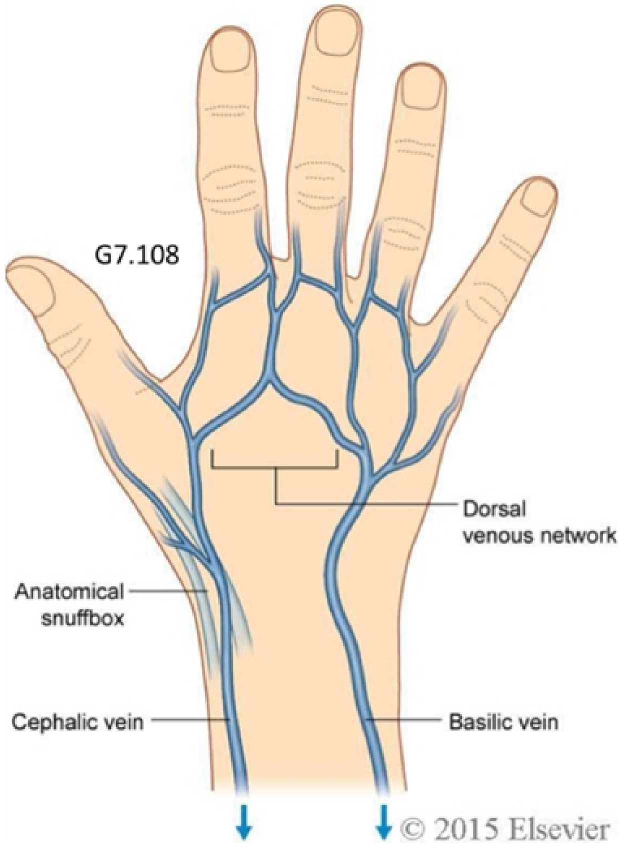
The muscles in each of these compartments have common actions, with the muscles of the anterior compartment **flexing the wrist and joints of the hand** and the muscles of the posterior compartment **extending the wrist and joints of the hand**. Muscles of these compartments work synergistically to adduct and abduct the wrist.



As you know, there are two sets of veins in the body, deep and superficial. Deep veins accompany arteries, usually with the same name. Superficial veins have no accompanying arteries. In the arm, deep veins are located, with their companion arteries, within the fascial compartments amongst the muscles, while **superficial veins** run in the loose, **superficial fascia** of the upper limb. **Shunting of blood between the two sets of veins functions in temperature regulation**. The greater the volume of blood returning to the heart via the superficial veins, the greater the heat loss, and vice versa.

Superficial veins of the arm end by draining into deep veins. The deep veins then ultimately drain into the SVC, thus returning venous blood to the right atrium.

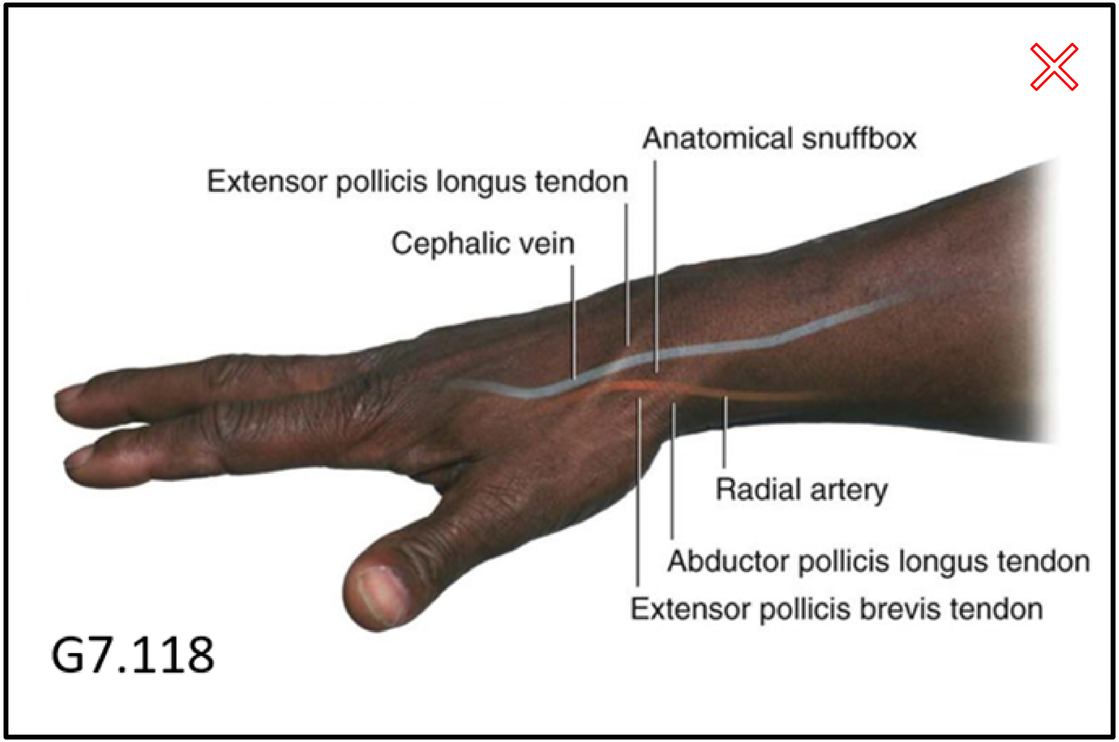
The **dorsal venous arch** collects blood from the hand and drains it proximally, toward the heart. The dorsal venous arch leads medially to the **basilic vein**, and leads laterally to the **cephalic vein**.

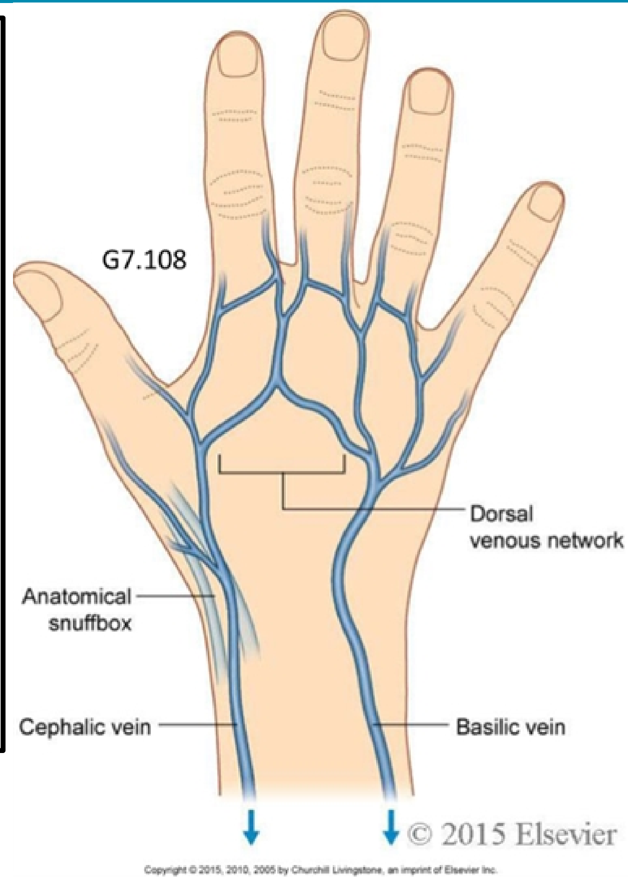


INFO

Venipuncture

The cephalic vein passes through the **anatomical snuffbox**, a landmark on the dorsolateral aspect of the wrist defined by the tendons of muscles that position the thumb. The cephalic vein is easily found here, particularly with venous distention following application of a tourniquet. This vein is a common site of short-term venous cannulation.





INFO

Venipuncture

The cephalic vein passes through the **anatomical snuffbox**, a landmark on the dorsolateral aspect of the wrist defined by the tendons of muscles that position the thumb. The cephalic vein is easily found here, particularly with venous distention following application of a tourniquet. This vein is a common site of short-term venous cannulation.

After passing through the anatomical snuffbox, the **cephalic vein** ascends along the **lateral** aspect of the arm. Ultimately, the cephalic vein runs in the groove between the deltoid and pectoralis major muscles (the "**deltopectoral groove**") and ends at the **deltopectoral** (clavipectoral) **triangle.** At the clavicle, the cephalic vein **pierces the deep fascia** and unites with the axillary vein, thus forming the **subclavian vein**.

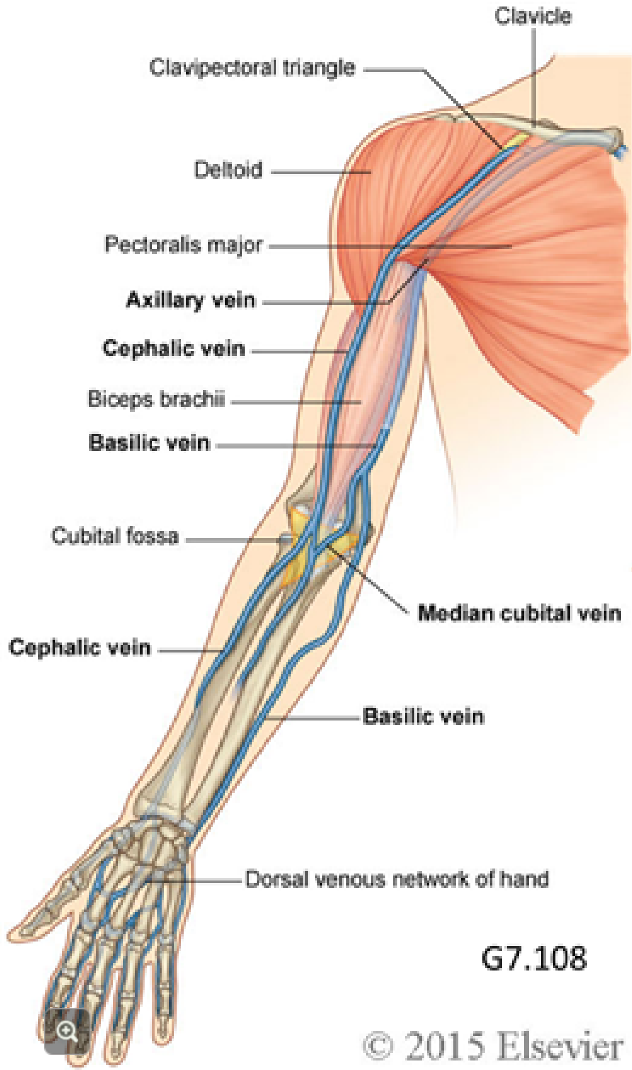
From the dorsal venous arch, the **basilic vein** ascends along the **medial** aspect of the forearm. It crosses the medial aspect of the elbow, and about midway between the elbow and the shoulder, it **pierces the brachial fascia**.

When the basilic vein pierces the brachial fascia it unites with the **brachial veins**, the deep veins of the arm. When this deep vein, thus formed, passes into the axilla, it becomes the **axillary vein**.

INFO

The Median Cubital Vein

The **cubital fossa** is the region anterior to the elbow. The **median cubital vein** is a superficial vein that joins the cephalic and basilic veins. It is a common site of phlebotomy.



After passing through the anatomical snuffbox, the **cephalic vein** ascends along the **lateral** aspect of the arm. Ultimately, the cephalic vein runs in the groove between the deltoid and pectoralis major muscles (the "**deltopectoral groove**") and ends at the **deltopectoral** (clavipectoral) **triangle.** At the clavicle, the cephalic vein **pierces the deep fascia** and unites with the axillary vein, thus forming the **subclavian vein**.

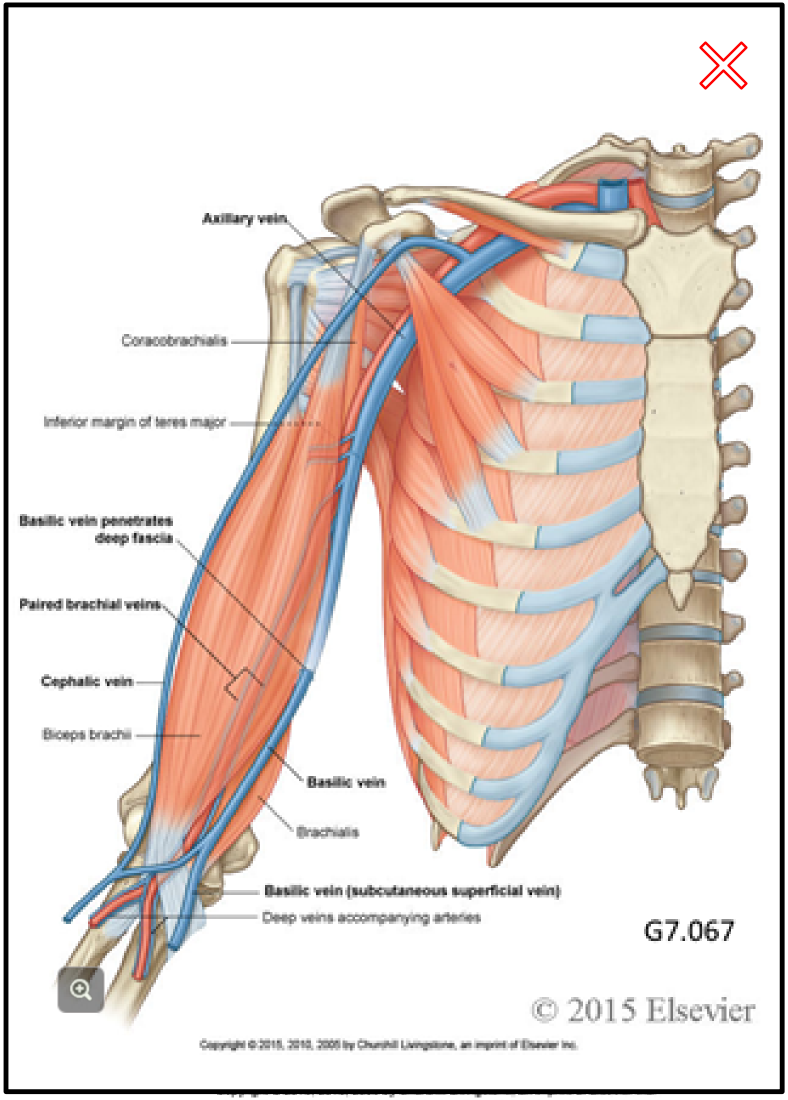
From the dorsal venous arch, the **basilic vein** ascends along the **medial** aspect of the forearm. It crosses the medial aspect of the elbow, and about midway between the elbow and the shoulder, it **pierces the brachial fascia**.

When the basilic vein pierces the brachial fascia it unites with the **brachial veins**, the deep veins of the arm. When this deep vein, thus formed, passes into the axilla, it becomes the **axillary vein**.

INFO

The Median Cubital Vein

The **cubital fossa** is the region anterior to the elbow. The **median cubital vein** is a superficial vein that joins the cephalic and basilic veins. It is a common site of phlebotomy.



After passing through the anatomical snuffbox, the **cephalic vein** ascends along the **lateral** aspect of the arm. Ultimately, the cephalic vein runs in the groove between the deltoid and pectoralis major muscles (the "**deltopectoral groove**") and ends at the **deltopectoral** (clavipectoral) **triangle.** At the clavicle, the cephalic vein **pierces the deep fascia** and unites with the axillary vein, thus forming the **subclavian vein**.

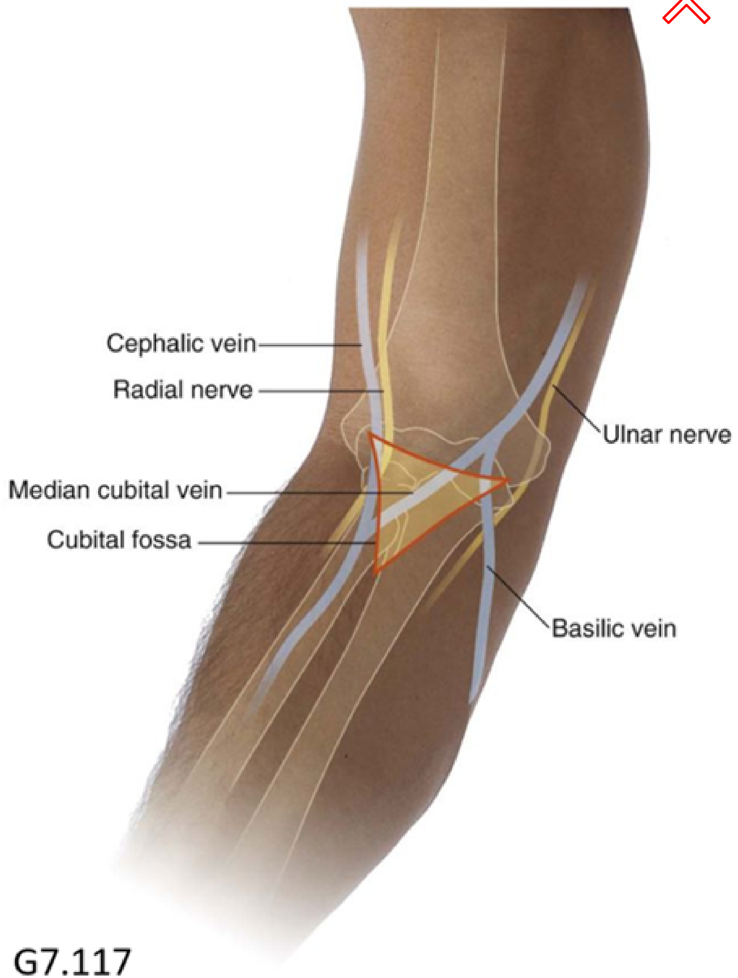
From the dorsal venous arch, the **basilic vein** ascends along the **medial** aspect of the forearm. It crosses the medial aspect of the elbow, and about midway between the elbow and the shoulder, it **pierces the brachial fascia**.

When the basilic vein pierces the brachial fascia it unites with the **brachial veins**, the deep veins of the arm. When this deep vein, thus formed, passes into the axilla, it becomes the **axillary vein**.

INFO

The Median Cubital Vein

The **cubital fossa** is the region anterior to the elbow. The **median cubital vein** is a superficial vein that joins the cephalic and basilic veins. It is a common site of phlebotomy.



G7.117

8.1 The Heart Internal

What you'll need:

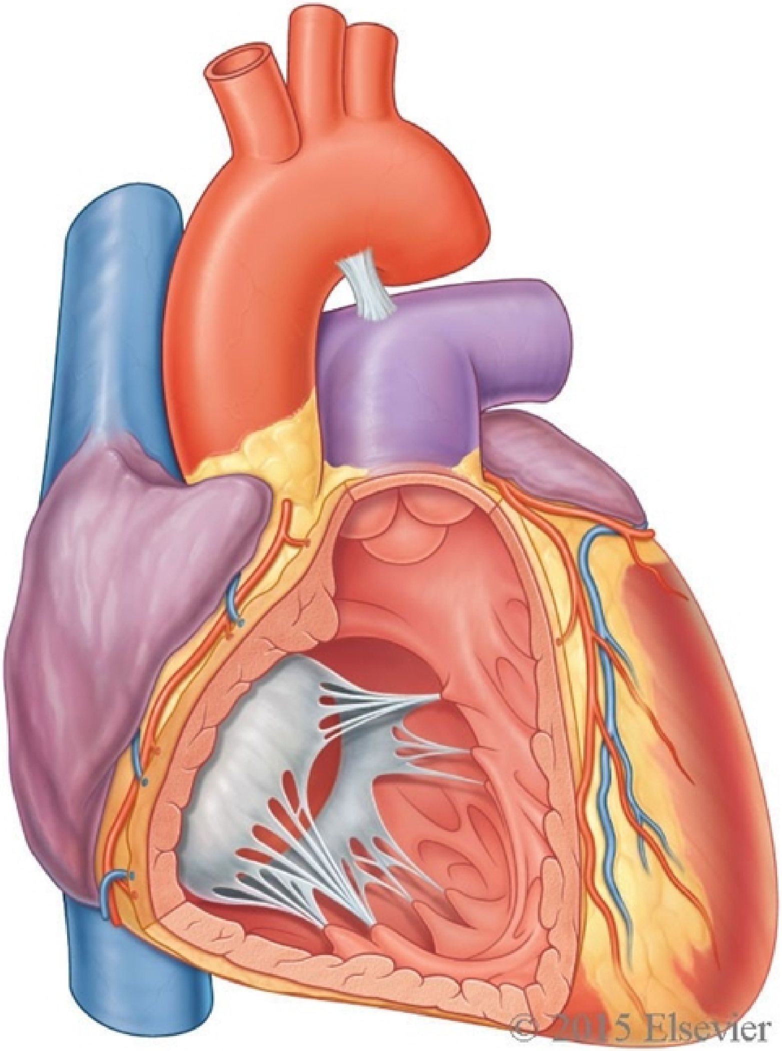
SPECIMENS

- Open heart model
- All cadaver 2 hearts

8.1 Objectives

When you have learned the material presented in this exercise, you will be able to:

- Identify the surfaces of the heart and the chambers that make up each
- identify and describe the internal features of the atria and ventricles.
- identify and describe the features of the atrioventricular and semilunar valves.
- identify and describe the locations of the components of the conducting system of the heart.



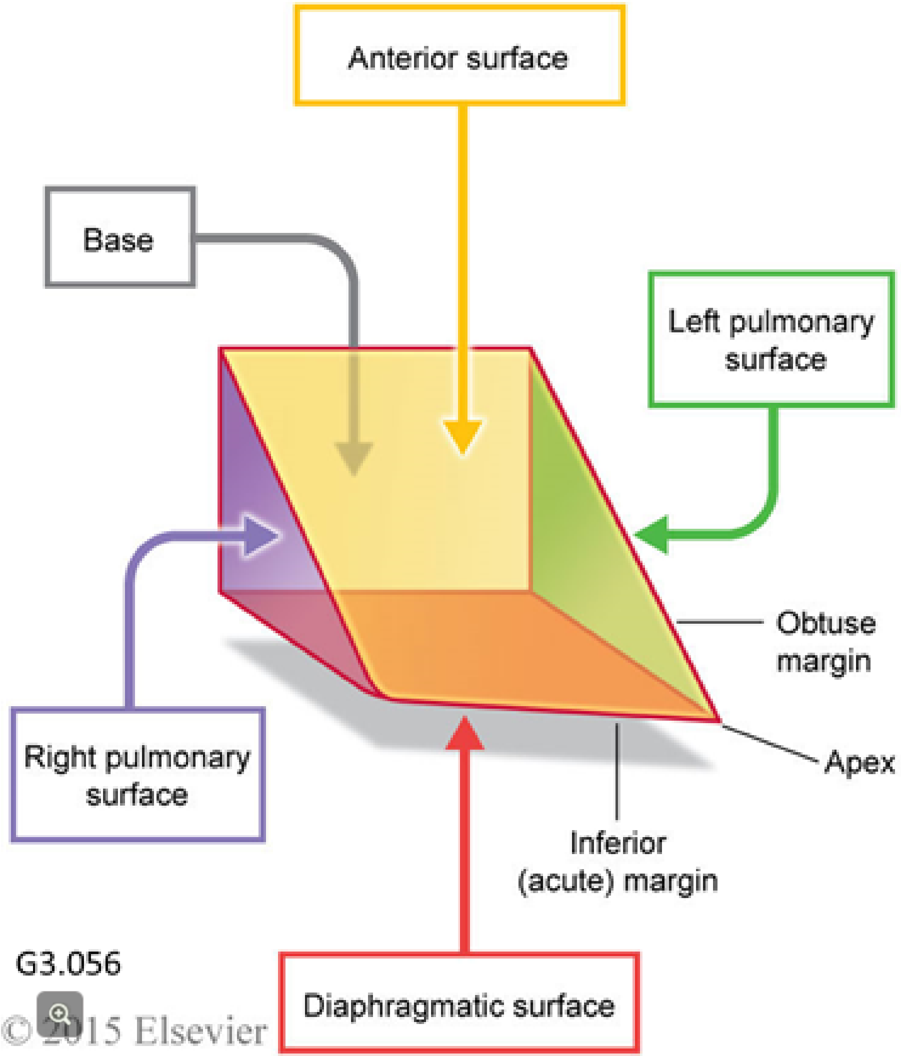
When you left the thorax of cadaver 2 at the end of Unit 1, you had opened the pericardial sac and explored the heart *in situ*. You will now remove the heart from the pericardial sac so that you can dissect it and study its internal features.

Recall that the heart has an apex, a base, anterior and diaphragmatic surfaces and right and left pulmonary surfaces.

T A S K

IDENTIFY:

these surfaces on the model of the heart.

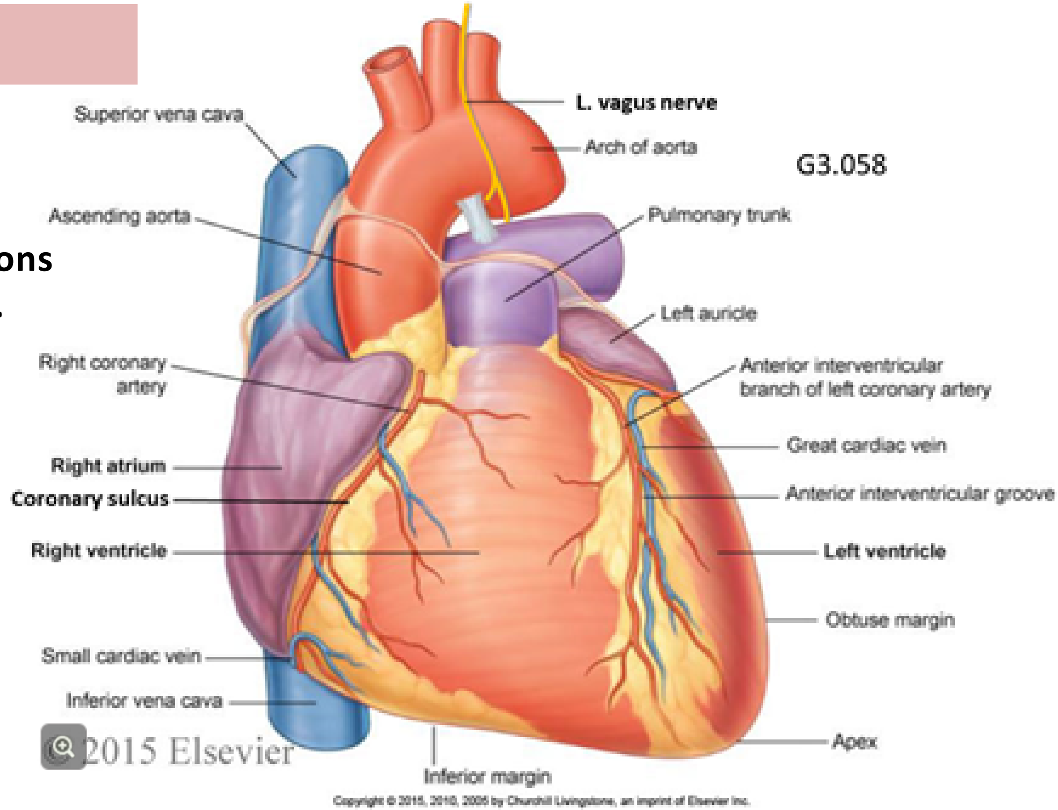


G3.056

T A S K

LOOK at the heart *in situ*

and confirm the structures that make up the anterior surface of the heart: they are largely the right ventricle, with flanking contributions from the right atrium and left ventricle.



Slip your hand inferior to the heart and feel its diaphragmatic surface; tip it upward to confirm that it consists largely of the left ventricle, with a lesser contribution from the right ventricle.

Slip your hand between the right margin of the heart and the pericardial sac and confirm that this border is made up of the right atrium.

Slip your hand between the left margin of the heart and the pericardial sac and confirm that this border is made up of the left ventricle.

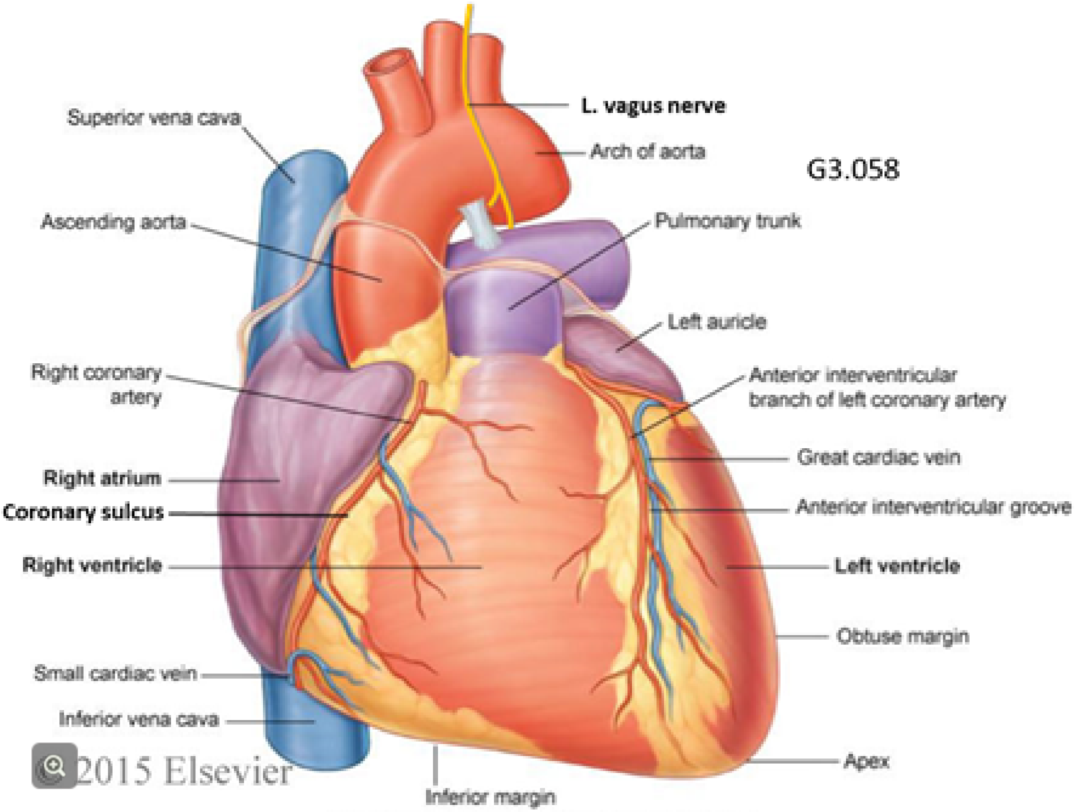
T A S K

LOOK at the heart *in situ*

The **superior border** of the heart aligns with the site of entry / exit if the great vessels, and with the superior border of the right and left atria and their appendages (auricles).

You cannot directly view the posterior border (base) of the heart, but slip your hand behind it and realize that it consists largely of the left atrium with a contribution from the right atrium and great vessels.

Lastly, notice the position of the apex of the heart: it is normally in the left fifth intercostal space in the midclavicular line.



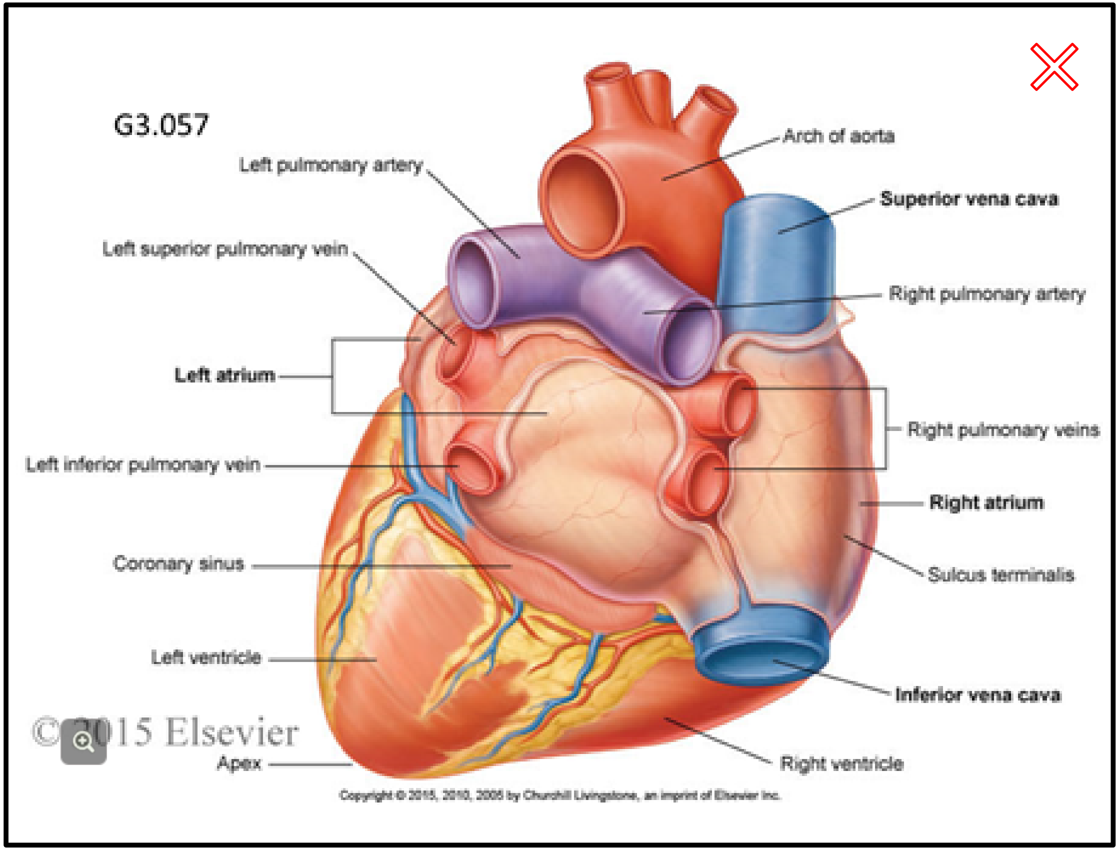
TASK

LOOK at the heart *in situ*

The **superior border** of the heart aligns with the site of entry / exit if the great vessels, and with the superior border of the right and left atria and their appendages (auricles).

You cannot directly view the posterior border (base) of the heart, but slip your hand behind it and realize that it consists largely of the left atrium with a contribution from the right atrium and great vessels.

Lastly, notice the position of the apex of the heart: it is normally in the left fifth intercostal space in the midclavicular line.



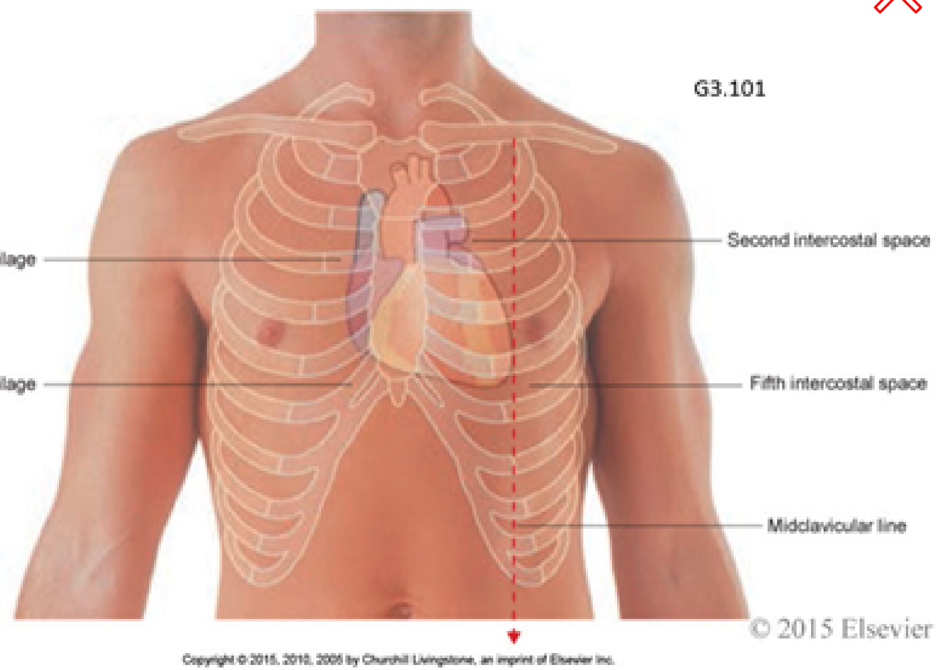
TASK

LOOK at the heart *in situ*

The **superior border** of the heart aligns with the site of entry / exit if the great vessels, and with the superior border of the right and left atria and their appendages (auricles).

You cannot directly view the posterior border (base) of the heart, but slip your hand behind it and realize that it consists largely of the left atrium with a contribution from the right atrium and great vessels.

Lastly, notice the position of the apex of the heart: it is normally in the left fifth intercostal space in the midclavicular line.



Remember that the **pericardial sac** consists of **two, fused layers**: an outer **fibrous layer of the parietal pericardium** and an inner **serous layer of the parietal pericardium**. The fibrous layer is continuous with the outermost, CT layer of blood vessels, the tunica adventitia, and the serous layer of the parietal pericardium reflects onto the heart to be continuous with the visceral layer of the serous pericardium. The **visceral layer** of the serous pericardium is **synonymous with the epicardium**, encountered when one studies the histology of the heart.

TASK

RUN your finger

over the surface of the heart and confirm that when you meet the limit of the pericardial cavity, the visceral layer of the serous pericardium reflects onto the inner surface of the pericardial sac to become the parietal layer of the serous pericardium. Realize that the pericardial cavity is a potential space, normally containing only a capillary layer of serous fluid that acts to lubricate the movement of the heart relative to the pericardial sac.

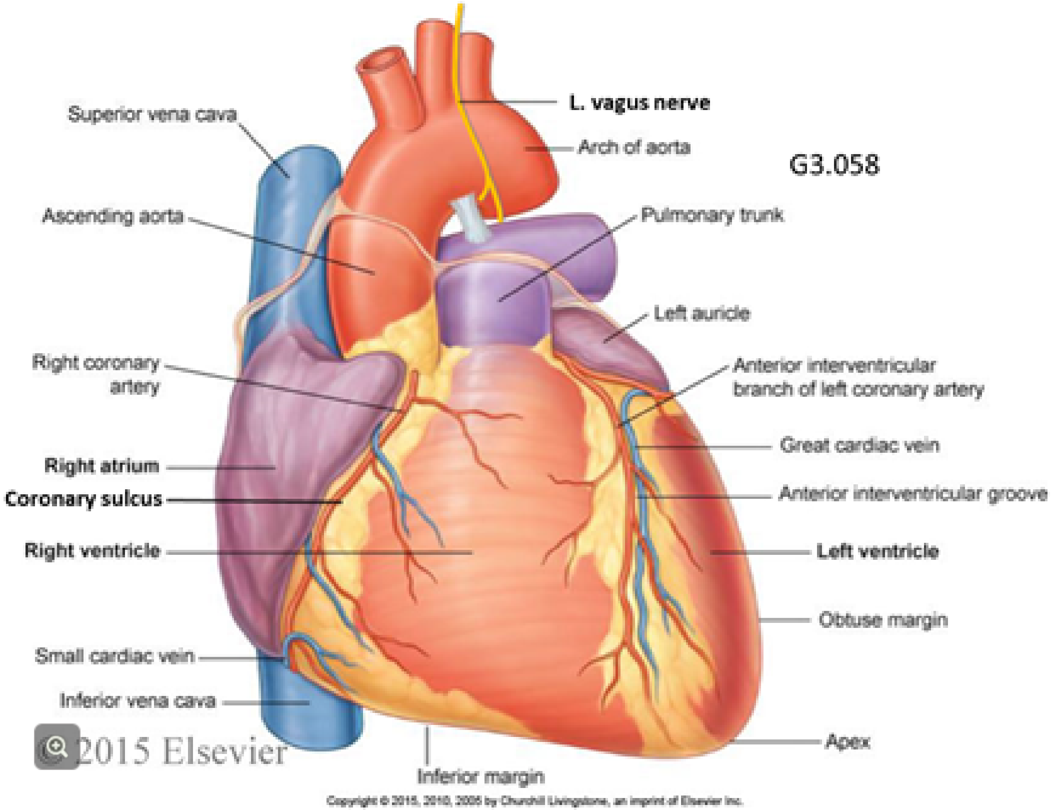
TASK

Start by IDENTIFYING

the following structures on the model from the anterior aspect, and on the heart *in situ*:

- the superior vena cava,
- the ascending aorta,
- the arch of the aorta, and
- the pulmonary trunk.

On the cadaver, slip your finger between the aortic arch and the pulmonary trunk and identify the ligamentum arteriosum i.



Lateral to the ligamentum arteriosum, identify a thick cord crossing the arch of the aorta; this is the left vagus nerve. Using a blunt probe, release the vagus nerve from overlying tissue and identify its recurrent branch, passing under the arch of the aorta to recur upward to the neck and larynx. The main trunk of the left vagus nerve continues distally, posterior to the root of the lung. **Do not dissect the vagus nerve any further at this time.**

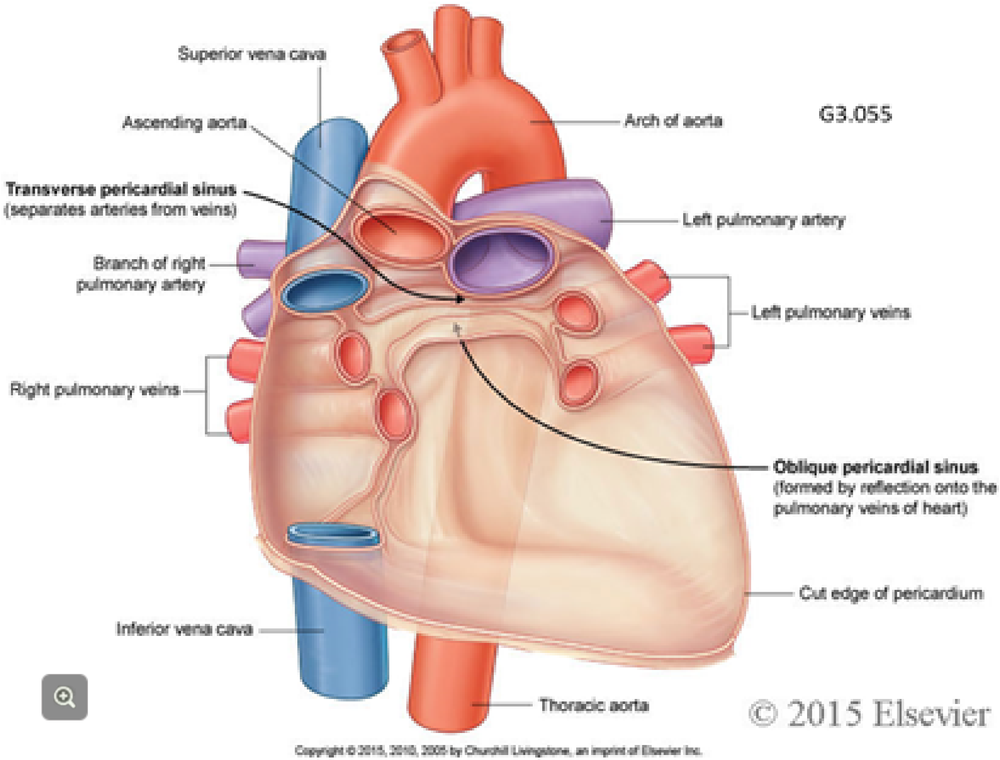
T A S K

In PREPARATION for

removing the heart, establish the limits of the pericardial sac, which will determine your incisions.

Slip one hand posterior to the heart and slide it superiorly; you will encounter a dead-end. This is the **oblique pericardial sinus**; realize that it is **bounded on the right by the IVC and superiorly by the pulmonary veins**.

Next, slide your left index finger between the SVC and the ascending aorta and push it to the (cadaver's) left until it emerges between the pulmonary trunk and the left atrial appendage. Your finger is in a serous-lined tunnel, the transverse pericardial sinus.



The formation of the sinuses will become clear upon learning the development of the heart.

Lastly, with your fingers, explore the limits of the pericardial cavity where visceral pericardium covering the great vessels reflects onto the inner surface of the pericardial sac.

TASK

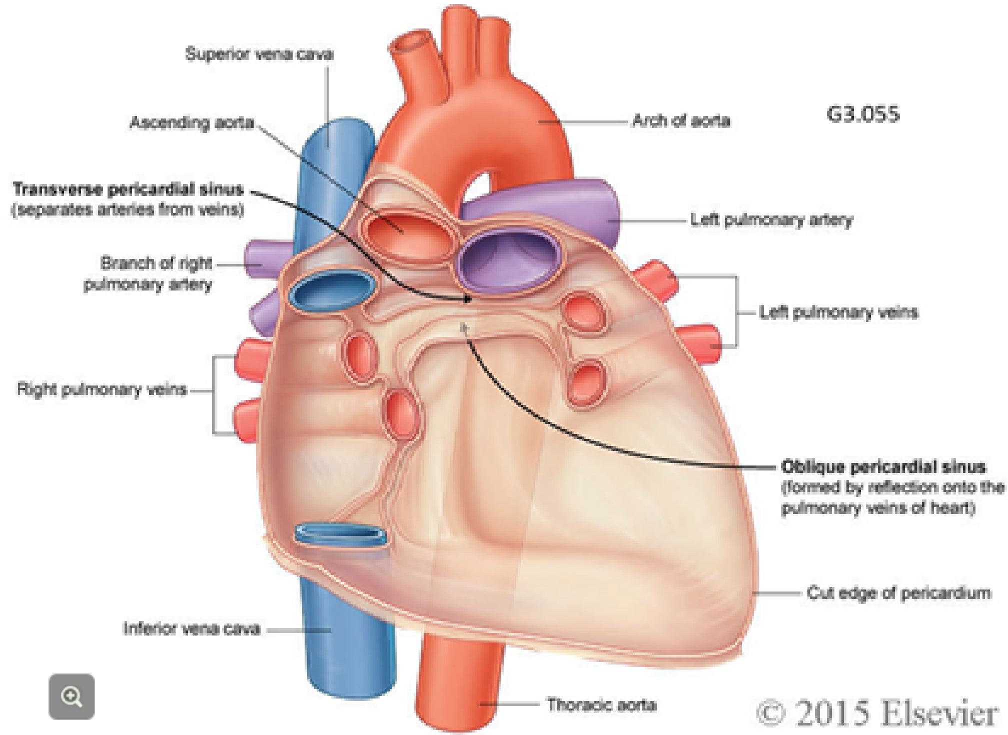
SLIDE a probe

through the transverse pericardial sinus. Insert the blunt end of large scissors through the sinus, anterior to the probe, and cut through the pulmonary trunk and ascending aorta, leaving a 1 cm stump of these vessels attached to the heart.

Continue to work with large scissors.

Cut through the SVC, leaving a 1 cm stump of the vessel attached to the right atrium.

Lift the diaphragmatic surface of the heart to stretch the IVC and cut through it close to the point where it passes through the diaphragm.



Now that the heart is free from the diaphragm, lift it further and feel the margins of the oblique sinus formed by the pulmonary veins. Cut through the pulmonary veins close to the pericardial sac. All vessels having now been cut, it remains only to cut the reflections of serous membrane that hold the heart in place, and remove it.

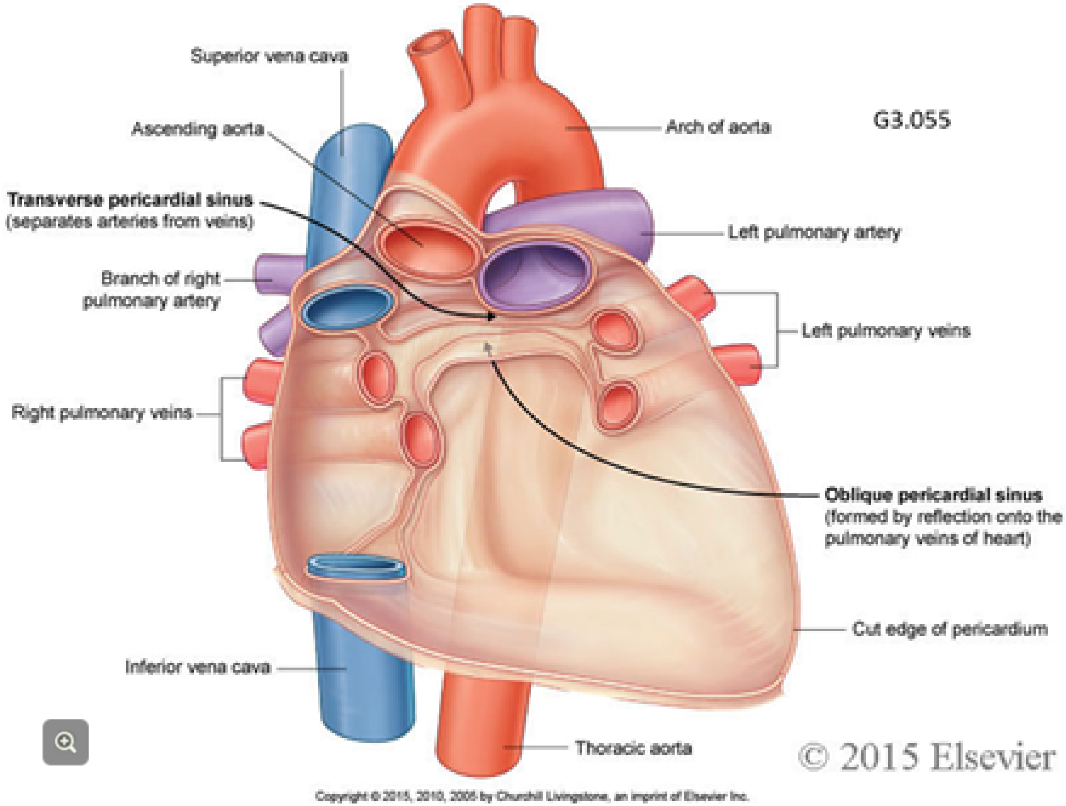
T A S K

COMPARE the posterior surface of the pericardial sac to the diagram provided.

Identify the openings of the vessels you have transected and the lines of pleural reflection. Moisten your cadaver, cover it with damp cloths and close the body bag while you proceed to dissect the heart.

The four pairs working on this exercise should gather together at one table so that they can share and study all four hearts being dissected.

The four chambers of the heart will be opened, the contained clotted blood will be removed, and the internal features will be studied. Be warned that the clotted blood will be quite hard, and you may need to break it up in order to remove it.



Since embarking on this exercise, you have **identified** the following structures and learned the **answers to the following questions**:

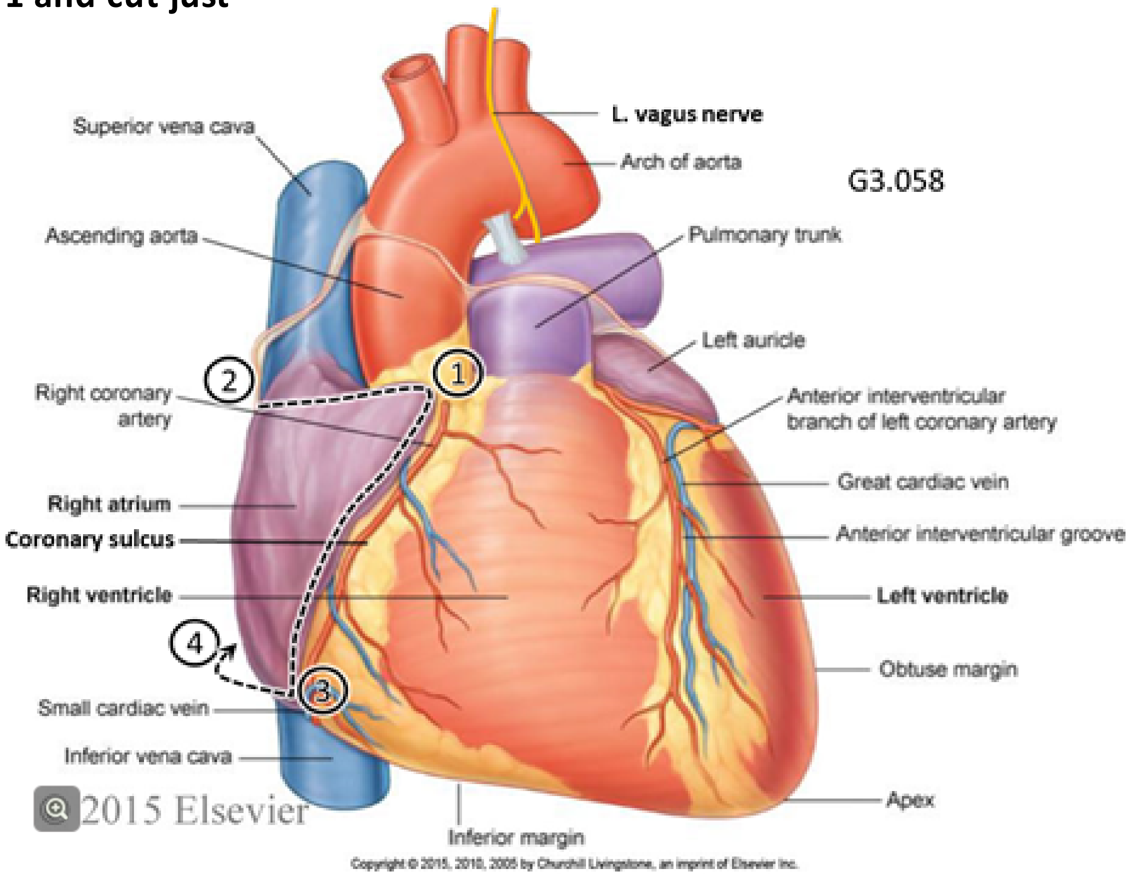
- Name / identify the chambers that make up the various surfaces of the heart: its anterior surface, its posterior surface (base), its inferior (diaphragmatic) surface, its right and left margin. What structures define its superior border?
- Identify and name the layers that form the pericardial sac. What is the histological composition of each? Identify the visceral layer of the serous pericardium. What is its synonym, used when describing the layers of the heart? What occupies the pericardial cavity in life? What is its purpose?
- Identify the superior vena cava, arch of the aorta, pulmonary arteries, ligamentum arteriosum, left vagus nerve and its recurrent branch.
- In the cadaver, in the remnants of the pericardial sac, identify the openings of the IVC, SVC, aorta, pulmonary trunk and pulmonary veins.

If you are satisfied with your **ability to identify these structures** and **answer these questions**, call your TA over for confirmation and for **permission to move on** to the next stage of the exercise.

TASK

INSERT the tips of large scissors into the tip of the right auricle at 1. Cut horizontally across the junction of the SVC to the atrium to 2. Insert your scissors again at 1 and cut just shy of the coronary sulcus until you meet the IVC at 3. Turn your scissors, and cut horizontally across the junction of the IVC, around the back, to 4. Reflect the flap of the atrial wall, remove the blood clots with forceps.

G3.058



TASK

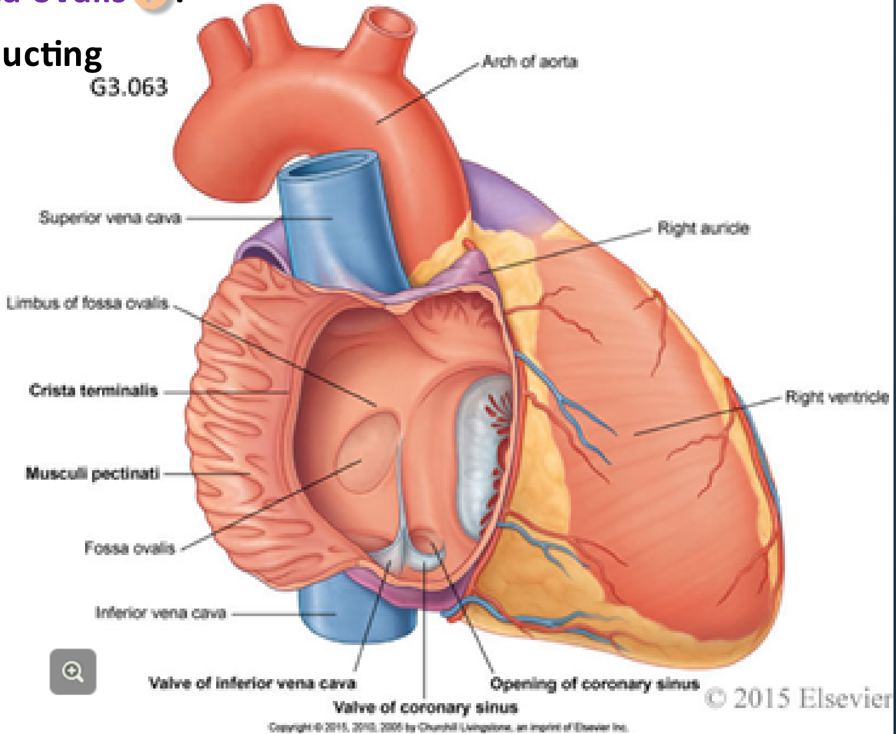
Look inside the right atrium and OBSERVE

that it has two distinctly different internal surfaces: one portion of the atrium has a very smooth surface, while the other is very rough in texture. This reflects development of the atrium from two separate embryologic tubes, one, the sinus venosus, which ultimately formed the venae cavae, and the other which ultimately formed the walls of the heart. **With reference to the accompanying diagram, identify the pectinate muscles, the crista terminalis, the opening of the SVC, the opening of the IVC, the opening of the coronary sinus, and the fossa ovalis.**

Note the locations of the components of the conducting system of the heart within the right atrial wall:

- **the sinoatrial (SA) node is located at the superior tip of the crista terminalis where it meets the SVC.** Impulses that originate at the SA node spread through the myocardium of both atria, thus triggering atrial systole.
- **the atrioventricular (AV) node is located in the interatrial septum, superior to the opening of the coronary sinus.** The impulse from the SA node arrives at the AV node, where it is delayed by the electrical properties of this group of cells. **This delay permits the atria to complete their emptying before the onset of ventricular systole.**

G3.063



You will use your fingers to explore the inside of the right ventricle and determine, by feel, the correct place to make the cuts through the wall of this chamber using your large scissors.

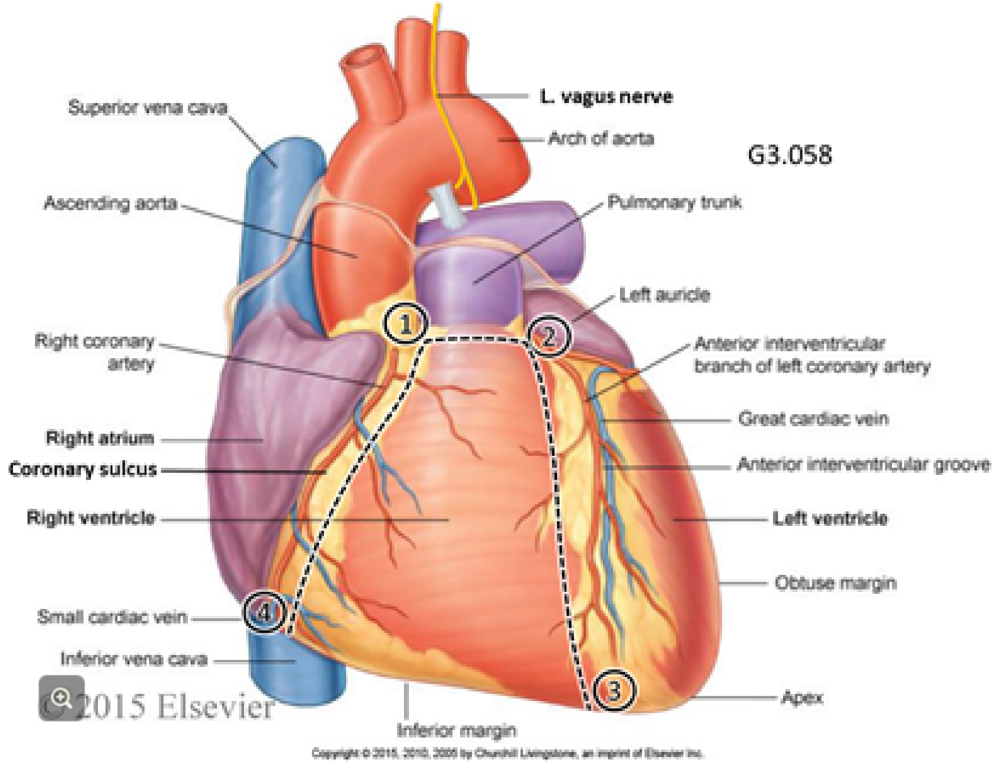
TASK

INSERT an index finger through the pulmonary trunk and locate the pulmonary semilunar valve. Proceed with caution; do not damage the semilunar valve cusps in passing your finger through the valve. Make your first cut horizontally, from 1 to 2, immediately below the level of the valve cusps.

Insert your finger again through the pulmonary semilunar valve and feel the interventricular septum. Cut from 2 to 3, along the edge of this muscular wall.

Put your finger through the opening you've created in the ventricular wall parallel to the atrioventricular (coronary) sulcus and feel for the anterior cusp of the right atrioventricular valve. Cut from 1 to 4 through the wall of the ventricle, without cutting the anterior cusp of this valve.

Leave the flap of ventricular wall attached to the heart along the line from 3 to 4. Remove the clotted blood with forceps.



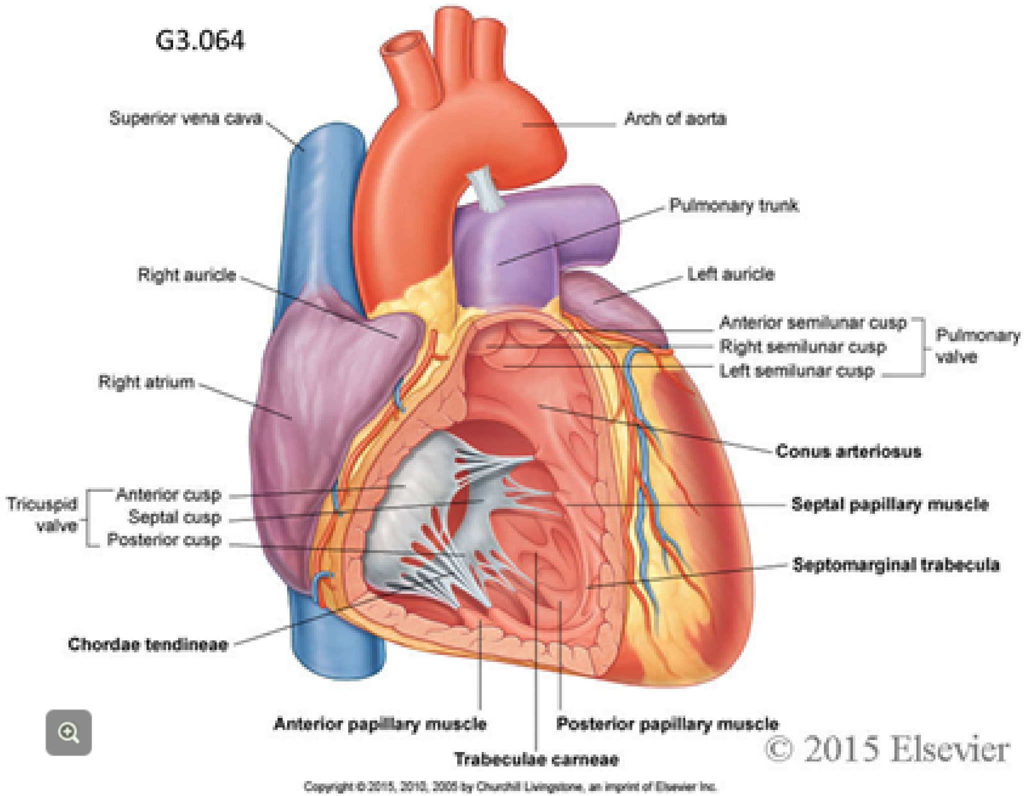
T A S K

LOOK at the right atrioventricular valve

and notice that it has three cusps: anterior, septal and posterior. It is often called the **tricuspid valve**. **Identify the chordae tendineae and the papillary muscles which together anchor the valve cusps to the ventricular wall. Identify the trabeculae carneae, coarse ridges of muscle on the internal surface of the ventricular wall.**

Identify the septomarginal trabecula (moderator band) extending from the wall of the interventricular septum to the base of the anterior papillary muscle. It contains the portion of the conducting system of the heart that controls the anterior papillary muscle.

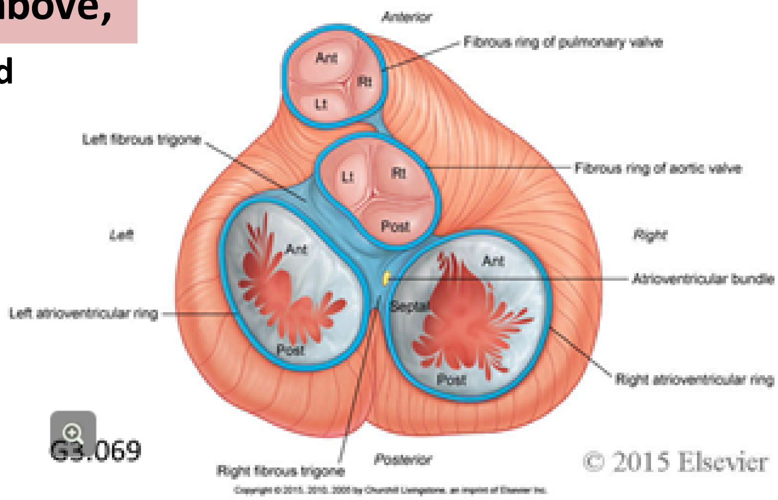
Look at the pulmonary semilunar valve and notice that the portion of the right ventricle leading to it is smooth, thus forming the conus arteriosus.



TASK

LOOK down into the pulmonary trunk from above, with the ventral side of the heart up, to understand the structure of the pulmonary semilunar valves. It will likely be necessary to shorten the pulmonary trunk by cutting across it with large scissors so that you can clearly see the pulmonary semilunar valve cusps.

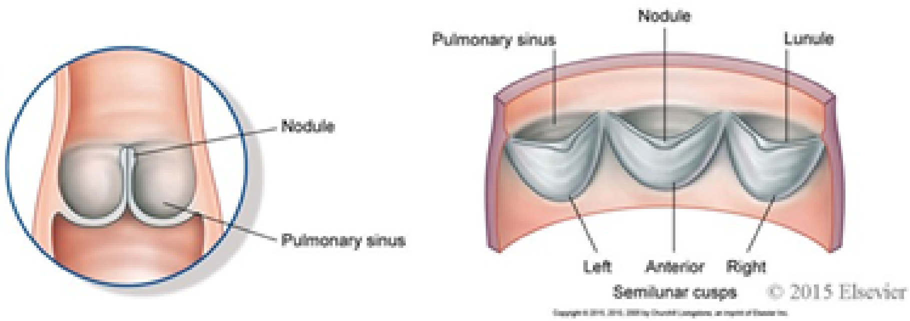
You will notice that the semilunar valves are much like three pockets lining the luminal wall of the vessel. **Identify the anterior, left and right semilunar valve cusps. Identify the spaces behind the valve cusps, inside the "pockets"; these are the pulmonary sinuses. The edge of each cusp consists of two lunula meeting in the centre at the nodule. Identify these features.**



G3.069

In the plane of the coronary sulcus is located the **fibrous skeleton of the heart**, a dense CT structure that forms four rings around the heart valves. These fibrous rings are **inflexible**, and so **determine the size of each of the openings**. They further provide **anchorage** for the valve cusps and the myocardium. The fibrous skeleton of the heart also plays a role in the cardiac cycle, as explained in the pre-lab SLM.

G3.065



TASK

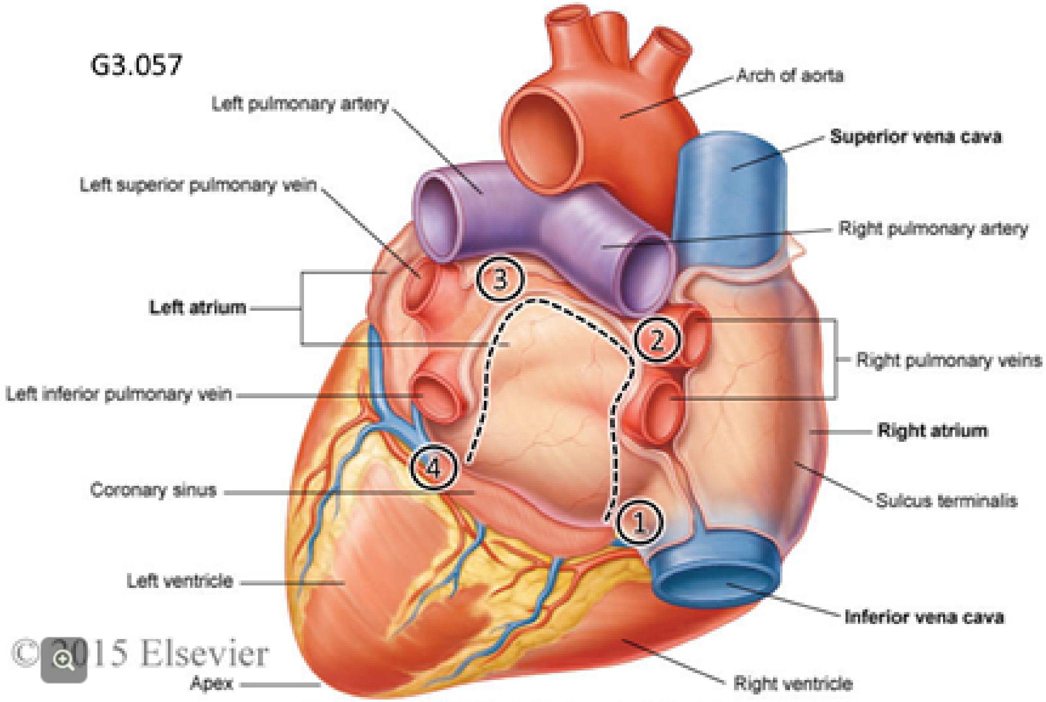
LOOK at the base of the heart, its posterior surface.

Depending on where the pulmonary veins were cut relative to the wall of the atrium, you should see two right pulmonary veins and two left pulmonary veins. These vessels return oxygenated blood to the left side of the heart.

Cut a flap in the wall of the left atrium from 1 to 2 to 3 to 4. Cut between the openings of the pulmonary veins, not through them, so as to leave them intact. Reflect the flap of atrial wall inferiorly, clean out the clotted blood with forceps.

Notice that the interior of the left atrium is largely smooth in texture. Find the opening into the left auricle and notice that the interior surface of this dead end is the one part of the left atrial wall that is rough. In the interatrial septum find the valve of the foramen ovale and recall the significance of this structure in the fetal circulation. Find the opening of the left atrioventricular valve.

G3.057



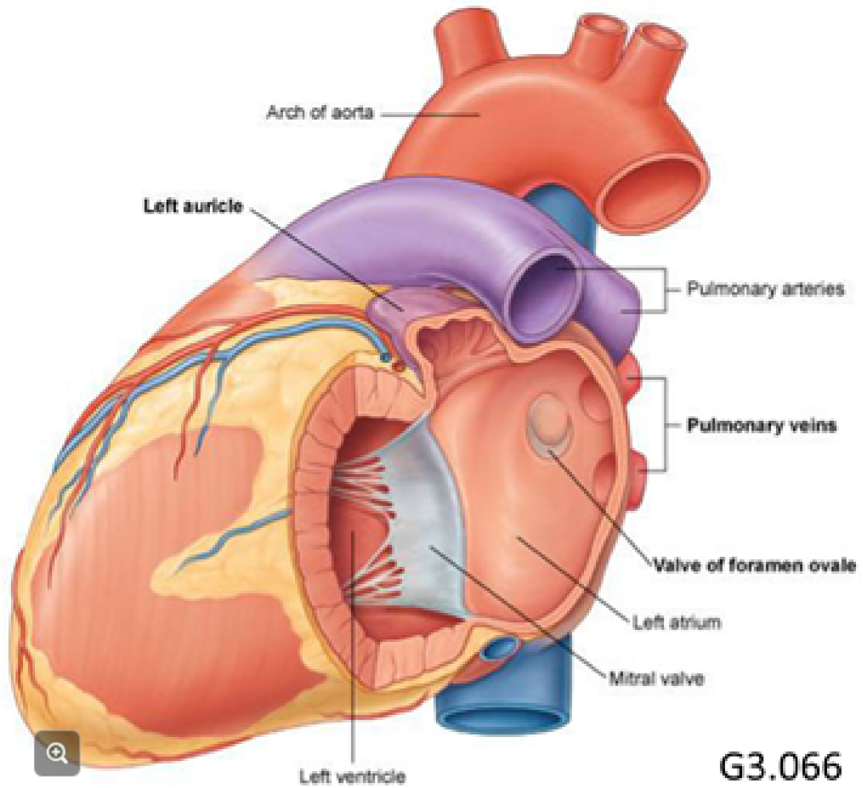
TASK

LOOK at the base of the heart, its posterior surface.

Depending on where the pulmonary veins were cut relative to the wall of the atrium, you should see two right pulmonary veins and two left pulmonary veins. These vessels return oxygenated blood to the left side of the heart.

Cut a flap in the wall of the left atrium from 1 to 2 to 3 to 4. Cut between the openings of the pulmonary veins, not through them, so as to leave them intact. Reflect the flap of atrial wall inferiorly, clean out the clotted blood with forceps.

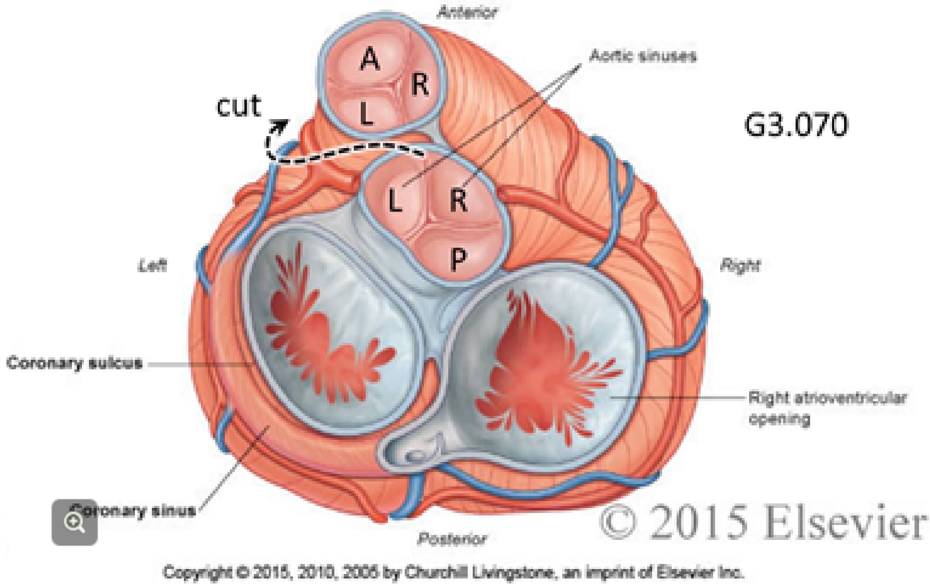
Notice that the interior of the left atrium is largely smooth in texture. Find the opening into the left auricle and notice that the interior surface of this dead end is the one part of the left atrial wall that is rough. In the interatrial septum find the valve of the foramen ovale and recall the significance of this structure in the fetal circulation. Find the opening of the left atrioventricular valve.

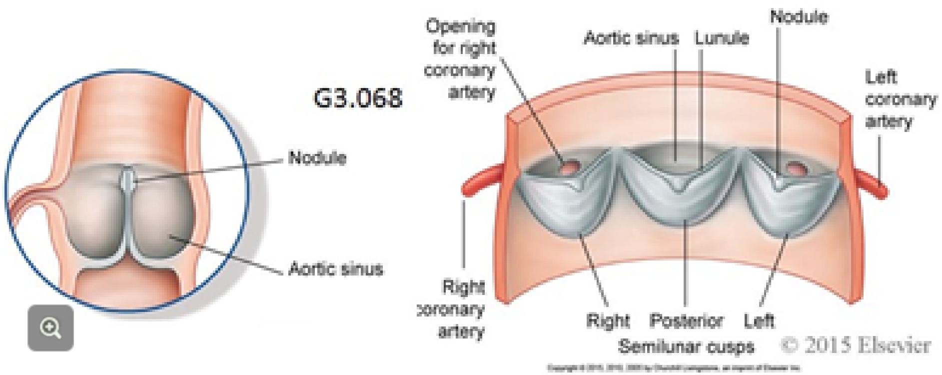


TASK

ENSURE that the ascending aorta has be cut short enough to allow you to clearly view the three cusps of the aortic semilunar valve. If necessary, remove any clotted blood behind the valve cusps being careful not to tear the cusps themselves. Notice that the structure of this valve is very similar to that of the pulmonary semilunar valve. Identify the left, right and posterior valve cusps. Identify its three sinuses, its lunula and nodules. Notice the presence of the ostia of the right and left coronary arteries within the sinuses of the right and left valve cusps, respectively.

The coronary circulation starts with the right and left coronary arteries. You will study the coronary circulation in exercise 8.3.

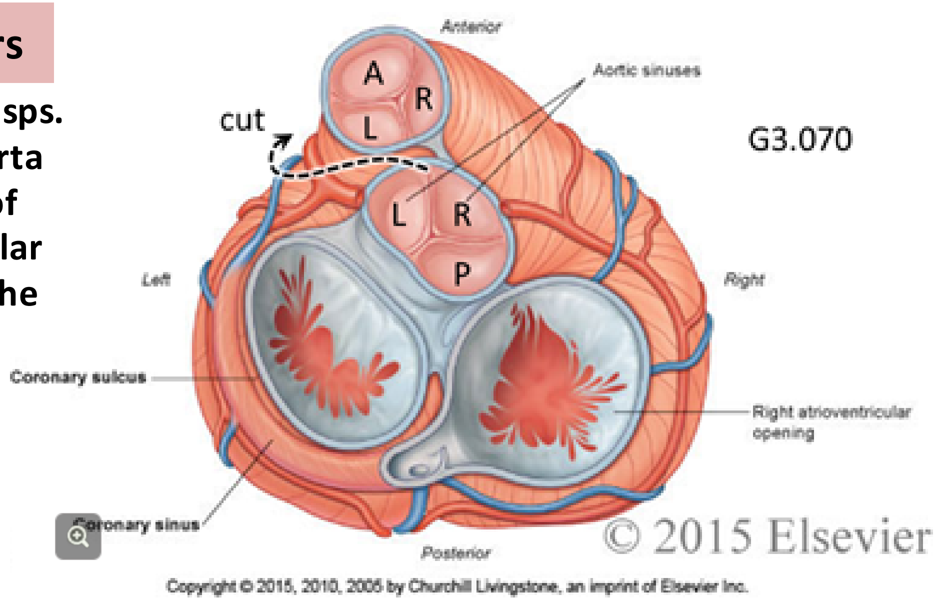


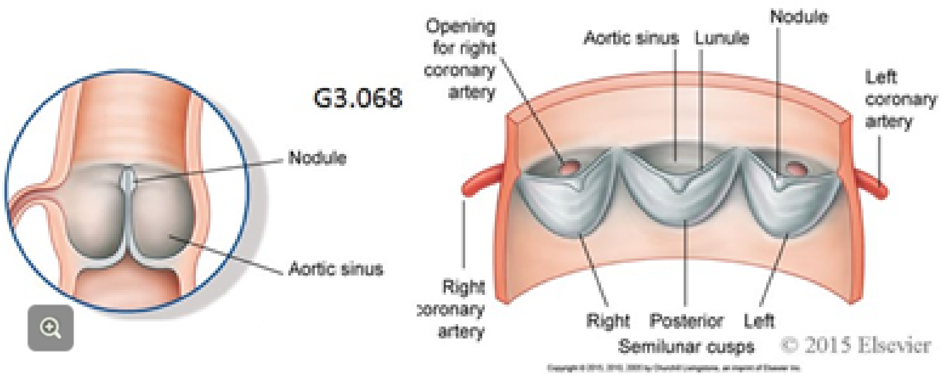


TASK

INSERT the tips of your large scissors between the right and left aortic valve cusps. Cut through the wall of the ascending aorta and continue your cut through the wall of the left ventricle, adjacent to the interventricular septum. Note that your cut will pass through the anterior interventricular (left anterior descending) artery and its companion vein, the great cardiac vein.

This approach will allow you to open both the ascending aorta and the left ventricle like a book, and clearly see the internal features of both of these structures.





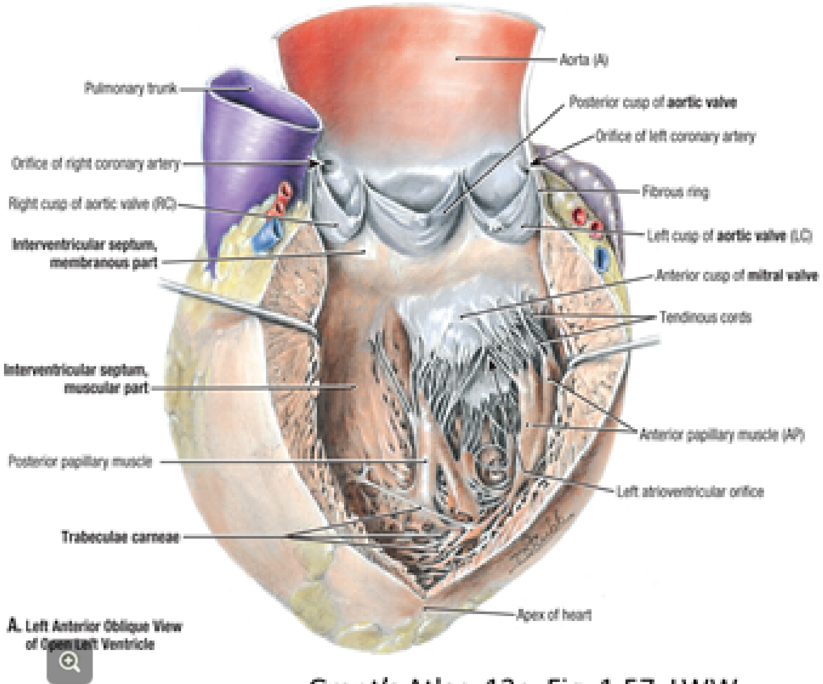
T A S K

OPEN the aorta and left ventricle widely, as illustrated

in the accompanying figure from Grant's Atlas of Anatomy, and carefully remove the clotted blood from its interior. Identify the anterior and posterior cusps of the left atrioventricular (mitral, bicuspid) valve. Identify the anterior and posterior papillary muscles and their associated chordae tendineae. Observe that the chordae tendineae of each papillary muscle extends to the cusps of both valves.

Compare the trabeculae carneae of the two ventricles. Notice that the trabeculae carneae of the left ventricle are coarser than those of the right ventricle.

Turn your attention to the aortic semilunar valve now that it has been opened and again identify its features: cusps, sinuses, lunules and nodules. Identify the ostia of the left and right coronary arteries behind their respective valve cusps, and note the absence of such an opening behind the posterior, "noncoronary" cusp.



Grant's Atlas, 13e, Fig. 1.57, LWW

TASK

INSERT the thumb of your dominant hand into the left ventricle

and your index finger in the right ventricle. Feel the significant thickness of the muscular portion of the interventricular septum. Slide your finger and thumb toward the semilunar valves and notice the thinness of the membranous portion of the interventricular septum.

Impulses originating in the AV node are carried through the membranous part of the interventricular septum by the **atrioventricular bundle**. At the junction with the muscular part of the interventricular septum, the AV bundle splits into the **right and left bundle branches**, which run on either side of this thick muscular divide, to be distributed to the myocardium of the ventricular wall via the Purkinje fibres.

INFO

Ventricular Septal Defects

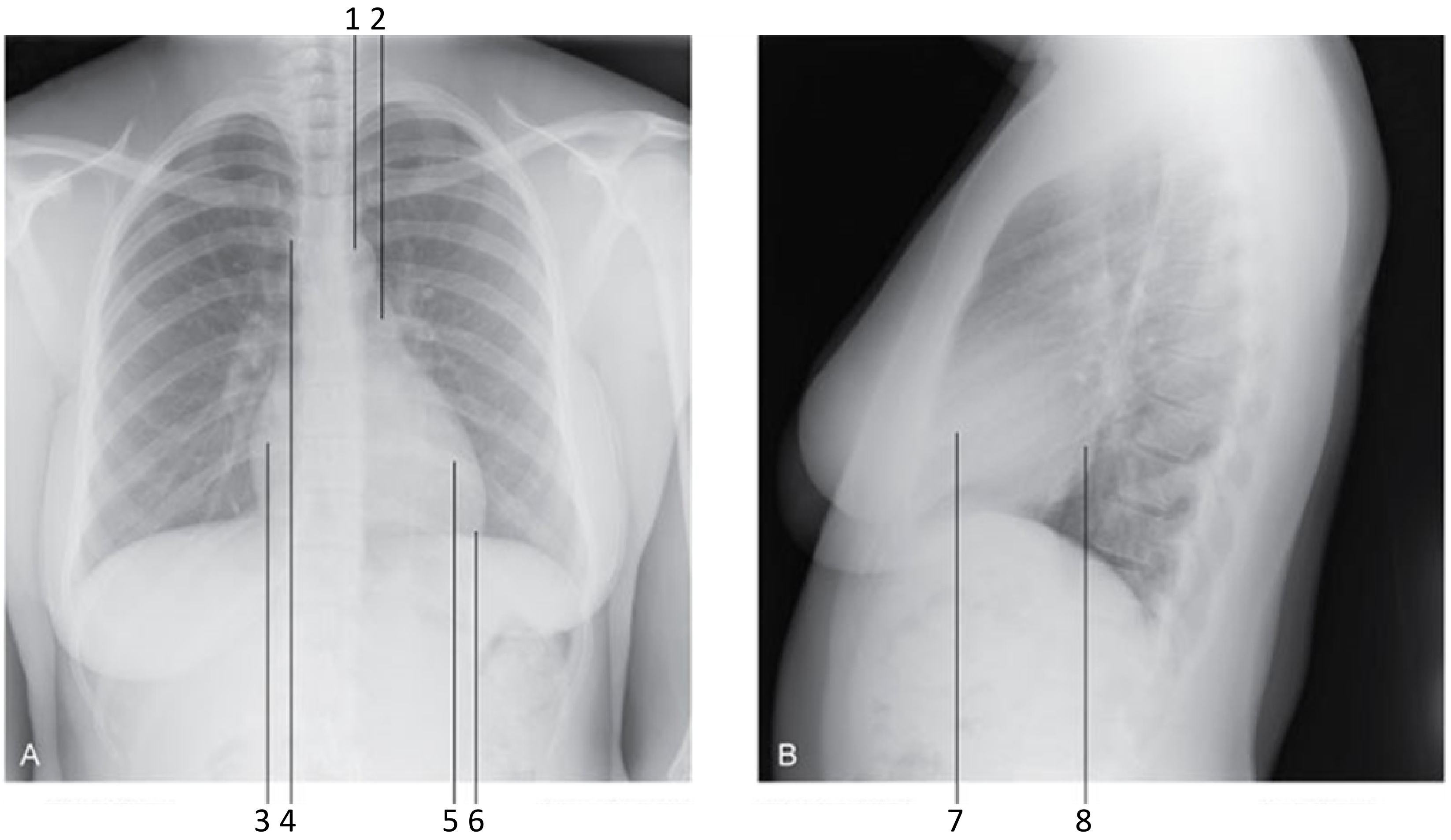
These two portions of the interventricular septum arise from distinct embryological origins and ultimately fuse to subdivide the ventricles during development. Congenital nonfusion of these septae results in a **ventricular septal defect**, which allows mixing of oxygenated blood from the left ventricle with deoxygenated blood in the right ventricle. This partially oxygenated blood is pumped to the lungs of the neonate, causing their heart to work harder.

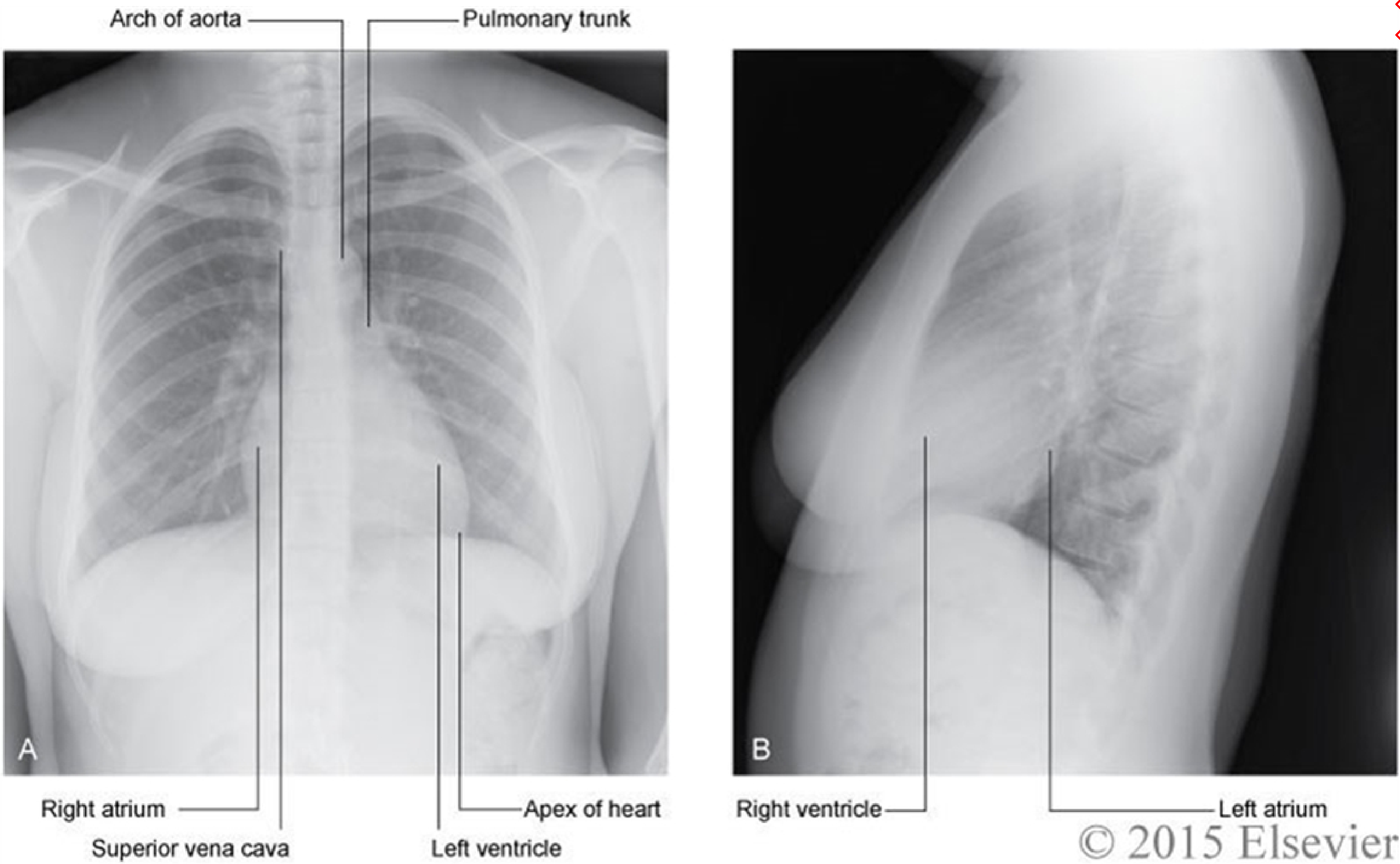
INFO

Atrial Septal Defects

An **atrial septal defect** occurs with congenital nonclosure, or incomplete closure, of the foramen ovale. Such defects, if small, may close on their own. If large, however, an atrial septal defect may contribute to heart failure or pulmonary hypertension.

Both types of septal defect may be surgically treatable once detected.


1 2
A
B
3 4
5 6
7
8


Arch of aorta
Pulmonary trunk
A
B
Right atrium
Superior vena cava
Apex of heart
Left ventricle
Right ventricle
Left atrium
© 2015 Elsevier

Since embarking on this exercise, you have **identified** the following structures and learned the **answers to the following questions**:

- In the right atrium, identify the pectinate muscles, crista terminalis, opening of the SVC, IVC and coronary sinus, fossa ovalis, location of the SA and AV nodes. What is the significance of the fossa ovalis?
- In the right ventricle, identify the tricuspid valve cusps, chordae tendineae, papillary muscles, trabeculae carneae, septomarginal trabecula, conus arteriosus and cusps of the pulmonary semilunar valve.
- From above, identify the anterior, left and right pulmonary semilunar valve cusps, their sinuses, lunula and nodules.
- Describe four functions of the fibrous skeleton of the heart.
- In the left atrium, identify the remnants of the valve of the foramen ovale, the rough interior of the left atrial appendage, the openings of the pulmonary veins and the opening of the left atrioventricular valve.
- From above, identify the left, right and posterior aortic valve cusps, their sinuses, lunula and nodules. Identify the ostia of the right and left coronary arteries.
- In the left ventricle, identify the cusps of the left atrioventricular (mitral, bicuspid) valve, the papillary muscles, chordae tendineae, trabeculae carneae, and the features of the aortic semilunar valve (cusps, sinuses, ostia, nodules, lunula.
- What parts of the conducting system of the heart are located in each of the membraneous and muscular portions of the interventricular septum?
- Be able to identify all structures indicated in the radiographs provided.

If you are satisfied with your **ability to identify these structures** and **answer these questions**, call your AT over for confirmation and for **permission to move on**.

8.2 Fascial Compartments and Vasculature of the Upper Limb

What you'll need:

SPECIMENS

- A prosected upper limb demonstrating the muscles, nerves and arteries of upper limb.
- A prosected specimen demonstrating the walls of the axilla.

Remember: you must not use sharp instruments on a prosection. Use, at most, a blunt probe to point out structures to your colleagues.

When you have learned the material presented in this exercise, you will be able to recognize and / or describe the:

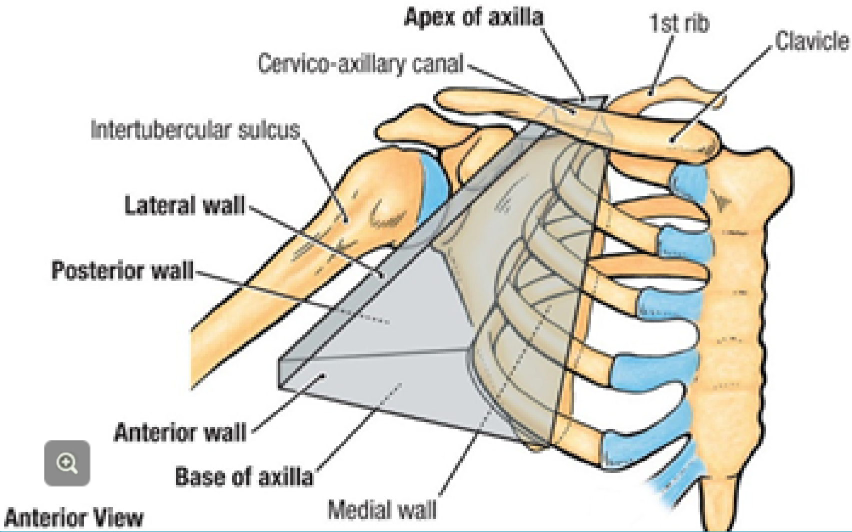
- the axilla, its borders and blood supply
- major groups of lymphatics in the upper limb
- major arteries and deep veins of the upper limb
- the location of the pulses of the upper limb

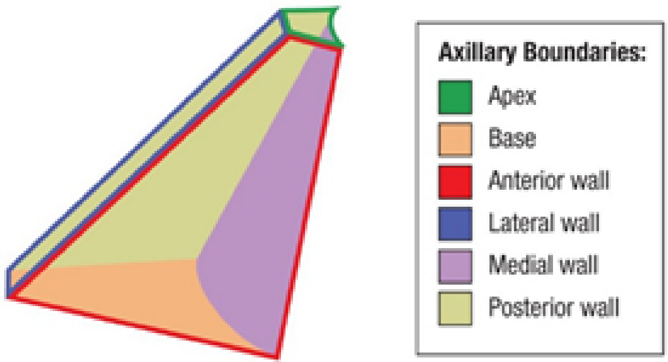
The axilla is a region of transition between the neck, thorax and upper limb. It is a pyramidal space, as illustrated in this figure from Grant's Atlas of Anatomy. The **base** of the pyramid includes the skin of the armpit, and its **apex** is above the clavicle. Its **anterior wall** includes the pectoral muscles of the chest, and its **posterior wall** includes the scapula and its associated muscles. Its **medial wall** is the lateral wall of the thorax, including the muscles that clothe it, and its **lateral wall** is a narrow strip along the medial aspect of the humerus, the **intertubercular groove**.

TASK

UNWRAP the specimen of the axilla.

Identify the pyramidal space illustrated here and insert your hand into it. Posterior to your hand, identify the scapula and its associated muscles (the posterior wall of the axilla), anterior to your hand, identify the pectoral muscles (the anterior wall of the axilla), medial to your hand, identify the lateral thoracic wall (the medial wall of the axilla), and lateral toy your hand, identify the intertubercular groove (the lateral wall of the axilla).

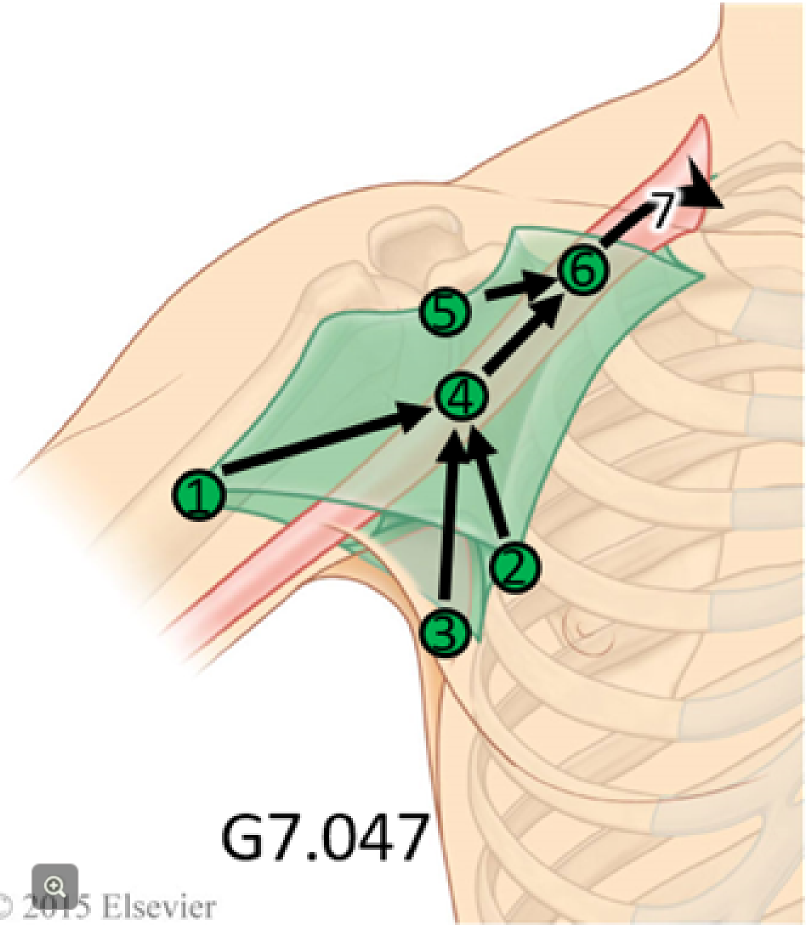




Grant's Atlas, 13e, Fig. 6.22, © 2013, LWW

Now that you understand the walls of the axilla, the naming of the axillary lymph nodes will make more sense. Axillary lymph nodes are commonly divided into five or six groups. **Identify the location of these groups of nodes on the specimen.**

1. Most lymph from the upper limb flows into the **humeral nodes** medial to the humerus.
2. **Pectoral nodes** receive lymph from the **anterior wall** of the axilla, the abdomen, chest, and breast.
3. **Subscapular nodes** receive lymph from the **posterior wall** of the axilla, the shoulder, back and neck.
4. **Central nodes** receive lymph from these three groups of nodes, and from there, lymph drains into the
5. Superficial lymphatics drain to **infraclavicular nodes** associated with the terminus of the **cephalic vein**.
6. **Apical nodes** receive lymph from central and infraclavicular nodes and from portions of the breast.
7. Efferent lymphatics vessels from the apical nodes form the **subclavian trunk**, which ultimately **empties into blood at the venous angles**.



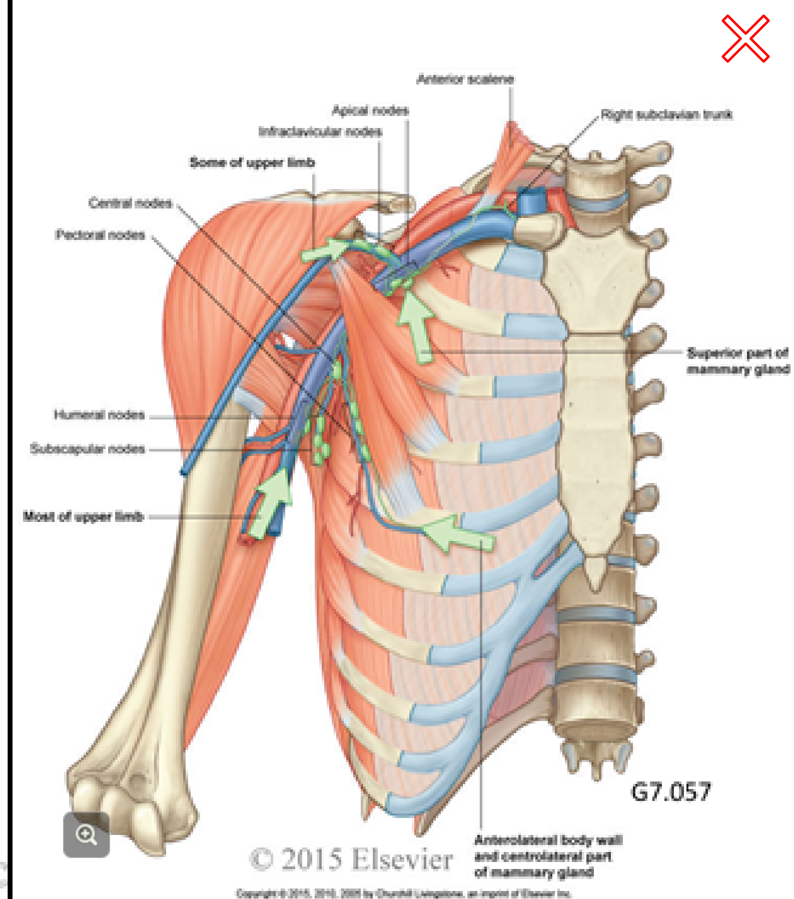
This is also illustrated here:

Moisten, wrap and bag the specimen of the axilla.

Now that you understand the walls of the axilla, the naming of the axillary lymph nodes will make more sense. Axillary lymph nodes are commonly divided into five or six groups. **Identify the location of these groups of nodes on the specimen.**

1. Most lymph from the upper limb flows into the **humeral nodes** medial to the humerus.
2. **Pectoral nodes** receive lymph from the **anterior wall** of the axilla, the abdomen, chest, and breast.
3. **Subscapular nodes** receive lymph from the **posterior wall** of the axilla, the shoulder, back and neck.
4. **Central nodes** receive lymph from these three groups of nodes, and from there, lymph drains into the
5. Superficial lymphatics drain to **infraclavicular nodes** associated with the terminus of the **cephalic vein**.
6. **Apical nodes** receive lymph from central and infraclavicular nodes and from portions of the breast.
7. Efferent lymphatics vessels from the apical nodes form the **subclavian trunk**, which ultimately **empties into blood at the venous angles**.

This is also illustrated here:



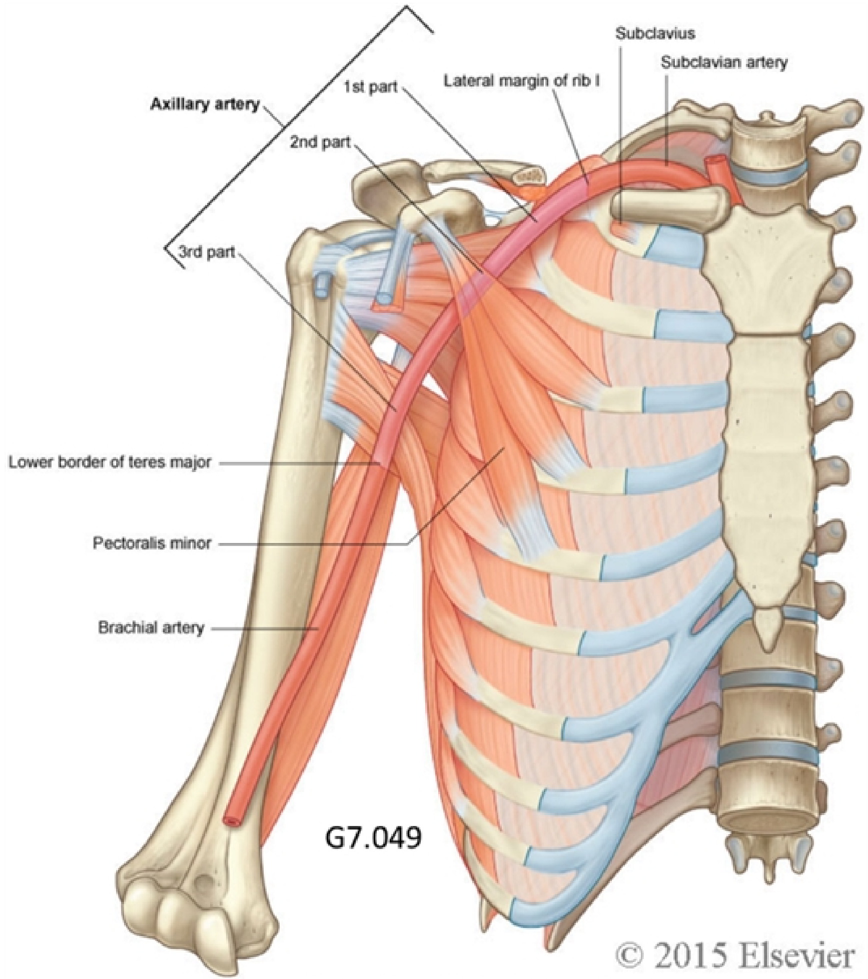
Moisten, wrap and bag the specimen of the axilla.

TASK

UNWRAP the prosected upper limb.

Identify the axillary artery, the continuation of the subclavian artery in the axilla .

The axillary artery is described as having **three parts, the second part being posterior to the pectoralis minor muscle**. The attachment of the pectoralis minor to the coracoid process may still be present in your prosection; if not; by identifying the **coracoid process**, you can visualize the position of the pectoralis minor anterior to the axillary artery. The parts of the axillary artery are of use in identifying its branches, as you will see. The mnemonic is that there is 1 branch from its 1st part, 2 branches from its 2nd part and 3 branches from its 3rd part.



INFO

Axillary Pulse

The pulse of the axillary artery can be palpated lateral to the dome of skin that forms the floor of the axilla, between the anterior and posterior axillary skin folds.

T A S K

UNWRAP the prosected upper limb.

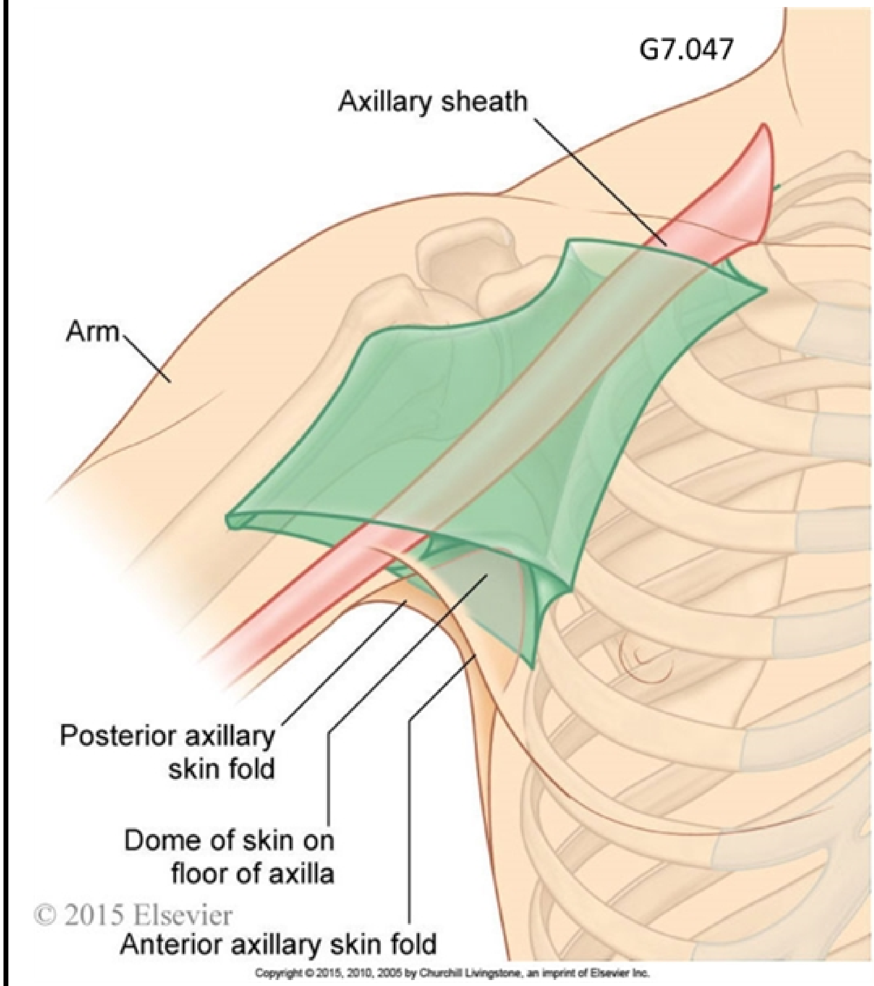
Identify the axillary artery, the continuation of the subclavian artery in the axilla .

The axillary artery is described as having **three parts**, **the second part being posterior to the pectoralis minor muscle**. The attachment of the pectoralis minor to the coracoid process may still be present in your prosection; if not; by identifying the **coracoid process**, you can visualize the position of the pectoralis minor anterior to the axillary artery. The parts of the axillary artery are of use in identifying its branches, as you will see. The mnemonic is that there is 1 branch from its 1st part, 2 branches from its 2nd part and 3 branches from its 3rd part.

I N F O

Axillary Pulse

The pulse of the axillary artery can be palpated lateral to the dome of skin that forms the floor of the axilla, between the anterior and posterior axillary skin folds.

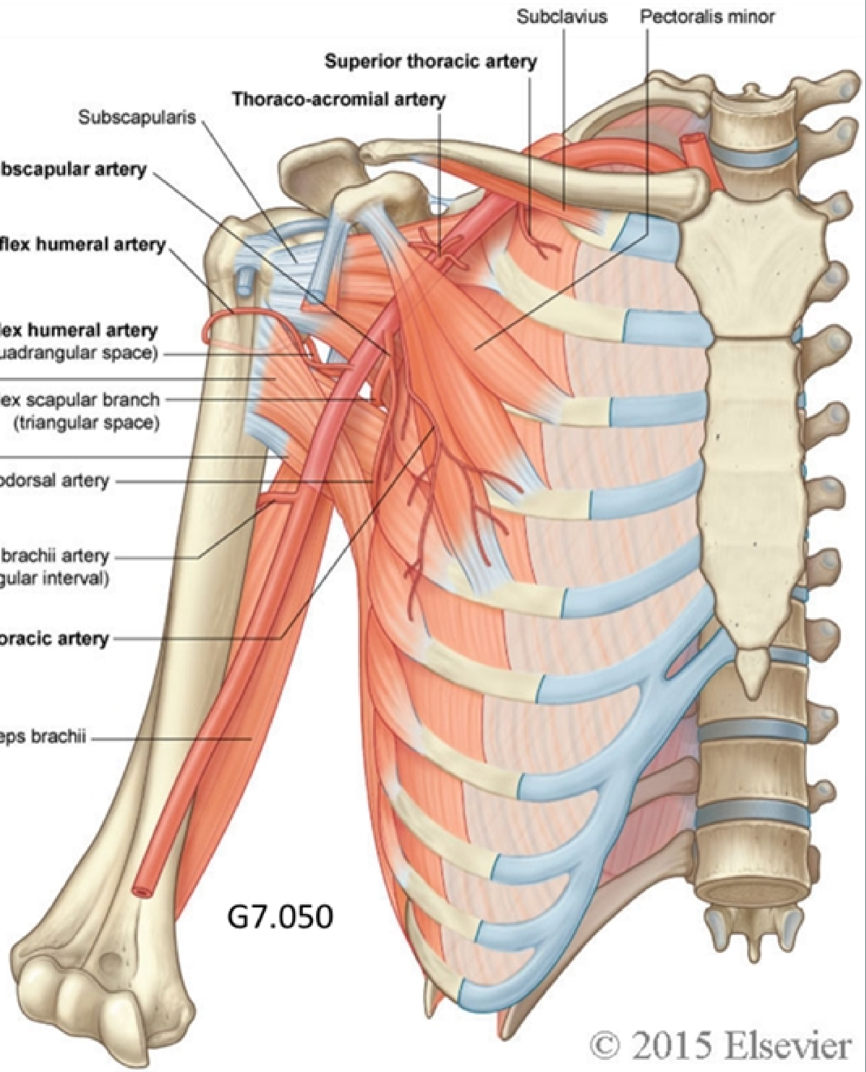


Branches of the axillary artery supply the walls of the axilla. Its first branch, proximal to the pectoralis minor, is small and will not be mentioned further here.

TASK

IDENTIFY,

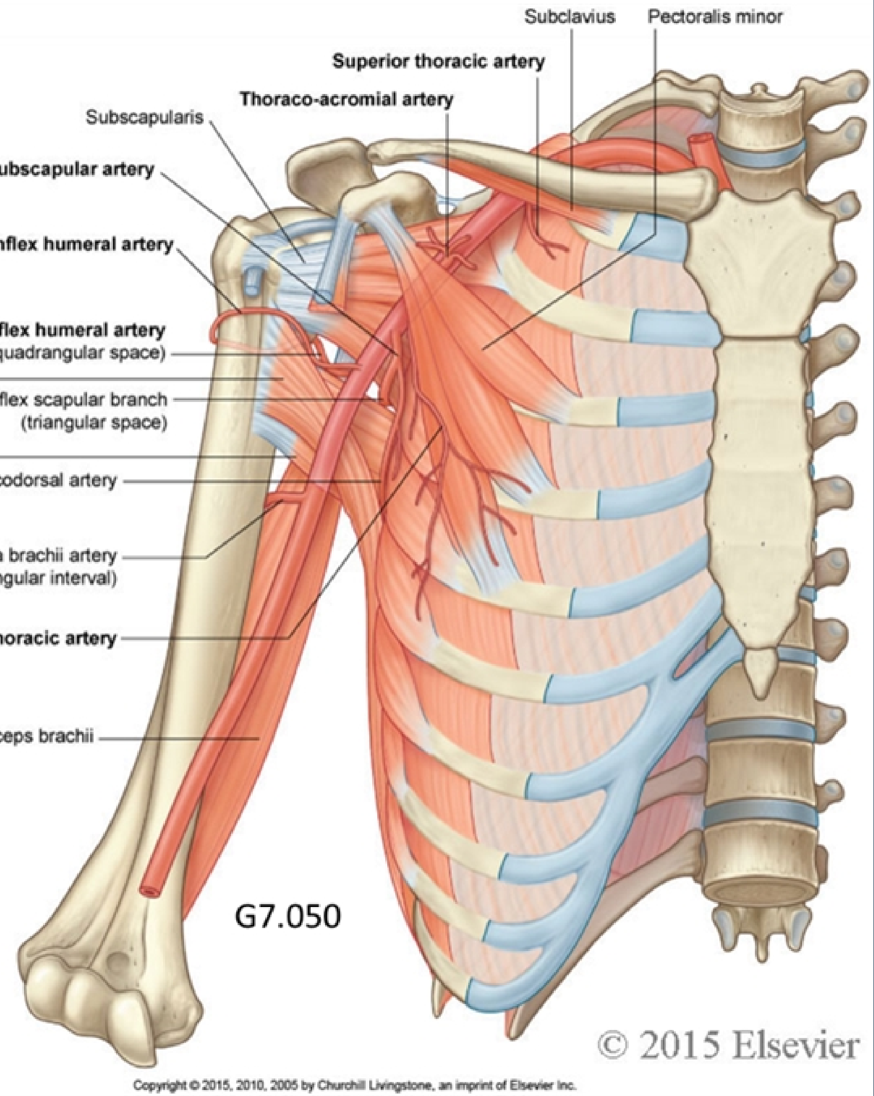
arising from its second part, the thoracoacromial trunk. Notice that the thoracoacromial trunk breaks immediately into four branches; they together supply the anterior wall of the axilla. The lateral thoracic artery, if it is present, will be a stump just distal to the thoracoacromial trunk. It supplies the medial wall of the axilla .



TASK

IDENTIFY, arising from its third part,

the subscapular artery, and the posterior and anterior circumflex humeral arteries. Notice the relationship of the subscapular artery to the lateral border of the scapula; it supplies the posterior wall of the axilla. Notice that the posterior circumflex humeral artery is significantly larger than the anterior circumflex humeral artery; this helps in distinguishing these two vessels. The **circumflex humeral vessels** wrap around the surgical neck of the humerus; their branches are clinically important in that they ascend to **supply blood to its head**.



INFO

Avascular necrosis (osteonecrosis)

of the humeral head can result from fractures of the anatomical neck of the humerus.

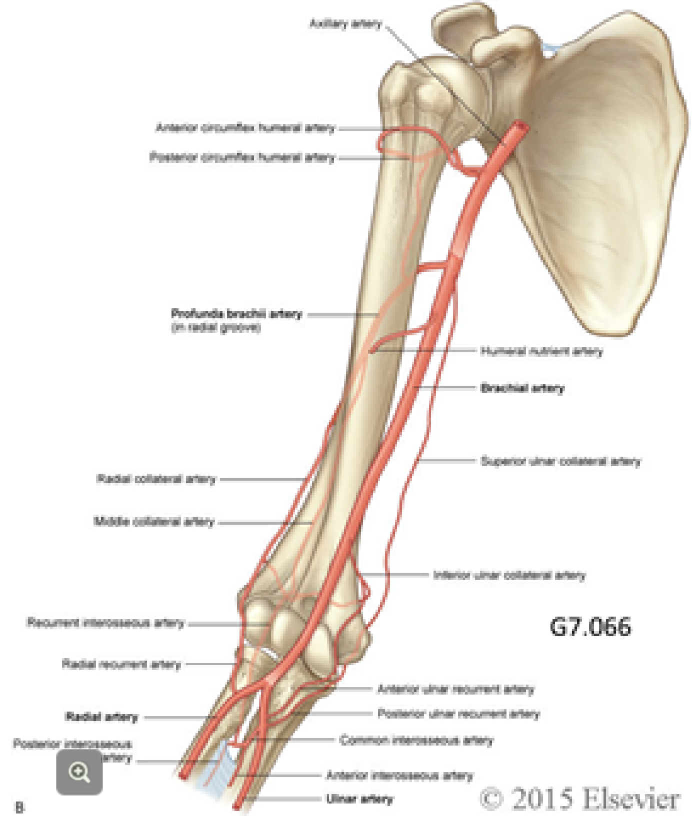
The **brachial artery and vein** are the continuation of the axillary artery and vein in the arm.

T A S K

IDENTIFY the brachial artery

and its major branch, the profunda brachii, or deep brachial artery. Notice that the brachial artery is the major vessel of the anterior (flexor) compartment of the arm. Notice that the profunda brachii is the major vessel of the posterior (extensor) compartment of the arm. The humeral nutrient artery, which supplies much of the blood to the shaft of the humerus, is also a branch of the brachial artery, although you won't be able to see it.

A rich anastomosis exists around the elbow, as around the knee. Connections between descending **collateral arteries** and ascending **recurrent arteries**, create this anastomosis.



G7.066

I N F O

Brachial Pulse

In the mid-arm, the brachial pulse can be palpated in the cleft between the anterior (flexor) compartment containing the biceps brachii muscle and the posterior (extensor) compartment, containing the triceps brachii muscle. **This is the position at which one places a blood pressure cuff**. In the cubital fossa, the brachial pulse can be palpated medial to the tendon of the biceps brachii. **one places a stethoscope here to listen for the brachial pulse while taking a blood pressure reading**.

The **brachial artery and vein** are the continuation of the axillary artery and vein in the arm.

TASK

IDENTIFY the brachial artery

and its major branch, the profunda brachii, or deep brachial artery. Notice that the brachial artery is the major vessel of the anterior (flexor) compartment of the arm. Notice that the profunda brachii is the major vessel of the posterior (extensor) compartment of the arm. The humeral nutrient artery, which supplies much of the blood to the shaft of the humerus, is also a branch of the brachial artery, although you won't be able to see it.

A rich anastomosis exists around the elbow, as around the knee. Connections between descending **collateral arteries** and ascending **recurrent arteries**, create this anastomosis.

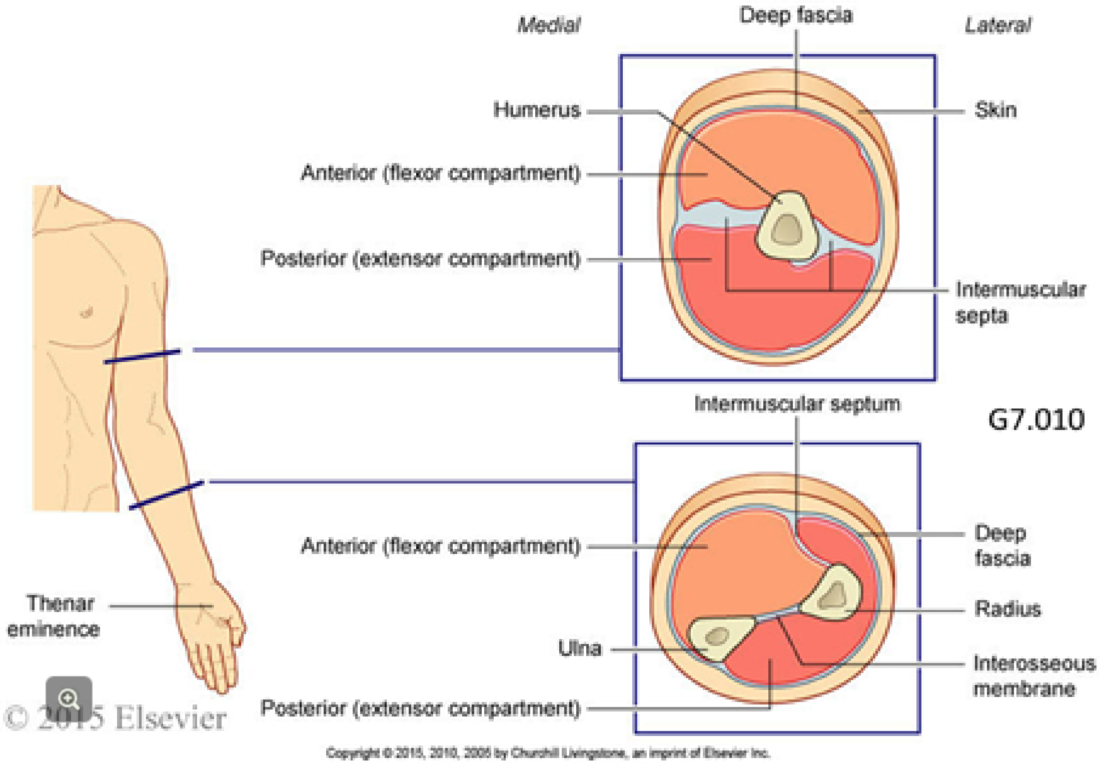
INFO

Brachial Pulse

In the mid-arm, the brachial pulse can be palpated in the cleft between the anterior (flexor) compartment containing the biceps brachii muscle and the posterior (extensor) compartment, containing the triceps brachii muscle. **This is the position at which one places a blood pressure cuff.** In the cubital fossa, the brachial pulse can be palpated medial to the tendon of the biceps brachii. **one places a stethoscope here to listen for the brachial pulse while taking a blood pressure reading**.

The radius and ulna are joined by a dense sheet of CT, the **antebrachial interosseous membrane**. In addition, dense CT intermuscular septae emanating from the deep fascia of the forearm, the **antebrachial fascia**, merge with the periosteum of the radius and ulna. These CT structures subdivide the forearm into **two compartments: anterior and posterior**.

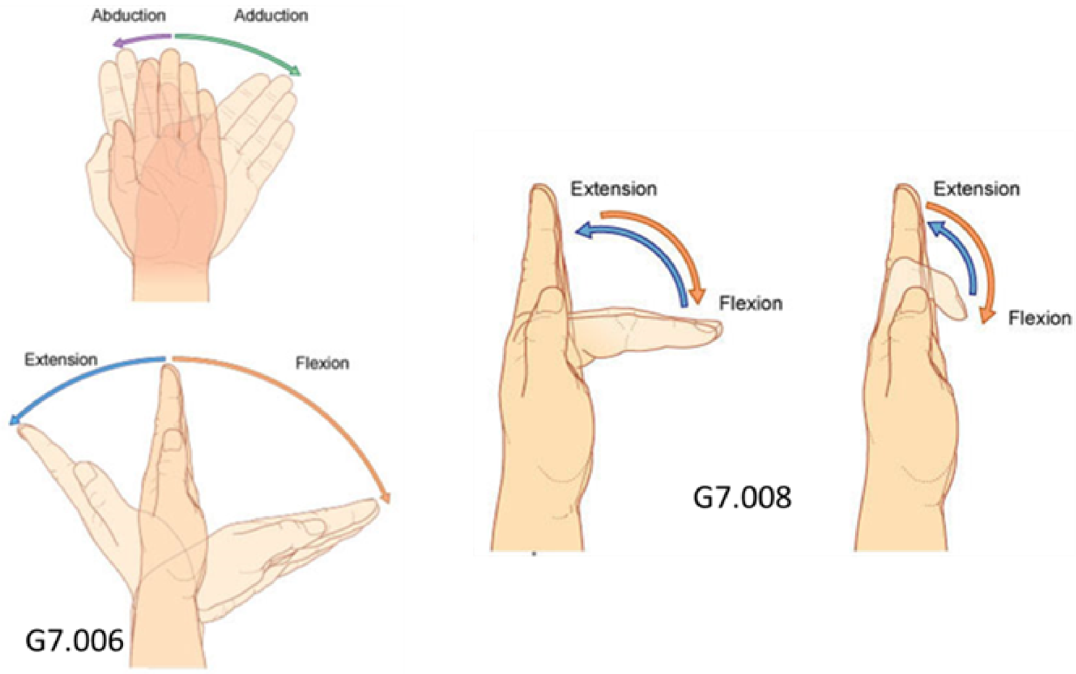
The muscles in each of these compartments have common actions, with the muscles of the anterior compartment **flexing the wrist and joints of the hand** and the muscles of the posterior compartment **extending the wrist and joints of the hand**. Muscles of these compartments work synergistically to adduct and abduct the wrist.



G7.010

The radius and ulna are joined by a dense sheet of CT, the **antebrachial interosseous membrane**. In addition, dense CT intermuscular septae emanating from the deep fascia of the forearm, the **antebrachial fascia**, merge with the periosteum of the radius and ulna. These CT structures subdivide the forearm into **two compartments: anterior and posterior**.

The muscles in each of these compartments have common actions, with the muscles of the anterior compartment **flexing the wrist and joints of the hand** and the muscles of the posterior compartment **extending the wrist and joints of the hand**. Muscles of these compartments work synergistically to adduct and abduct the wrist.



TASK

EXPLORE the cubital fossa and locate the bifurcation of the brachial artery. Identify the radial and ulnar arteries, each running distally in the anterior compartment of the forearm, anterior to their namesake bones.

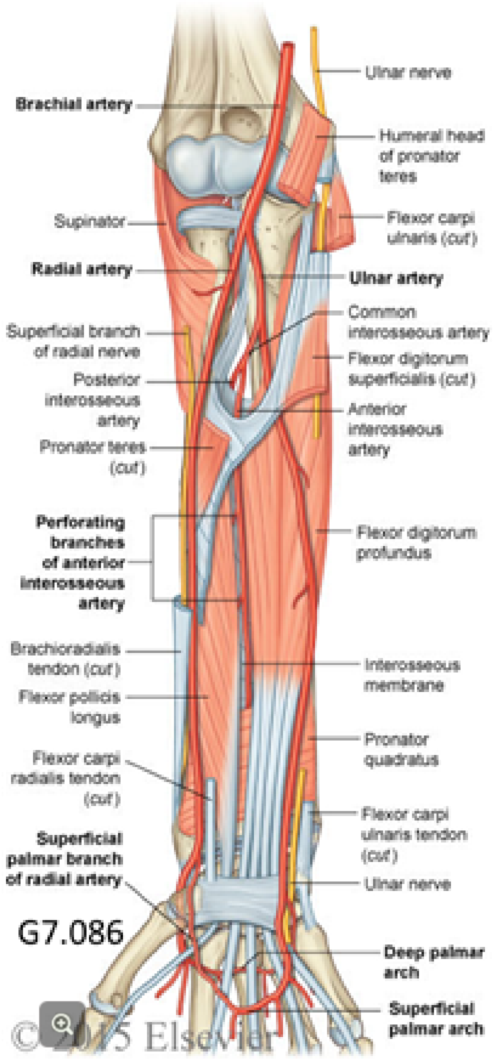
Identify the common interosseous artery arising from the ulnar artery in the proximal forearm. Locate its two branches, the anterior and posterior interosseous arteries. These arteries are named for the compartments of the forearm in which they are located and their close proximity to the antebrachial interosseous membrane. They supply deeper tissues of the forearm.

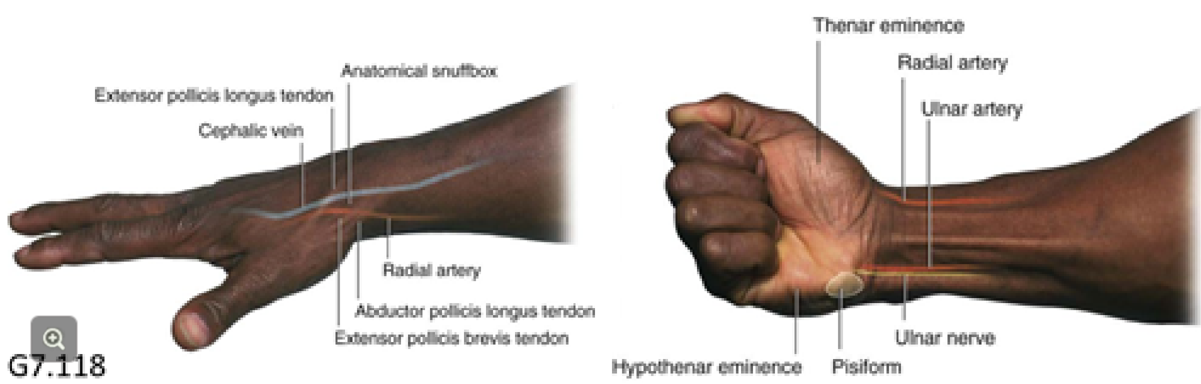
INFO

Radial and Ulnar Pulses

An ulnar pulse can be felt in the wrist lateral to the tendon of the flexor carpi ulnaris muscle, proximal to the pisiform bone.

A radial pulse can be felt in the wrist lateral to the tendon of the flexor carpi radialis muscle. It can also be felt in the floor of the anatomical snuffbox.





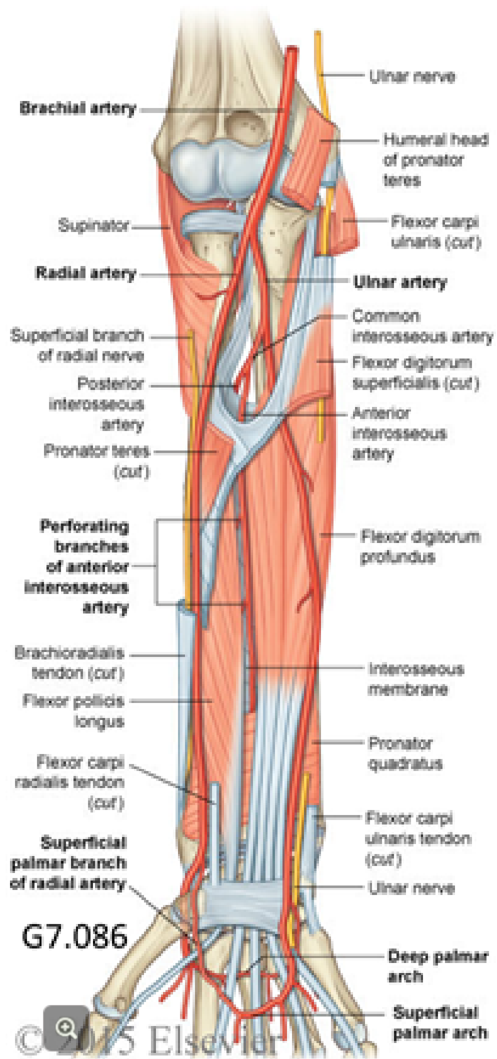
G7.118

Radial and Ulnar Pulses

INFO

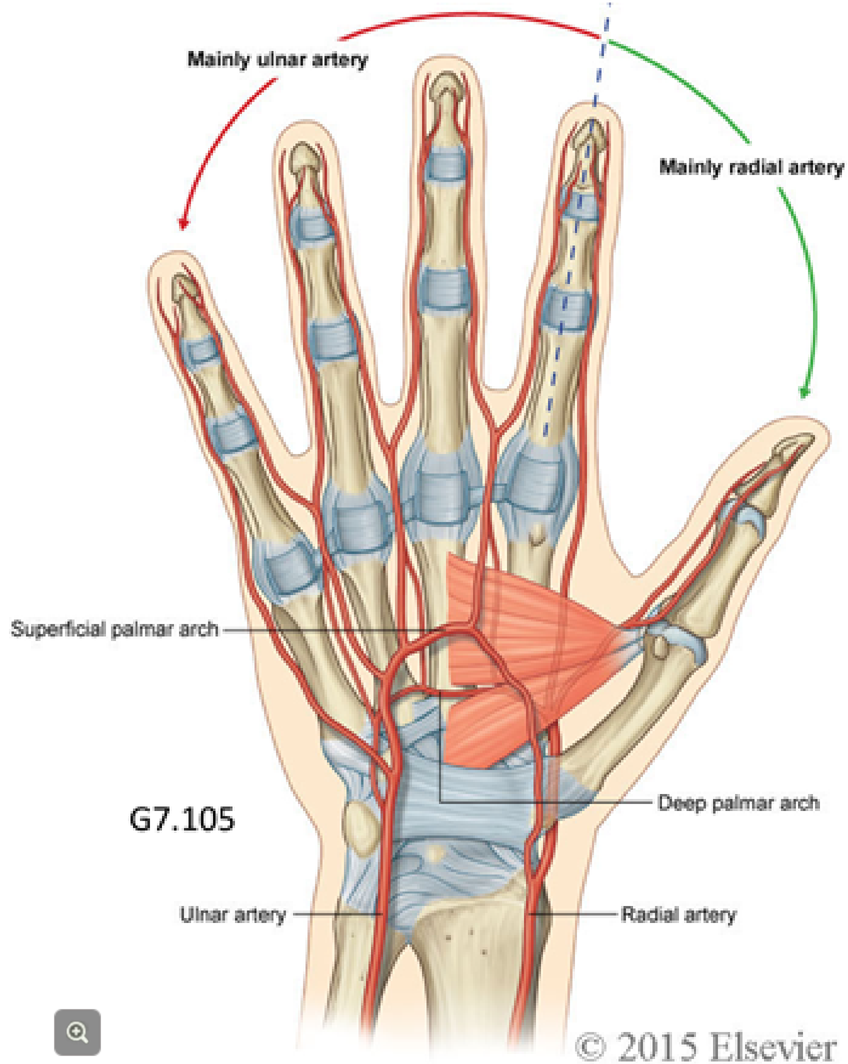
An ulnar pulse can be felt in the wrist lateral to the tendon of the flexor carpi ulnaris muscle, proximal to the pisiform bone.

A radial pulse can be felt in the wrist lateral to the tendon of the flexor carpi radialis muscle. It can also be felt in the floor of the anatomical snuffbox.



G7.086

The blood supply of the hand and digits arise from the **superficial and deep palmar arches**. At the wrist, the radial and ulnar arteries bifurcate, and their branches come together at different levels within the palm. Branches of the superficial and deep arches unite to supply the digits.



G7.105

The six pulse points of the upper limb are illustrated in the accompanying figure. Attempt to find these pulses on yourself and on a willing partner.

Since embarking on this exercise, you have **identified** the following structures and learned the **answers to the following questions**:

- Identify and describe the structures that make up the walls of the axilla. What makes up its base? Where is its apex?
- Which group of axillary lymph nodes are associated with i) the brachial vein, ii) anterior wall of the humerus, iii) posterior wall of the humerus? Which group receives lymph from these three? Which group of nodes is associated with the terminus of the cephalic vein? Which group of nodes ultimately receive blood from all of these groups?
- Identify the axillary artery. From what vessel does it arise? Identify and name the branches of the axillary artery that supply the medial, lateral, anterior and posterior walls of the axilla. What vessels supply blood to the humeral head?
- Identify the brachial artery and the deep branchial artery. In which compartment of the arm is each located?
- Name the compartments of the forearm. Identify the radial and ulnar arteries, the common interosseous artery and the anterior and posterior interosseous arteries. In which compartment is each located? Which arteries give rise to the palmar arches?
- Describe the location of six pulses within the upper limb.

If you are satisfied with your **ability to identify these structures** and **answer these questions**, call your TA over for confirmation and for **permission to move on**.

8.3 The Heart External and Coronary Blood Supply

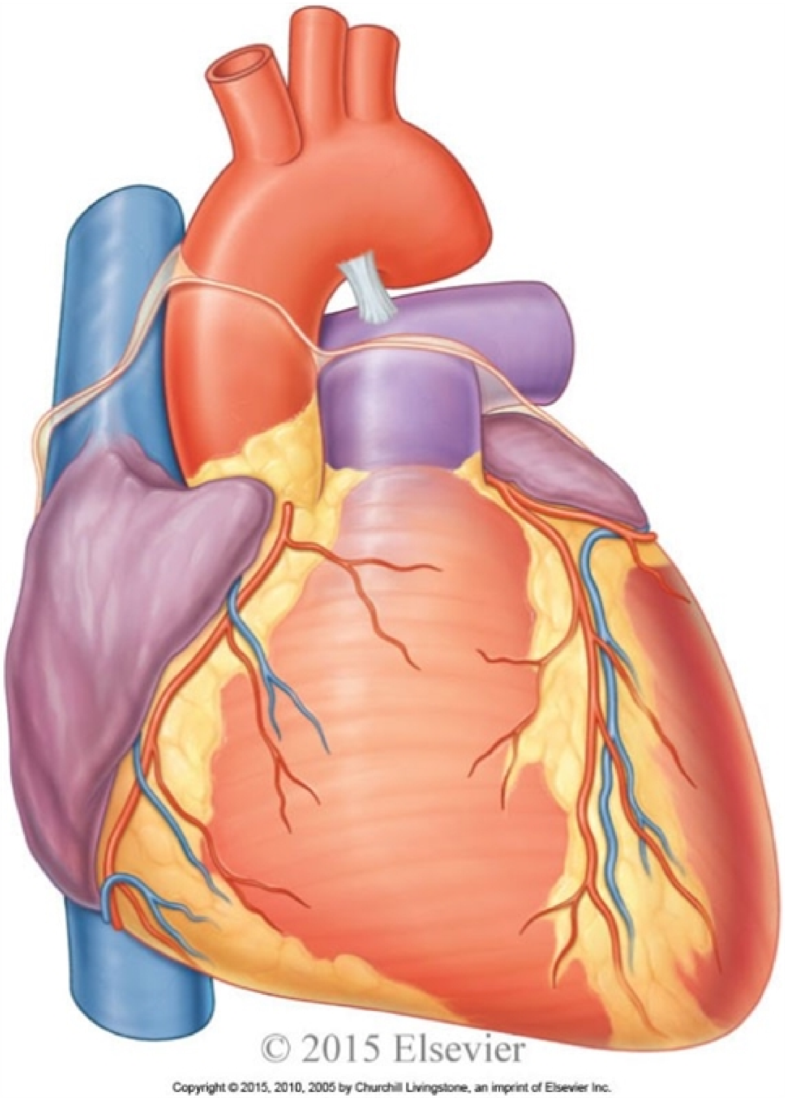
What you'll need:

SPECIMENS

- Closed heart model
- All cadaver 1 hearts

When you have learned the material presented in this exercise, you will be able to:

- identify the surfaces of the heart and the chambers that make up each
- identify, and describe distribution of, the arteries and veins of the coronary circulation.



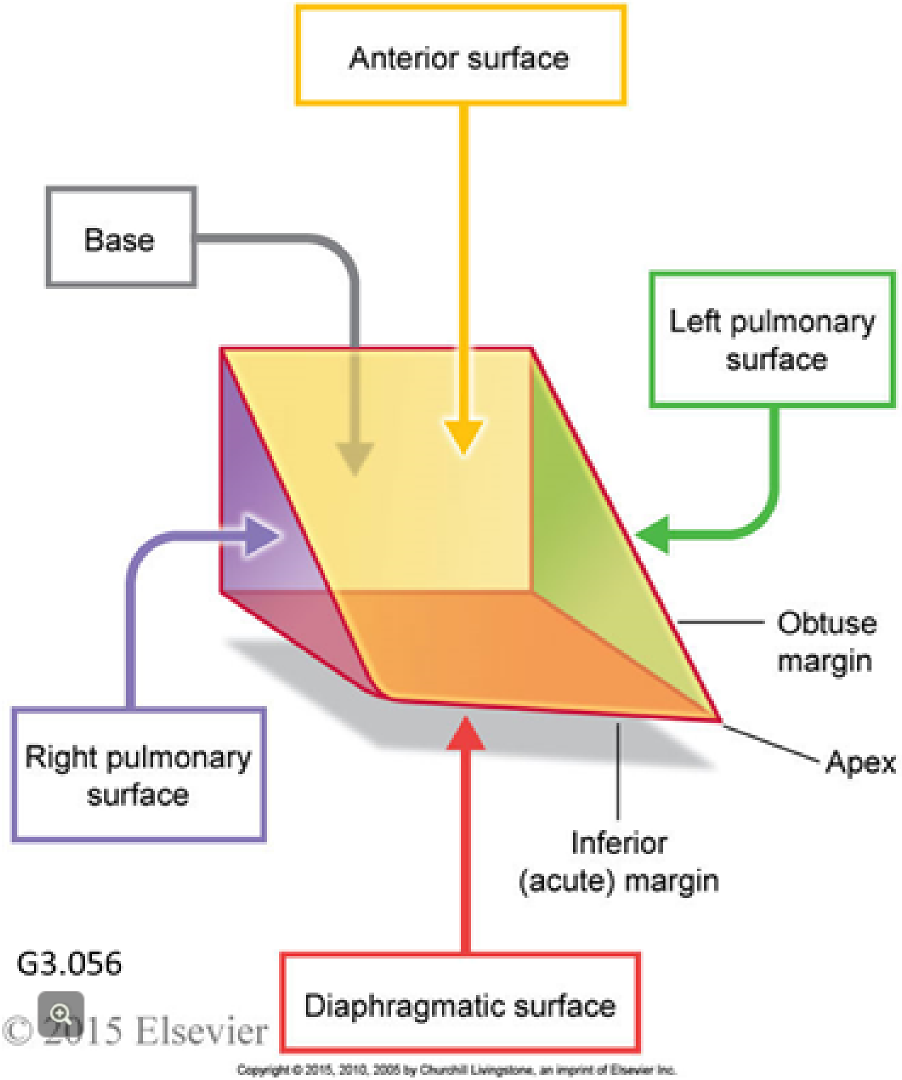
When you left the thorax of cadaver 1 at the end of Unit 1, you had studied the pleural cavity and lungs. You will now remove the heart from the pericardial sac so that you can study its external features, and dissect the major coronary vessels.

Recall that the heart has an apex, a base, anterior and diaphragmatic surfaces and right and left pulmonary surfaces.

TASK

IDENTIFY:

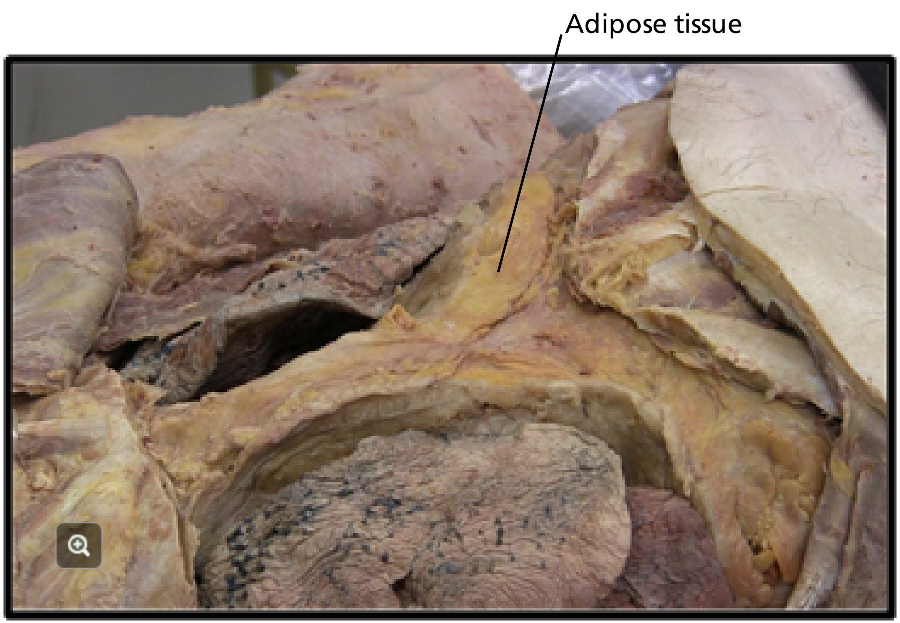
these surfaces on the model of the heart.

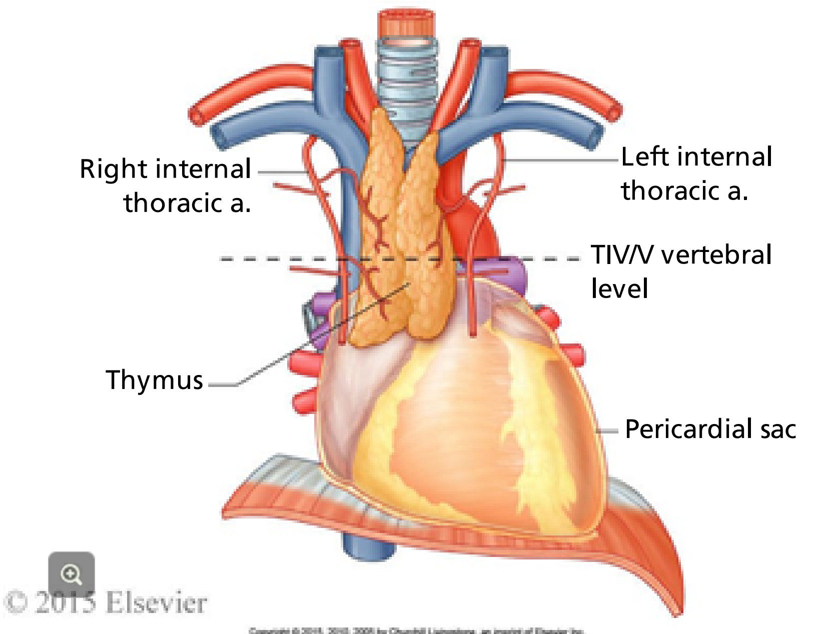


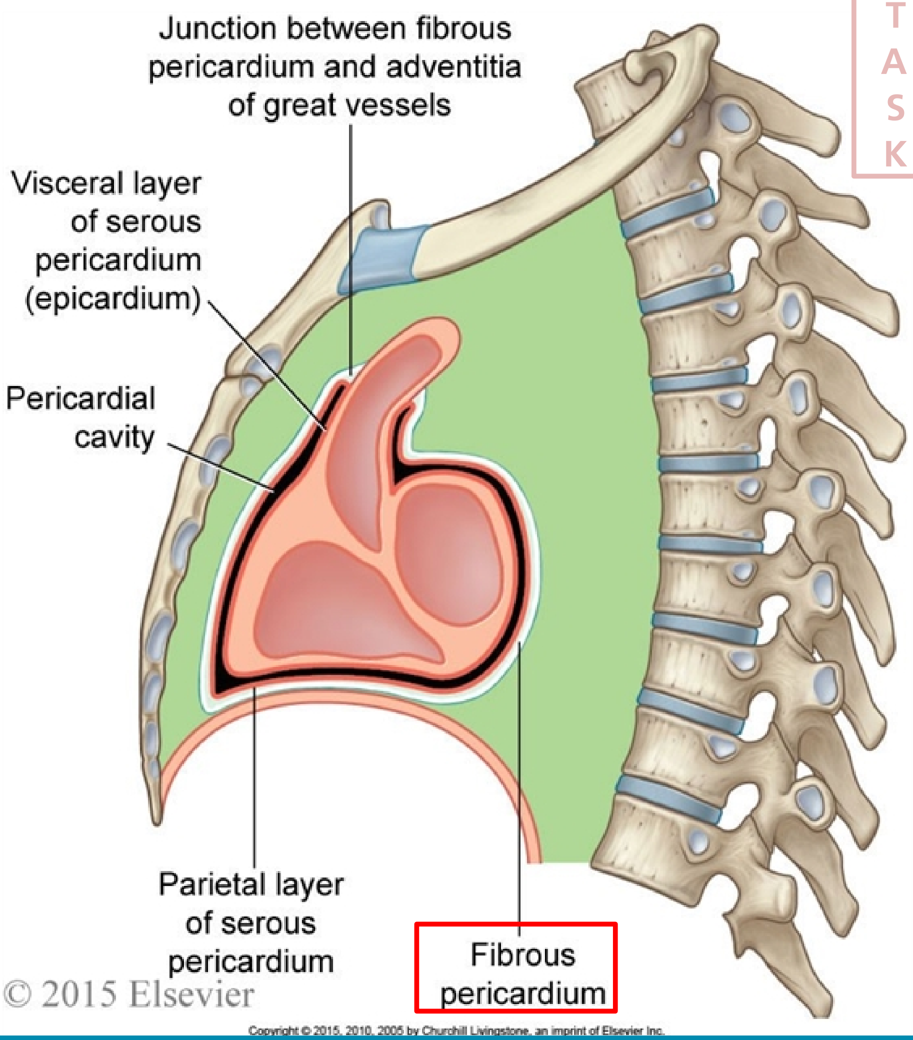
8.3 The Thymus Gland is Located Within the Mediastinum

Recall that the heart is located between the pleural cavities, in the **middle mediastinum**, and that the **anterior mediastinum** lies between it and the internal surface of the sternum.

Turn your attention to the cadaver. At this point you should see a collection of adipose tissue in the midline, anterior to the heart, and the lungs on either side. While the bulk of the **thymus gland** is located in the superior mediastinum, posterior to the manubrium of the sternum, it may extend inferiorly into the anterior mediastinum. The thymus gland is involved in the development of the immune system, particularly in children and adolescents. It is during these early life years that it is largest in size. In the elderly, it is atrophied and often indistinguishable from adjacent adipose tissue. Know the location of the thymus gland, but **do not try to identify the thymus gland in your cadaver.**







TASK

Using blunt dissection (NO SCALPELS!)

with large forceps and large, blunt closed scissors (ask your TA to demonstrate), scrape away adipose tissue to thoroughly clean the anterior surface of the fibrous pericardium.

The **fibrous pericardium** defines the middle mediastinum.

It is composed of **dense, irregular connective tissue**, and as such, is a tough, white, **inextensible** sack.

T
A
S
K

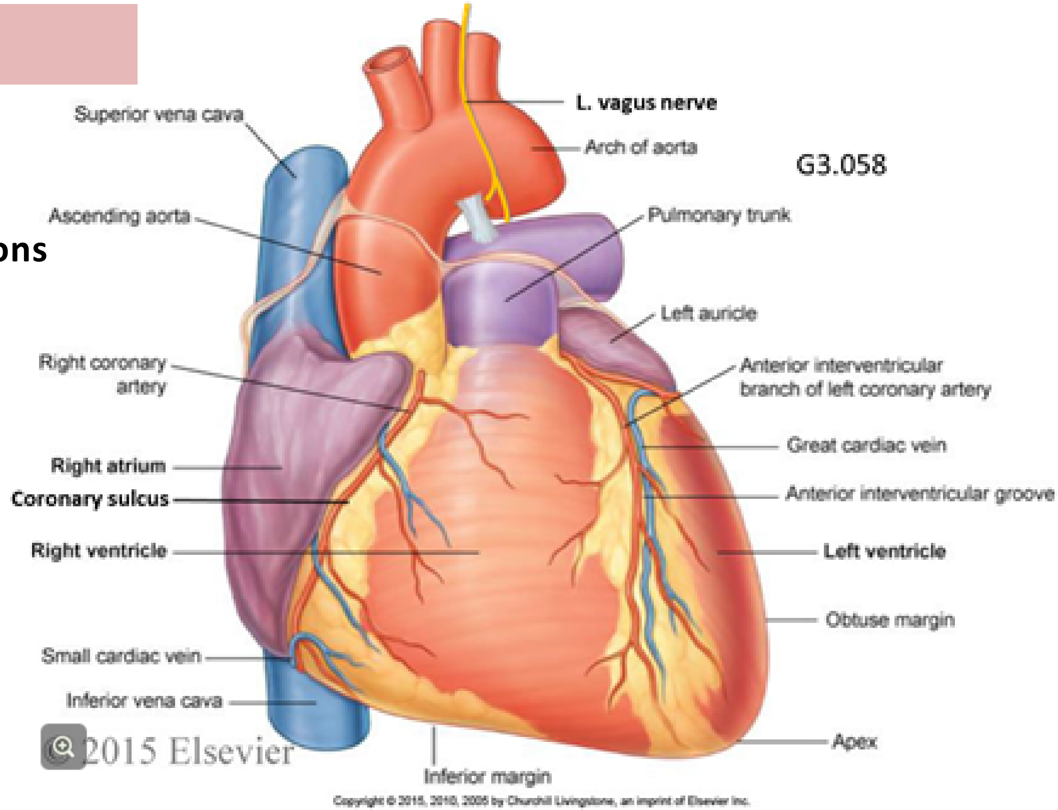
OPEN the fibrous pericardium following these dissection steps:

1. **Using forceps, lift the fibrous pericardium away from the heart, and only now may you open your scissors.**
2. **Gently pierce the fibrous pericardium in the midline with the sharp point of the scissors. Do not insert your instrument deeply through the sack; you are trying to avoid impaling the heart.**
3. **Cut a vertical slit along the midline of the fibrous pericardium.**
4. **Make two horizontal slits, one at the top of the sack, the other at the bottom of the sack.**
5. **You are now able to reflect the fibrous pericardium away from the heart, like opening two doors.**

TASK

LOOK at the heart *in situ*

and confirm the structures that make up the anterior surface of the heart: they are largely the right ventricle, with flanking contributions from the right atrium and left ventricle.



Slip your hand inferior to the heart and feel its diaphragmatic surface; tip it upward to confirm that it consists largely of the left ventricle, with a lesser contribution from the right ventricle.

Slip your hand between the right margin of the heart and the pericardial sac and confirm that this border is made up of the right atrium.

Slip your hand between the left margin of the heart and the pericardial sac and confirm that this border is made up of the left ventricle.

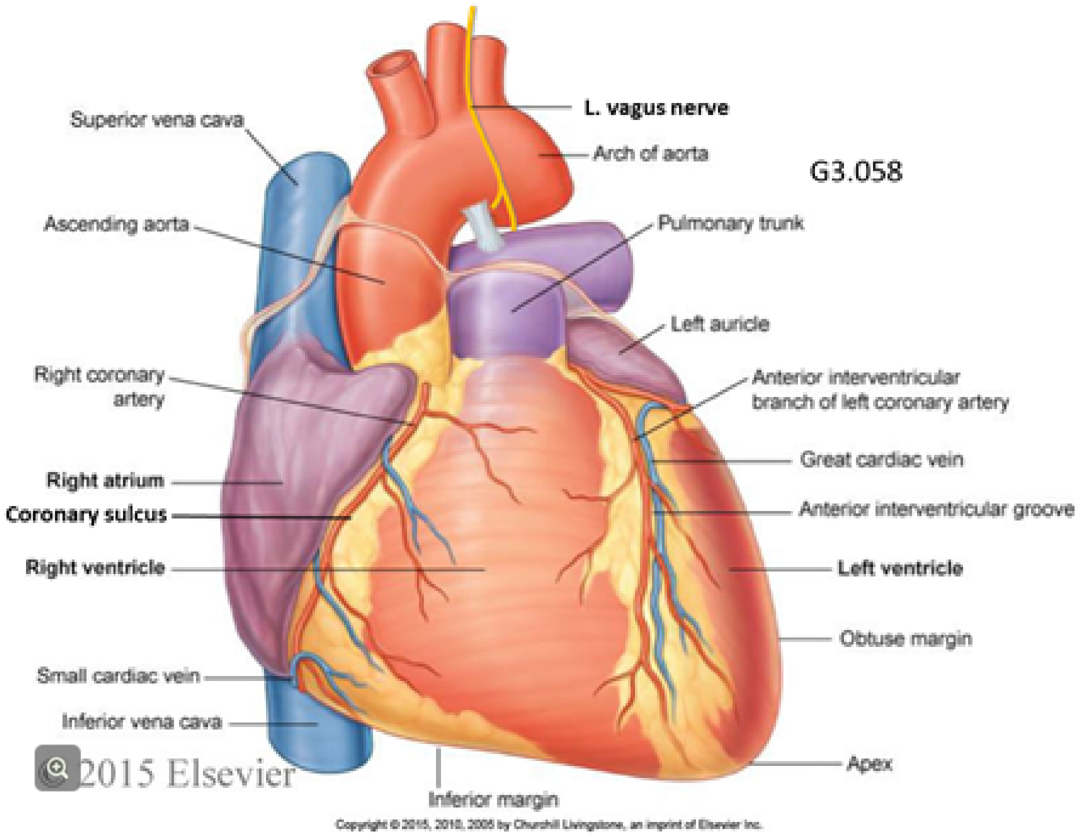
TASK

LOOK at the heart *in situ*

The superior border of the heart is described as consisting of the right and left atria and their appendages (auricles).

You cannot directly view the posterior border (base) of the heart, but slip your hand behind it and realize that it consists largely of the left atrium with a contribution from the right atrium and great vessels.

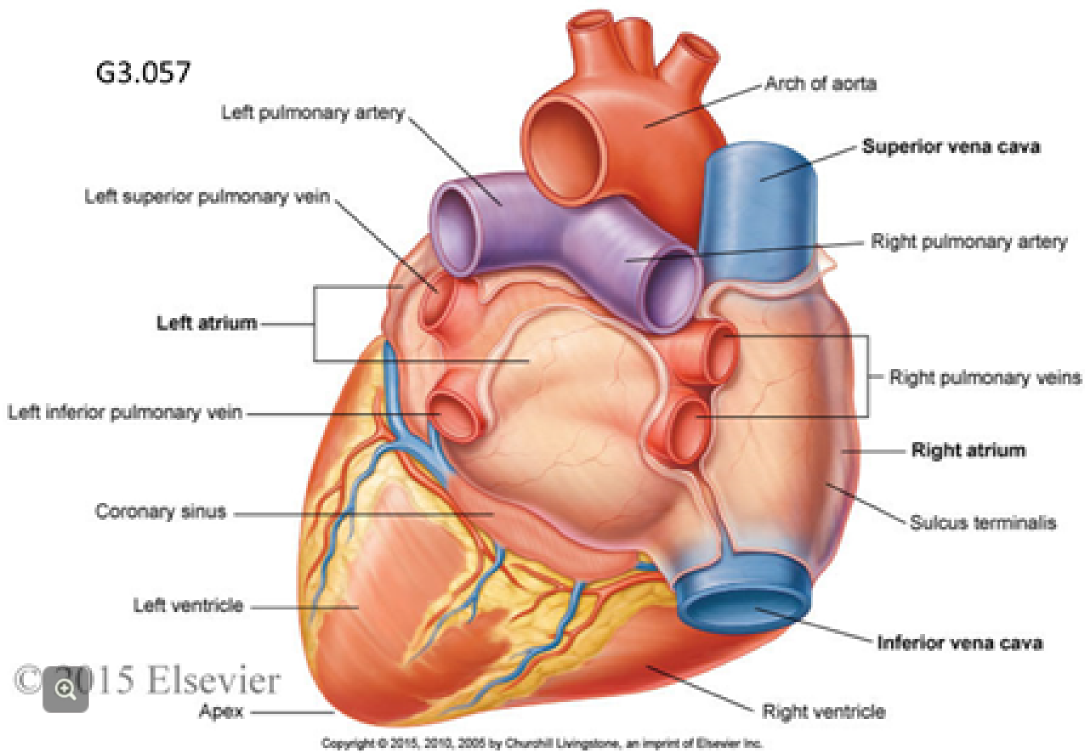
Lastly, notice the position of the apex of the heart: it is normally in the left fifth intercostal space in the midclavicular line.



T A S K

LOOK at the heart *in situ*

The superior border of the heart is described as consisting of the right and left atria and their appendages (auricles).



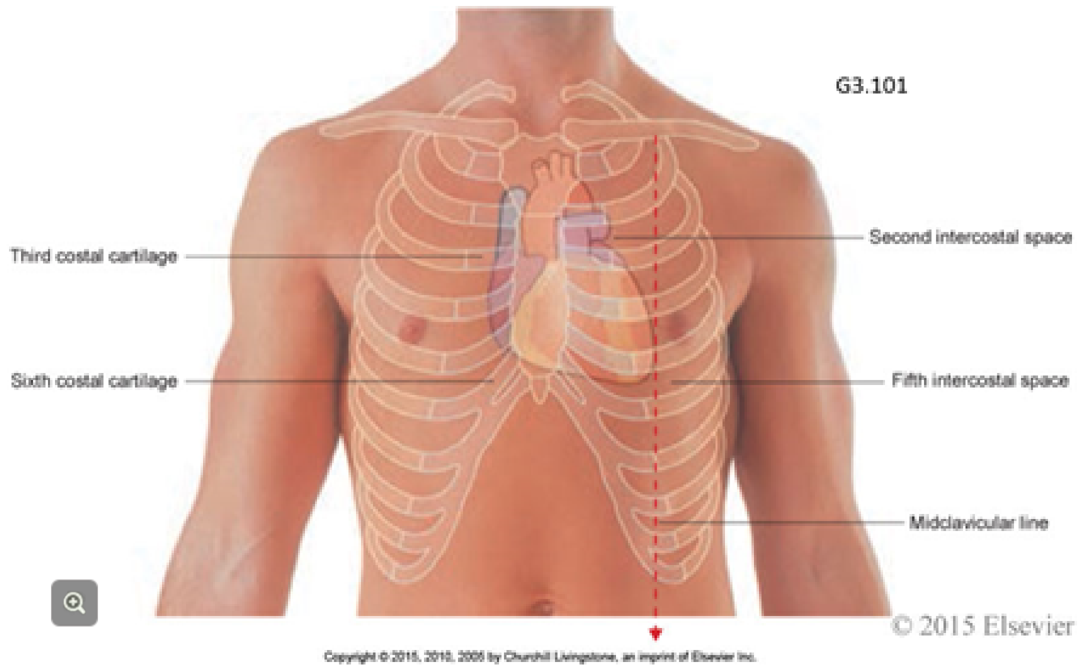
You cannot directly view the posterior border (base) of the heart, but slip your hand behind it and realize that it consists largely of the left atrium with a contribution from the right atrium and great vessels.

Lastly, notice the position of the apex of the heart: it is normally in the left fifth intercostal space in the midclavicular line.

TASK

LOOK at the heart *in situ*

The superior border of the heart is described as consisting of the right and left atria and their appendages (auricles).



You cannot directly view the posterior border (base) of the heart, but slip your hand behind it and realize that it consists largely of the left atrium with a contribution from the right atrium and great vessels.

Lastly, notice the position of the apex of the heart: it is normally in the left fifth intercostal space in the midclavicular line.

Remember that the **pericardial sac** consists of **two, fused layers**: an outer **fibrous layer of the parietal pericardium** and an inner **serous layer of the parietal pericardium**. The fibrous layer is continuous with the outermost, CT layer of blood vessels, the tunica adventitia, and the serous layer of the parietal pericardium reflects onto the heart to be continuous with the visceral layer of the serous pericardium. The **visceral layer** of the serous pericardium is **synonymous with the epicardium**, encountered when one studies the histology of the heart.

TASK

RUN your finger

over the surface of the heart and confirm that when you meet the limit of the pericardial cavity, this membrane reflects onto the inner surface of the pericardial sac to become the parietal layer of the serous pericardium. Realize that the pericardial cavity is a potential space, normally containing only a capillary layer of serous fluid that acts to lubricate the movement of the heart relative to the pericardial sac.

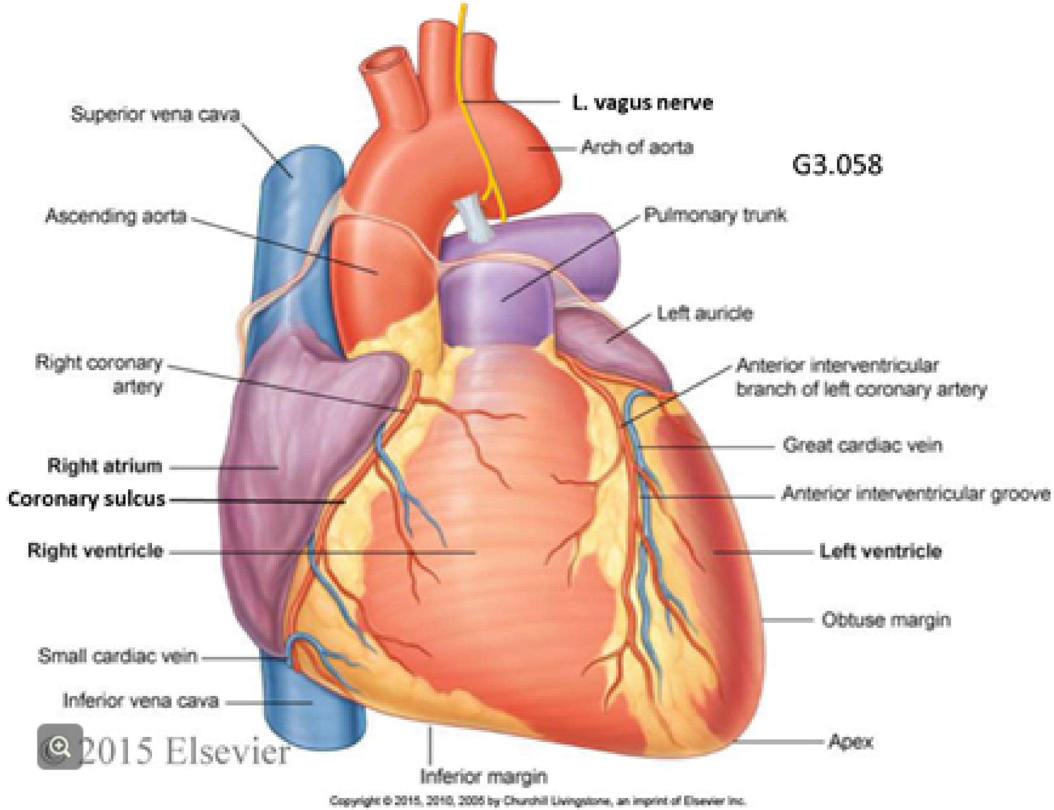
TASK

Start by IDENTIFYING

the following structures on the model from the anterior aspect, and on the heart *in situ*:

- the superior vena cava,
- the ascending aorta,
- the arch of the aorta, and
- the pulmonary trunk.

On the cadaver, slip your finger between the aortic arch and the pulmonary trunk and identify the ligamentum arteriosum.



Lateral to the ligamentum arteriosum, identify a thick cord crossing the arch of the aorta; this is the left vagus nerve. Using a blunt probe, release the vagus nerve from overlying tissue and identify its recurrent branch, passing under the arch of the aorta to recur upward to the neck and larynx. The main trunk of the left vagus nerve continues distally, posterior to the root of the lung. **Do not dissect the vagus nerve any further at this time.**

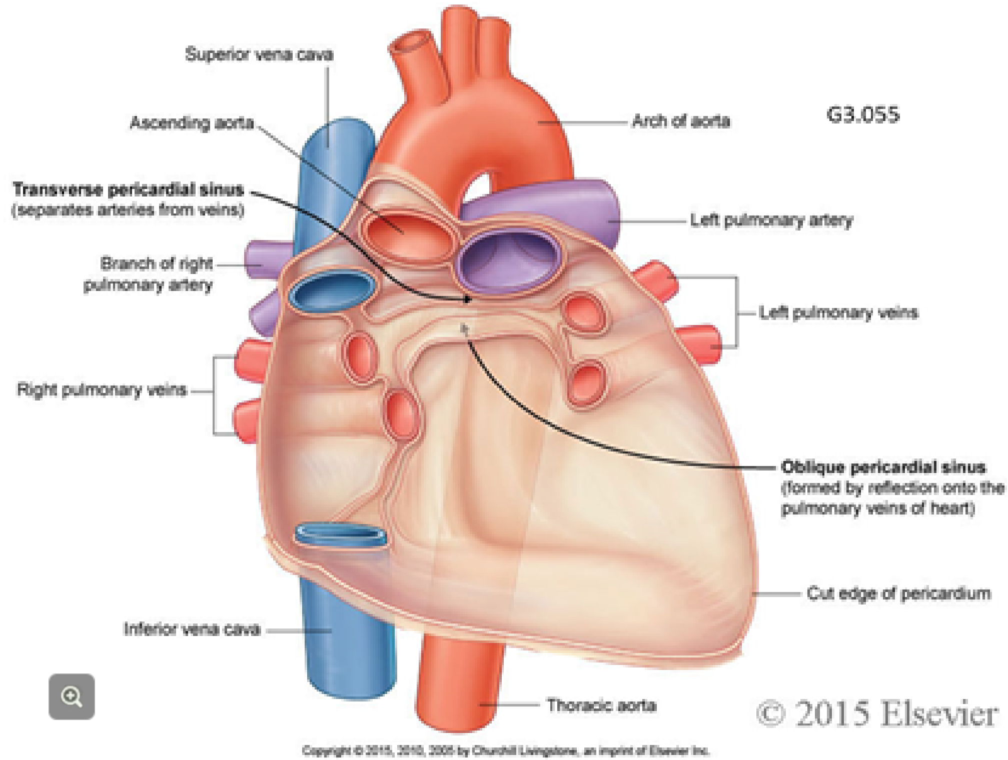
TASK

In PREPARATION for

removing the heart, establish the limits of the pericardial sac, which will determine your incisions.

Slip one hand posterior to the heart and slide it superiorly; you will encounter a dead-end. This is the **oblique pericardial sinus**; realize that it is **bounded on the right by the IVC and superiorly by the pulmonary veins**.

Next, slide your left index finger between the SVC and the ascending aorta and push it to the (cadaver's) left until it emerges between the pulmonary trunk and the left atrial appendage. Your finger is in a serous-lined tunnel, the transverse pericardial sinus.



The formation of the sinuses will become clear upon learning the development of the heart.

Lastly, with your fingers, explore the limits of the pericardial cavity where visceral pericardium covering the great vessels reflects onto the inner surface of the pericardial sac.

T A S K

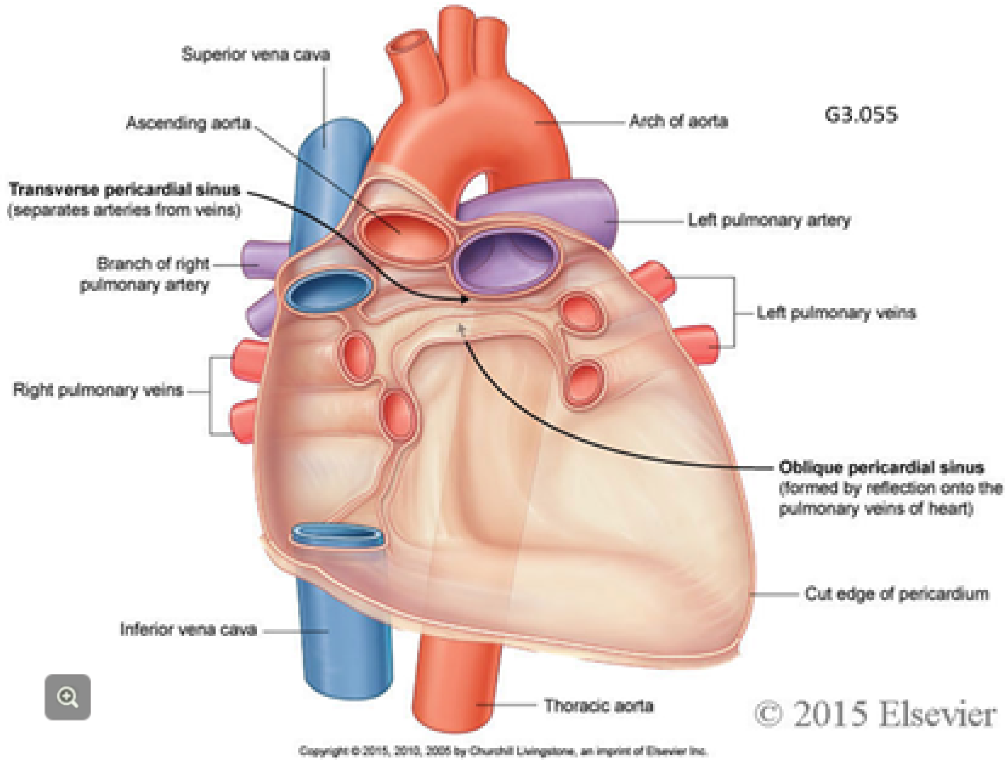
SLIDE a probe

through the transverse pericardial sinus. Insert the blunt end of large scissors through the sinus, anterior to the probe, and cut through the pulmonary trunk and ascending aorta, leaving a 1 cm stump of these vessels attached to the heart.

Continue to work with large scissors.

Cut through the SVC, leaving a 1 cm stump of the vessel attached to the right atrium.

Lift the diaphragmatic surface of the heart to stretch the IVC and cut through it close to the point where it passes through the diaphragm.



Now that the heart is free from the diaphragm, lift it further and feel the margins of the oblique sinus formed by the pulmonary veins. Cut through the pulmonary veins close to the pericardial sac. All vessels having now been cut, it remains only to cut the reflections of serous membrane that hold the heart in place, and remove it.

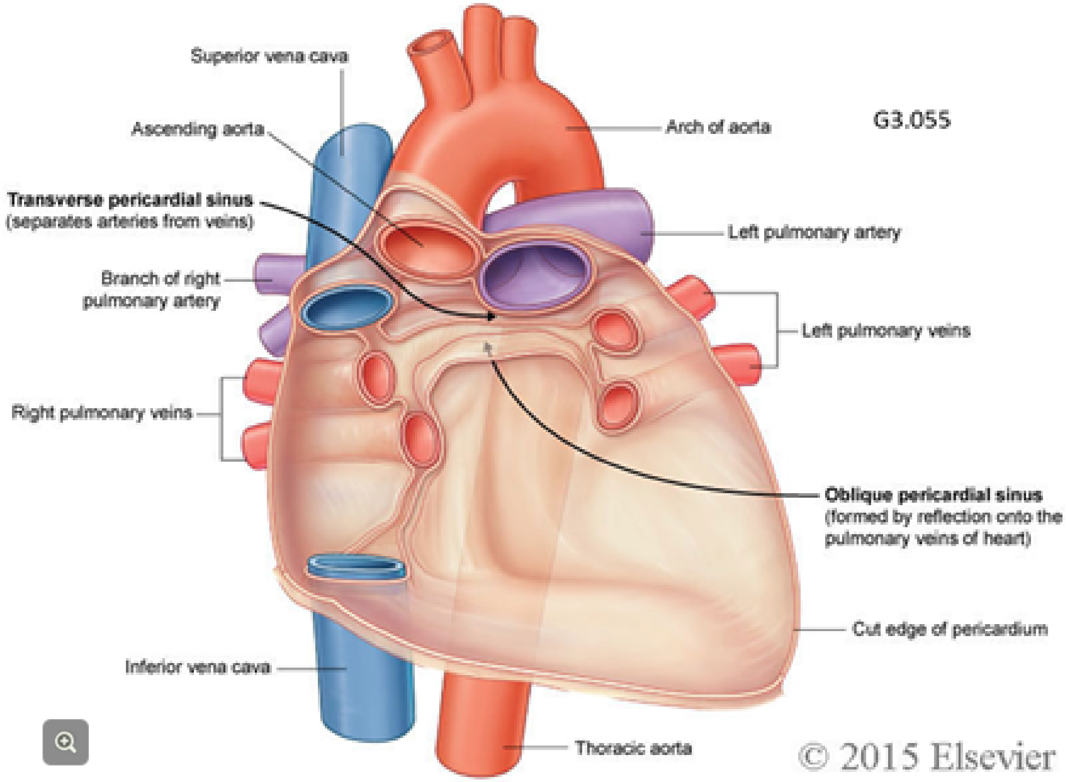
T A S K

COMPARE the posterior surface of the pericardial sac to the diagram provided.

Identify the openings of the vessels you have transected and the lines of pleural reflection. Moisten your cadaver, cover it with damp cloths and close the body bag while you proceed to dissect the heart.

The four pairs working on this exercise should gather together at one table so that they can share and study all four hearts being dissected.

The coronary blood vessels will be dissected and their courses over the surface of the heart will be studied. The blood supply to the various walls and structures of the heart will be understood with reference to the position of these vessels on the surface of the heart.



Since embarking on this exercise, you have **identified** the following structures and learned the **answers to the following questions**:

- Describe the location of the thymus gland.
- Name / identify the chambers that make up the various surfaces of the heart: its anterior surface, its posterior surface (base), its inferior (diaphragmatic) surface, its right and left margin. What structures define its superior border?
- Identify and name the layers that form the pericardial sac. What is the histological composition of each? Identify the visceral layer of the serous pericardium. What is its synonym, used when describing the layers of the heart? What occupies the pericardial cavity in life? What is its purpose?
- Identify the superior vena cava, arch of the aorta, pulmonary arteries, ligamentum arteriosum, left vagus nerve and its recurrent branch.
- In the cadaver, in the remnants of the pericardial sac, identify the openings of the IVC, SVC, aorta, pulmonary trunk and pulmonary veins.

If you are satisfied with your **ability to identify these structures** and **answer these questions**, call your TA over for confirmation and for **permission to move on** to the next stage of the exercise.

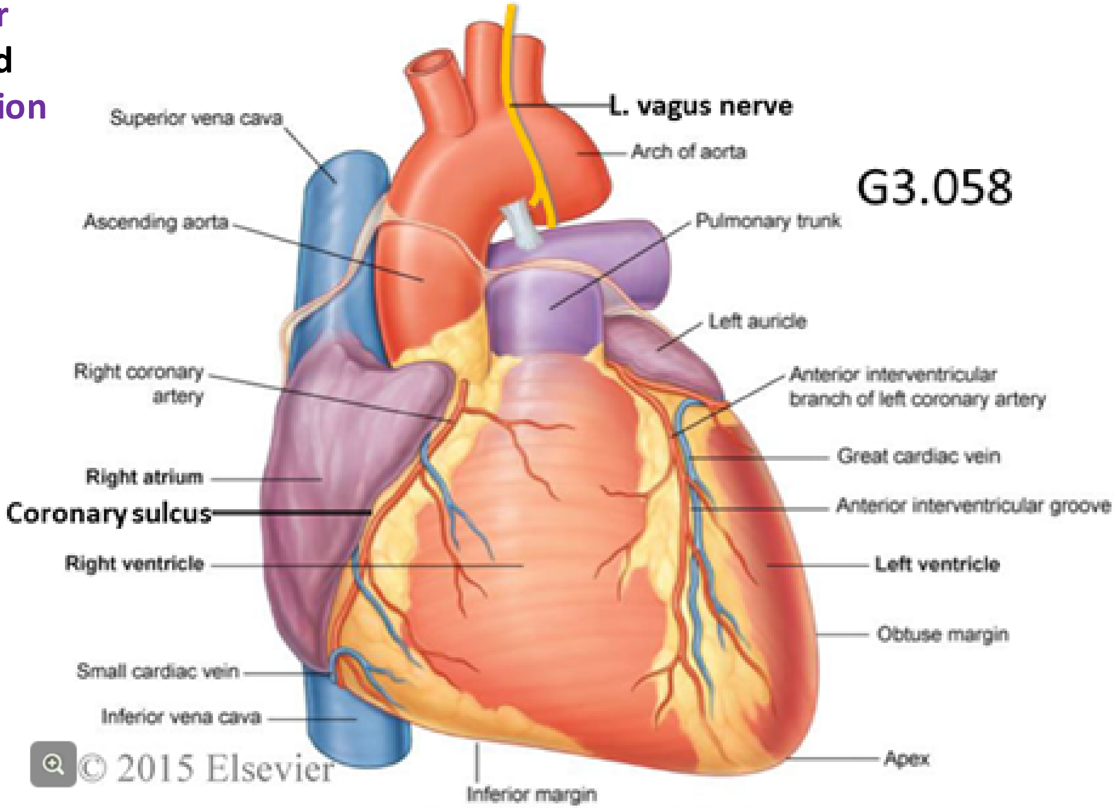
T A S K

IDENTIFY the coronary (atrioventricular) sulcus.

Its name comes from the fact that it runs around the heart like a crown on a head. **It separates the atria, above and behind, from the ventricles, below and in front**. Turn the heart around in your hand and confirm this for yourself.

Identify the anterior interventricular sulcus, which separates the right and left ventricles and denotes the location of the interventricular septum.

Notice that the anterior interventricular sulcus joins the coronary sulcus at a right angle.



T A S K

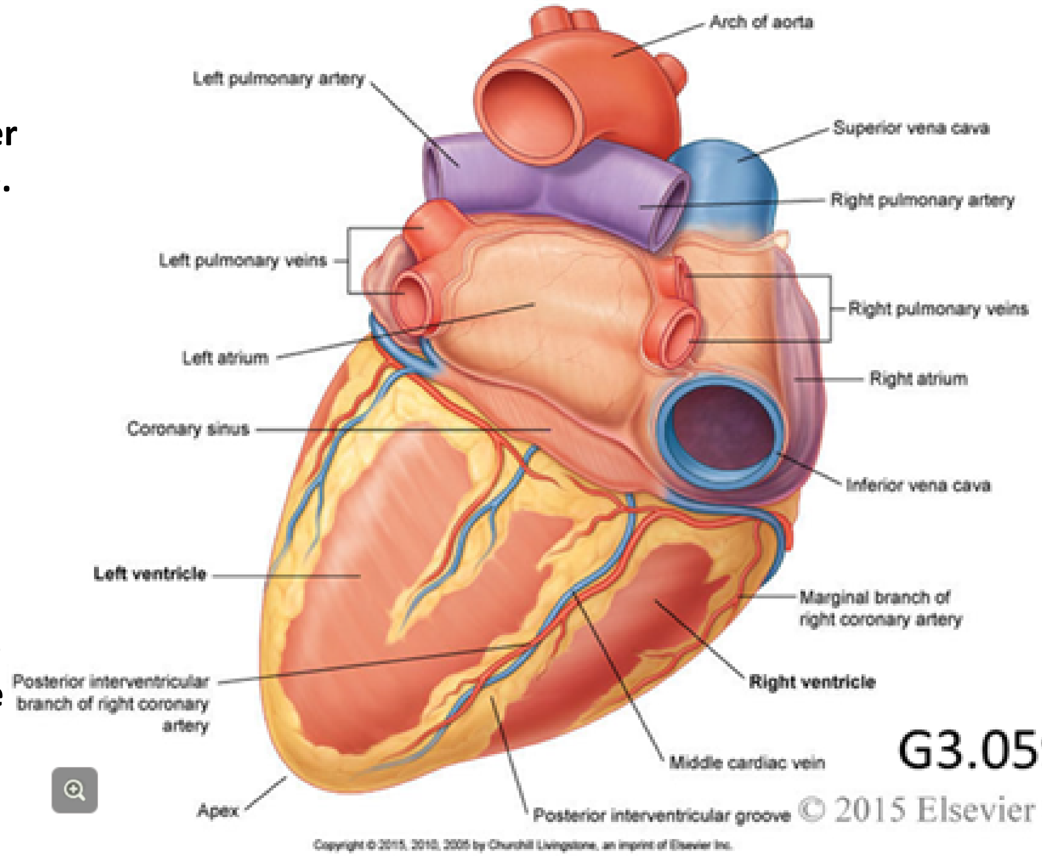
TURN the heart over

and follow the anterior interventricular sulcus onto the diaphragmatic (inferior) surface of the heart, where it becomes the posterior interventricular sulcus.

Identify the chambers that make up the diaphragmatic surface of the heart: the left ventricle with a smaller contribution from the right ventricle.

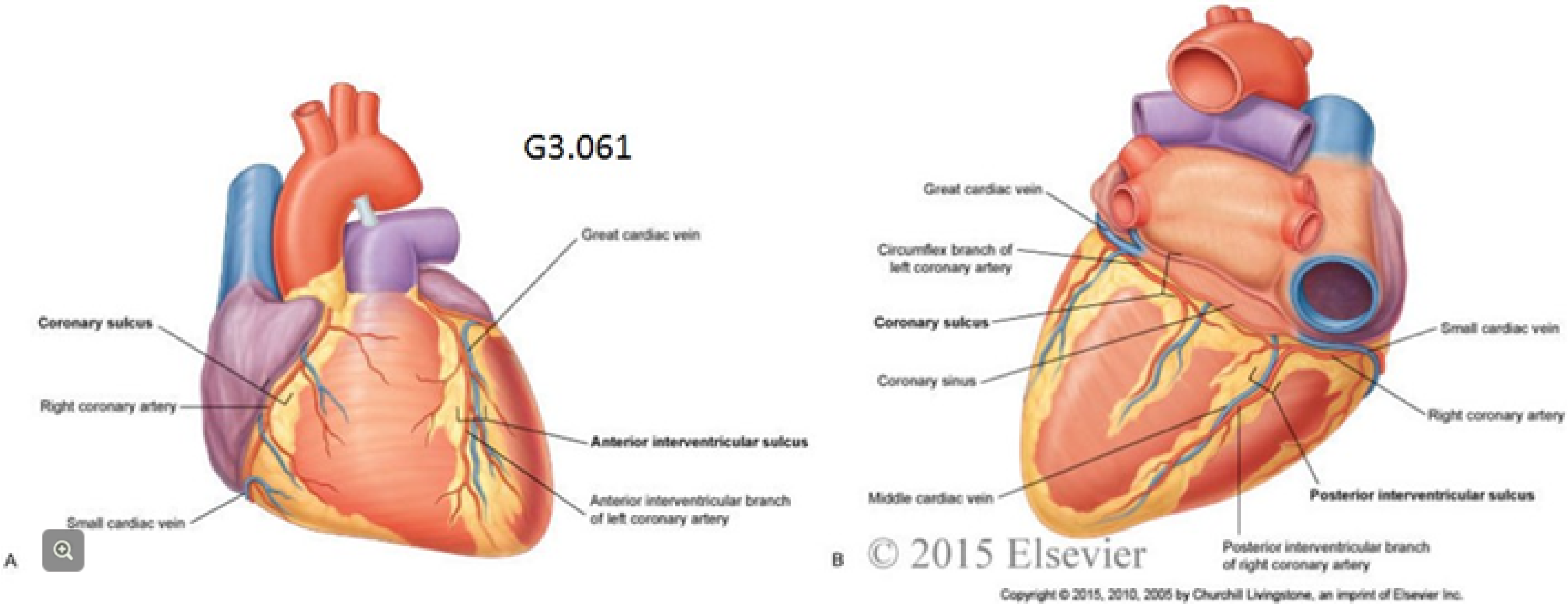
Identify the chambers that make up the base (posterior surface) of the heart: the left atrium with a smaller contribution from the right atrium. Identify the pulmonary veins, associated with the left atrium and the opening of the IVC associated with the right atrium.

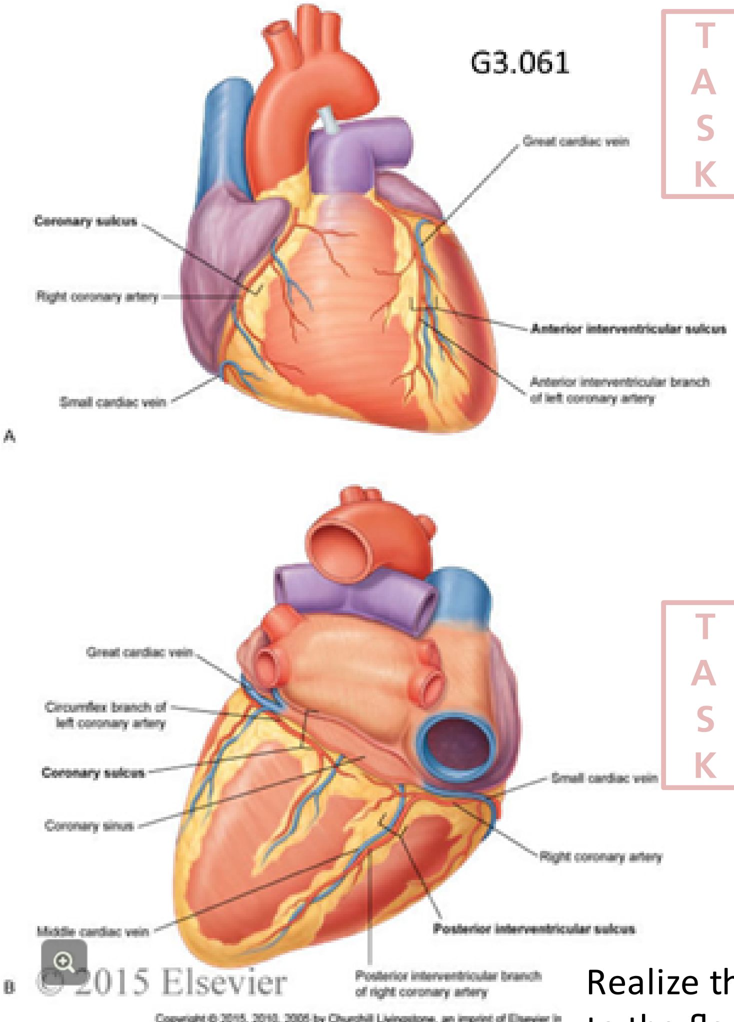
From its superior aspect, identify the aorta and aortic semilunar valve, the pulmonary trunk and pulmonary semilunar valve, and the SVC.



G3.059

The coronary arteries and cardiac veins largely course in the coronary and interventricular sulci. They lie in fat, sandwiched between the visceral pericardium (epicardium) and the myocardium. You will use blunt dissection to free them of this fat, leaving the vessels exposed and available for later study by you and your colleagues. The cardiac veins lie superficial to the coronary arteries, so you will encounter them first in your dissection.





TASK

Start by IDENTIFYING:

the coronary sinus on the diaphragmatic surface of the heart lying in the coronary sulcus. The term "sinus" is used to denote a dilated space, in this case the widest venous vessel of the heart which collects blood from most of its major veins. The coronary sinus empties into the right atrium. Its opening is seen in Exercise 8.1, upon studying the internal features of the right atrium. **Use a probe, a scalpel handle, or closed scissors to carefully scrape away the fat that surrounds the coronary sinus in order to expose the vessel for study.**

TASK

Continuing with blunt dissection, FOLLOW:

the coronary sinus toward the left border of the heart. Its name changes to the great cardiac vein. The great cardiac vein continues in the coronary sulcus until it meets the anterior interventricular sulcus, at which point it descends toward the apex of the heart.

Realize that you have been following this vein in the direction opposite to the flow of blood within its lumen. Blood flows in the great cardiac vein runs from the apex of the heart toward the coronary sinus.

TASK

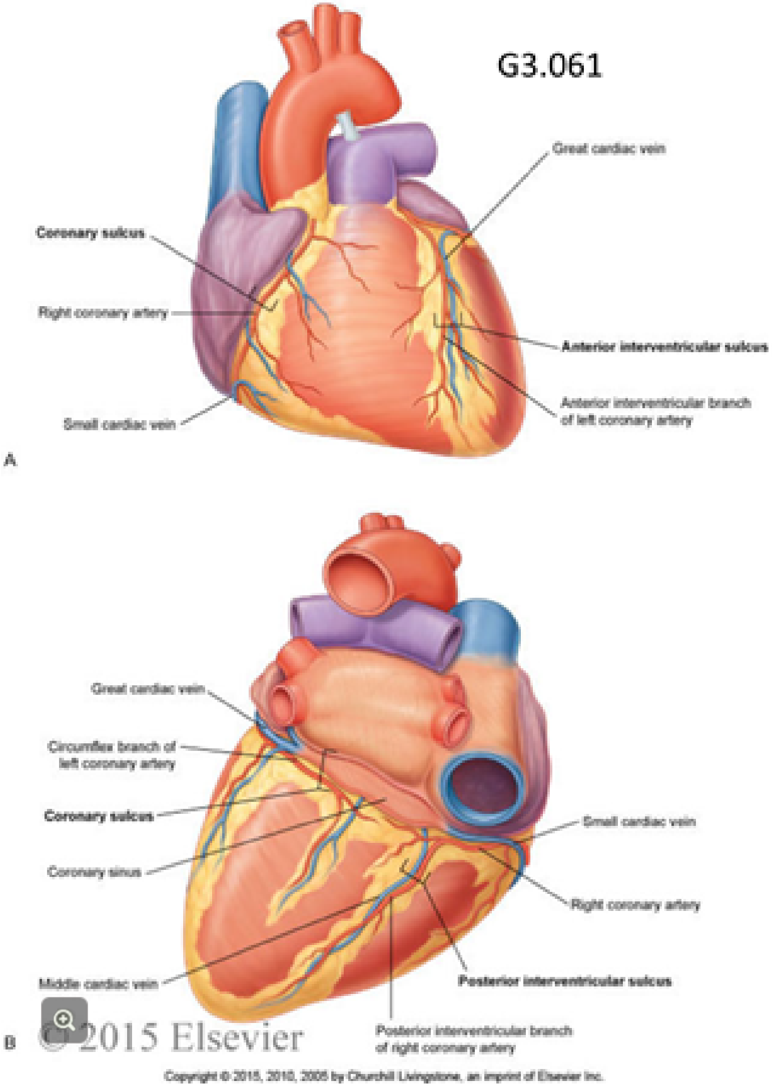
FIND the junction of

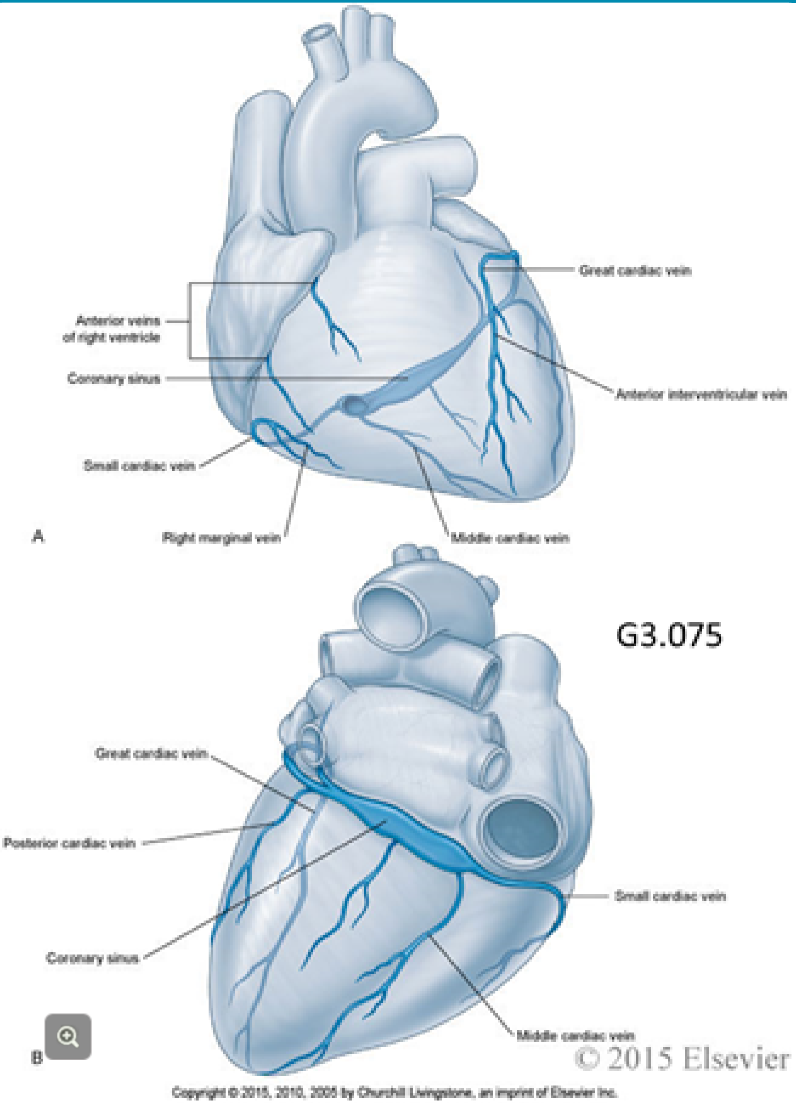
the **middle cardiac vein** **with the coronary sinus at the point** **where the posterior interventricular sulcus meets the coronary sulcus**. **Again, using blunt dissection, clear the fat surrounding the middle cardiac vein, exposing it along its length within the posterior interventricular sulcus** **to the apex of the heart**. Realize that the great and middle cardiac vein form a **venous anastomosis** at the apex of the heart.

TASK

It may be difficult to EXPOSE

the small cardiac vein, which runs in the coronary sulcus between the right atrium and right ventricle as far as the right margin of the heart. It, too empties into the coronary sinus, close to its junction with the posterior interventricular sulcus. **If you are unable to locate the small cardiac vein, study it in an atlas picture or diagram.**





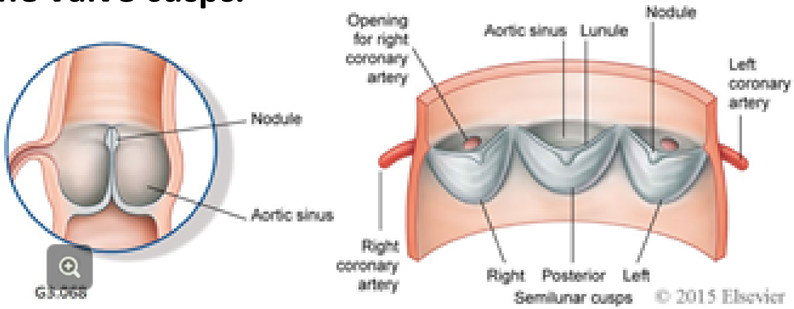
So far, all the veins you have studied have been tributaries to the coronary sinus. The anterior cardiac veins are not. You will be unable to identify the anterior cardiac veins in your dissection, but understand their significance using the accompanying diagram.

The anterior cardiac veins collect blood from the anterior wall of the right ventricle, and drain directly into the right atrium. Because they pass superficial to the right coronary artery, you may notice anterior cardiac veins when you dissect the right coronary artery.

TASK

TURN your attention to the ascending aorta.

Look down the ascending aorta toward the left ventricle. If you cannot see the aortic semilunar valve cusps clearly, it might help to shorten the stump of the aorta using large scissors. **Identify the aortic semilunar valve cusps, right, left and posterior. Identify the aortic sinuses, right, left and posterior, behind each of the valve cusps.**

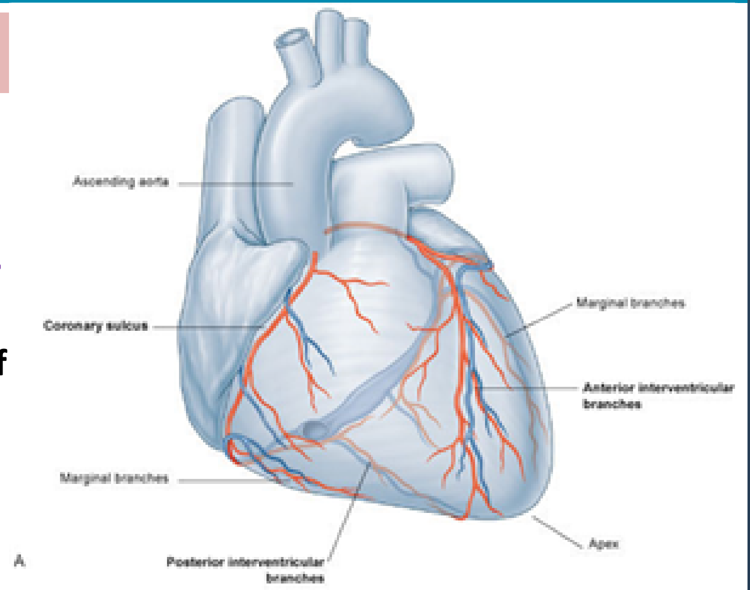


G3.068

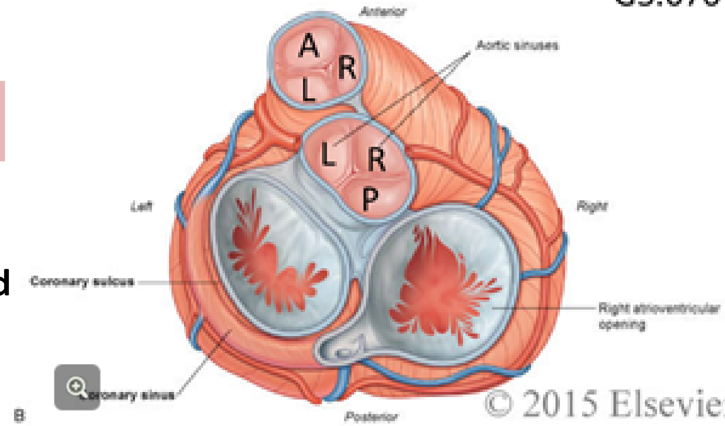
TASK

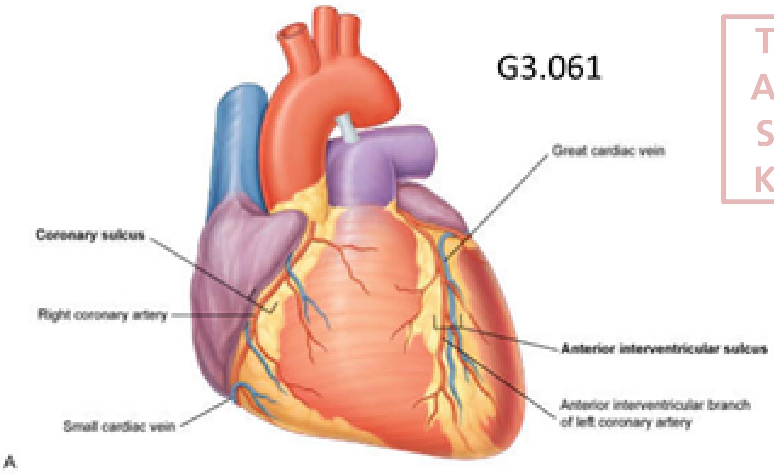
LOOK into the right and left aortic sinuses

and locate the os of the right and left coronary arteries, respectively. By inserting the tip of a blunt probe into the os of each of these arteries in turn, and palpating the external surface of the aorta, you will locate the origin of these arteries, and the point at which you will start your dissection of these vessels.



G3.070

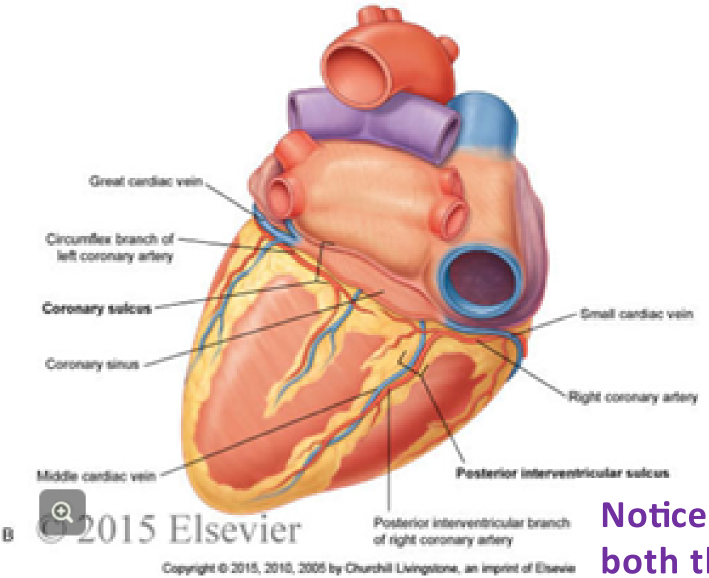




TASK

Having IDENTIFIED:

the origin of the left coronary artery using a blunt probe and your finger, start to remove the fat that surrounds it, using blunt dissection, so as to expose the vessel. Do not destroy the veins that you have previously exposed. The left coronary artery is short, perhaps a mere half centimeter. It bifurcates almost immediately to give the **anterior interventricular** (left anterior descending) **artery** and the **circumflex artery**.

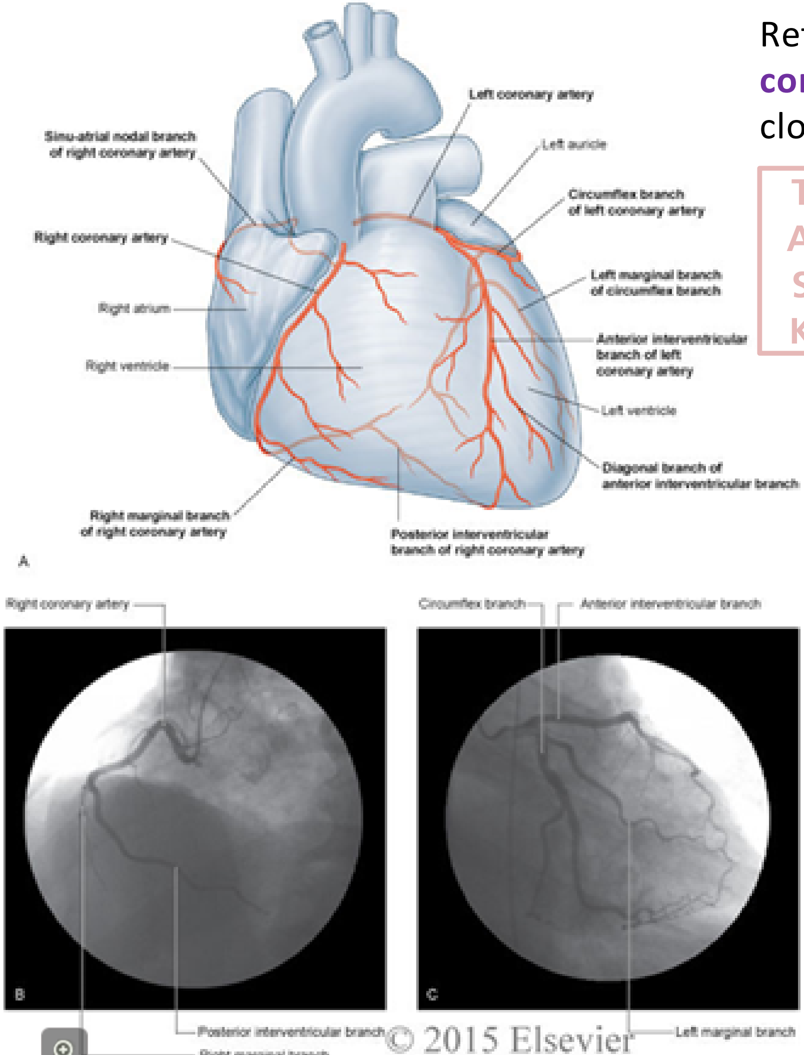


TASK

WORK carefully along the length of:

the anterior interventricular artery toward the apex of the heart, removing fat through blunt dissection. Return to the bifurcation of the left coronary artery and follow its other branch, the circumflex artery, in the coronary sulcus, around to the diaphragmatic surface of the heart. At the left margin of the heart, you may encounter a **left marginal branch**.

Notice that the great cardiac vein is the venous companion to both the anterior interventricular artery and the circumflex artery.



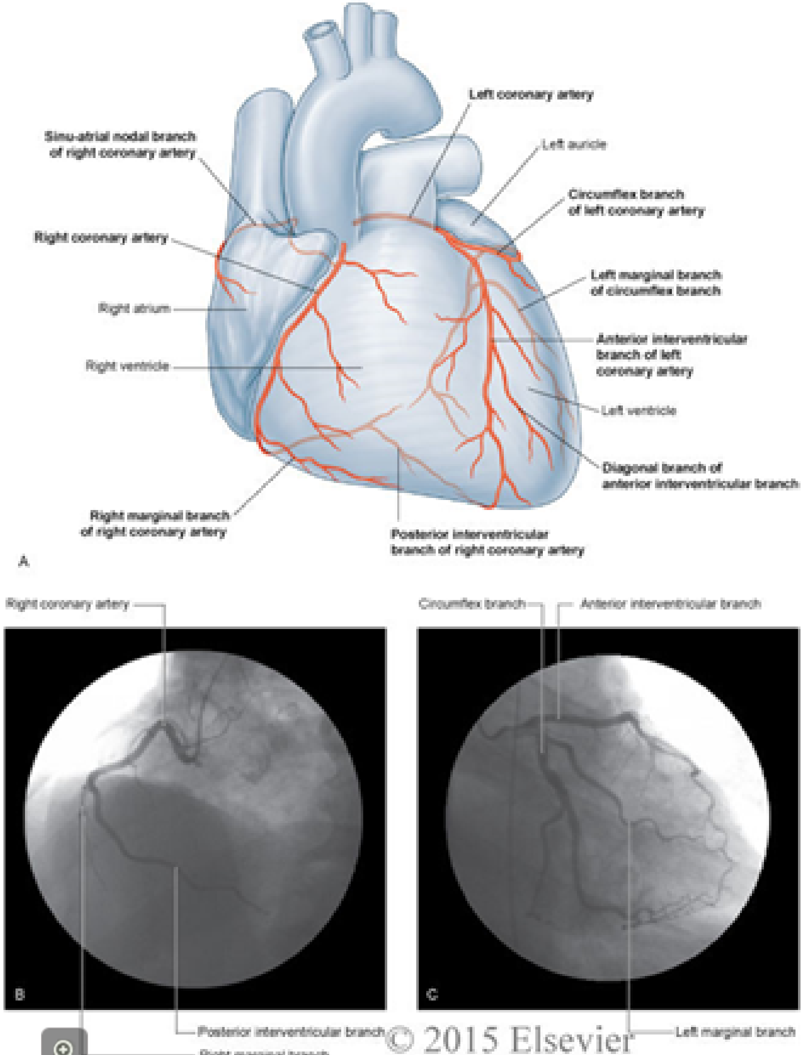
G3.071

Return to the aorta to begin your dissection of the **right coronary artery**. Again, use the back of a scalpel handle, closed scissors or a blunt probe to perform blunt dissection.

TASK

Near the origin of the right coronary artery:

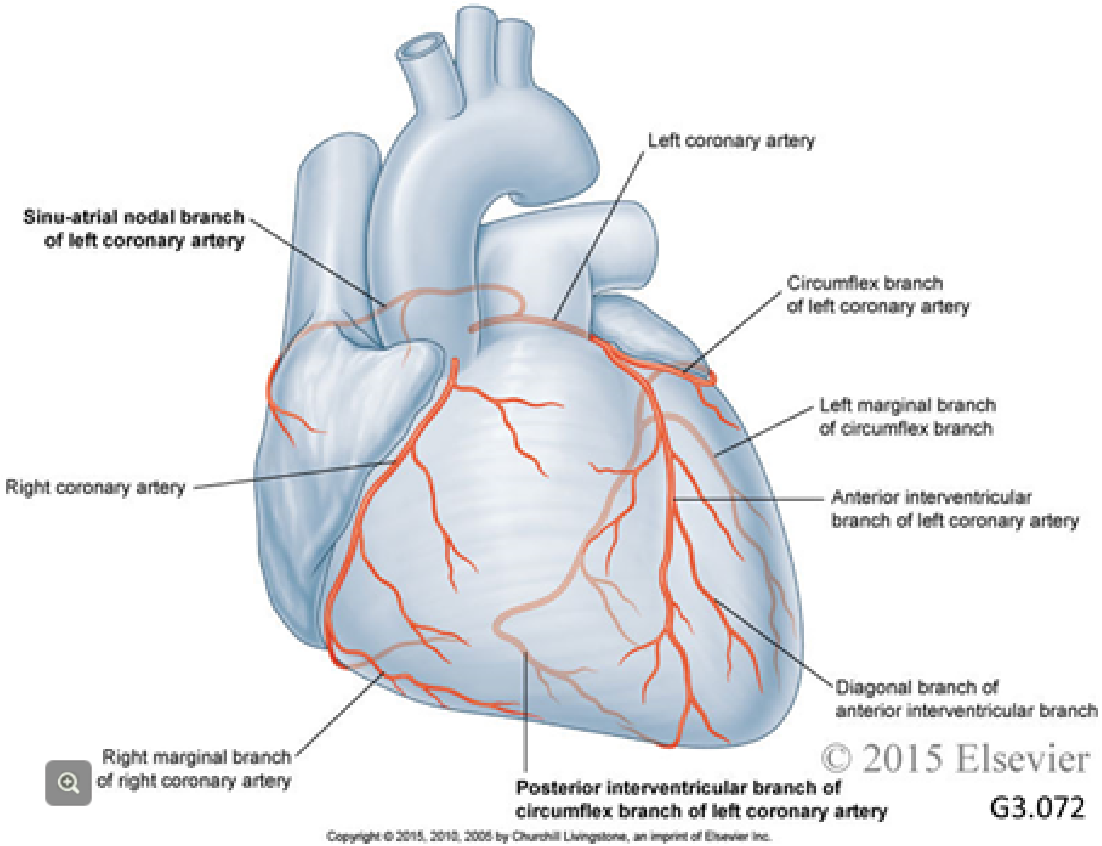
Look for the anterior right atrial branch, which tracts toward the SVC and which, in most people, gives rise to the sinoatrial nodal branch. Continue cleaning fat from the right coronary artery, taking care not to damage the anterior cardiac veins, should you have found them earlier in the dissection. At the right margin of the heart, you may encounter and clean the right marginal branch of the right coronary artery. Continue cleaning the right coronary artery around to the diaphragmatic surface of the heart toward the junction of the coronary sulcus with the posterior interventricular sulcus. At this point, the right coronary artery turns to follow the posterior interventricular sulcus toward the apex of the heart as the posterior interventricular artery.



G3.071

Notice that the middle cardiac vein is the venous companion to the posterior interventricular artery. It is worth mentioning that the AV nodal branch arises from the right coronary artery at the point where it bends to become the posterior interventricular artery. This is easy to remember once you learn the internal location of the AV node adjacent to the opening of the coronary sinus in exercise 8.1.

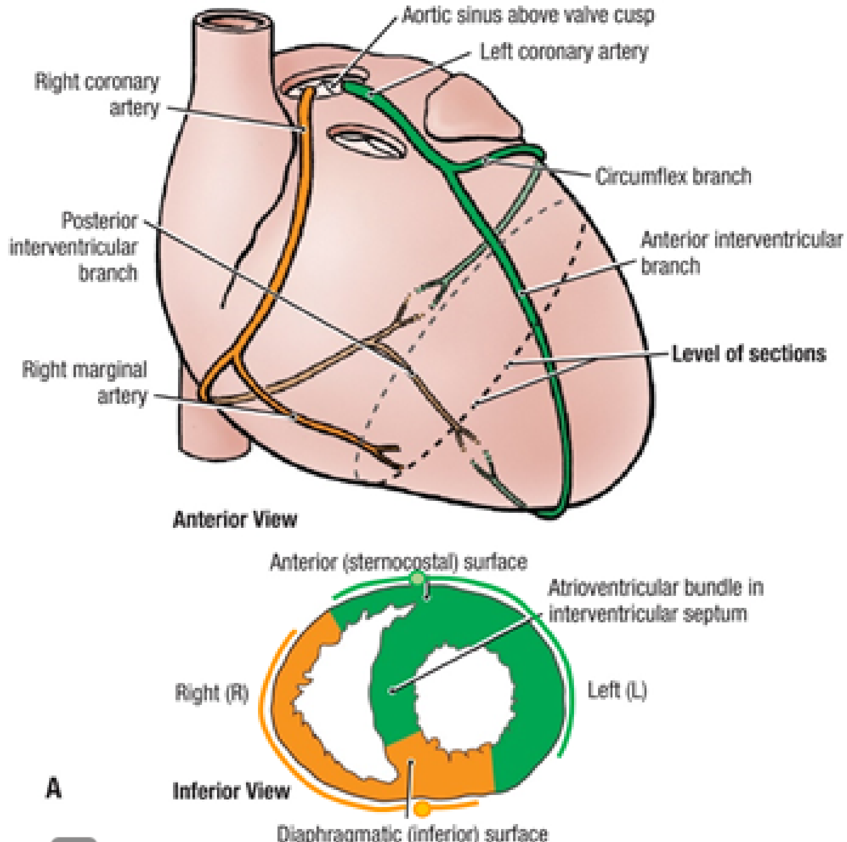
The architecture of the coronary blood supply varies between individuals, as illustrated in the accompanying figure. In a significant minority of individuals, the posterior interventricular artery arises from the terminus of the circumflex branch of the left coronary artery. Also illustrated, is the common variation in which the SA nodal branch arises from the left coronary artery.



The accompanying diagram from Grant's Atlas of Anatomy clearly illustrates the distribution of the coronary arteries to the ventricular walls and interventricular septum, including major portions of the conducting system of the heart located in the interventricular septum.

The distribution of the left coronary artery is in green and the distribution of the right coronary artery is in orange. A cross section of the heart is shown on the bottom, and the interventricular branches of the coronary arteries are shown on the sternocostal and diaphragmatic surfaces of the heart.

As can be seen, the left coronary artery, via penetrating branches of the anterior interventricular artery, supplies that anterior 2/3 of the interventricular septum, and therefore the atrioventricular bundle and its bundle branches. Obstruction of the anterior interventricular artery can cause failure of the conducting system of the heart.



Grant's Atlas, 13e, Fig. 1.51, LWW

Since embarking on this exercise, you have **identified** the following structures and learned the **answers to the following questions**:

- Identify the coronary, and the anterior and posterior interventricular sulci. What structure lies deep to the interventricular sulci?
- Using the isolated heart, identify its various surfaces: its anterior surface, its posterior surface (base), its inferior (diaphragmatic) surface, its right and left margin. Identify the chambers that make up each.
- Identify the coronary sinus, great cardiac vein, middle cardiac vein and small cardiac vein. Which veins anastomose at the apex of the heart? Describe the anterior cardiac veins.
- Identify the aortic semilunar valve cusps, right, left and posterior, and their associated sinuses. Identify the ossa of the right and left coronary arteries within the sinuses.
- On the surface of the heart, identify the left coronary artery, the anterior interventricular artery, the circumflex artery, right coronary artery, the posterior interventricular artery. Identify the right and left marginal arteries and the sinoatrial nodal artery in at least one of the hearts in your lab. Which arteries anastomose at the apex of the heart? Which arteries anastomose at the junction of the coronary sulcus with the posterior interventricular sulcus? Where does the AV nodal branch arise?
- Name the venous companion to the anterior interventricular, circumflex, right coronary and posterior interventricular arteries.
- When presented with a heart surface, be able to describe its blood supply.

If you are satisfied with your **ability to identify these structures** and **answer these questions**, call your TA over for confirmation and for **permission to move on**.

8.4 The Skeleton of the Upper Limb

What you'll need:

SPECIMENS

- Hanging skeleton
- Articulated upper limb
- Loose scapula, clavicle, humerus, radius, ulna
- Articulated hand

When you have learned the material presented in this exercise, you will be able to recognize and describe the:

- bones of the pectoral girdle and their major features
- bones of the upper limb and their major features
- bones that meet to form the articulations of the upper limb

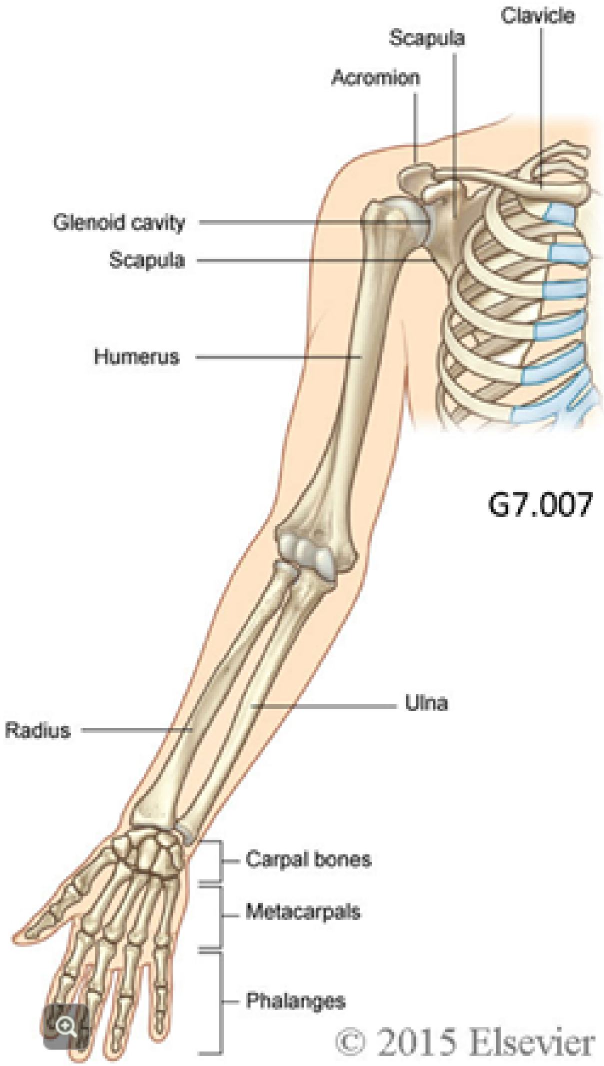
The upper limb includes the **humerus, radius, ulna** and the bones of the wrist and hand, the **carpal bones**, **metacarpals** and **phalanges**. The upper limbs are attached to the axial skeleton by the **pectoral girdle**, consisting of the **clavicle and scapula**.

TASK

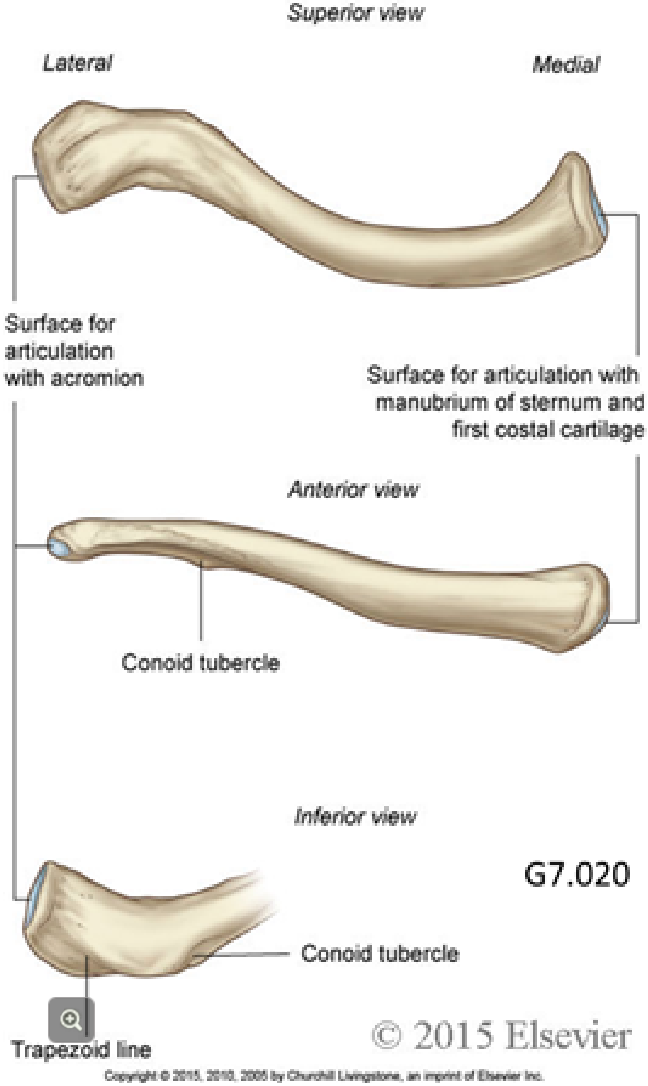
Start by IDENTIFYING:

each of these bones on the articulated skeleton, the articulated upper limb and from amongst the individual bones with which you have been supplied.

The **pectoral girdle** attaches the upper limbs to the axial skeleton. It consists of the **clavicles and scapulae**. The medial end of each clavicle articulates with the manubrium of the sternum at the **sternoclavicular joint**; this is the only articulation between the upper limb and the axial skeleton. The lateral end of the clavicle articulates with acromion of the scapula at the **acromioclavicular joint**. Identify these joints on the articulated skeleton.



G7.007



TASK

CHOOSE a disarticulated clavicle

from amongst the bones with which you have been provided.

Differentiate the sternal end from the acromial end by their shapes: the sternal end is round in profile, like a club, while the acromial end is flat, like a paddle. Its superior surface, being subcutaneous, is smooth, while its inferior surface is rough, as it is bound down by ligaments at both its medial and lateral ends.

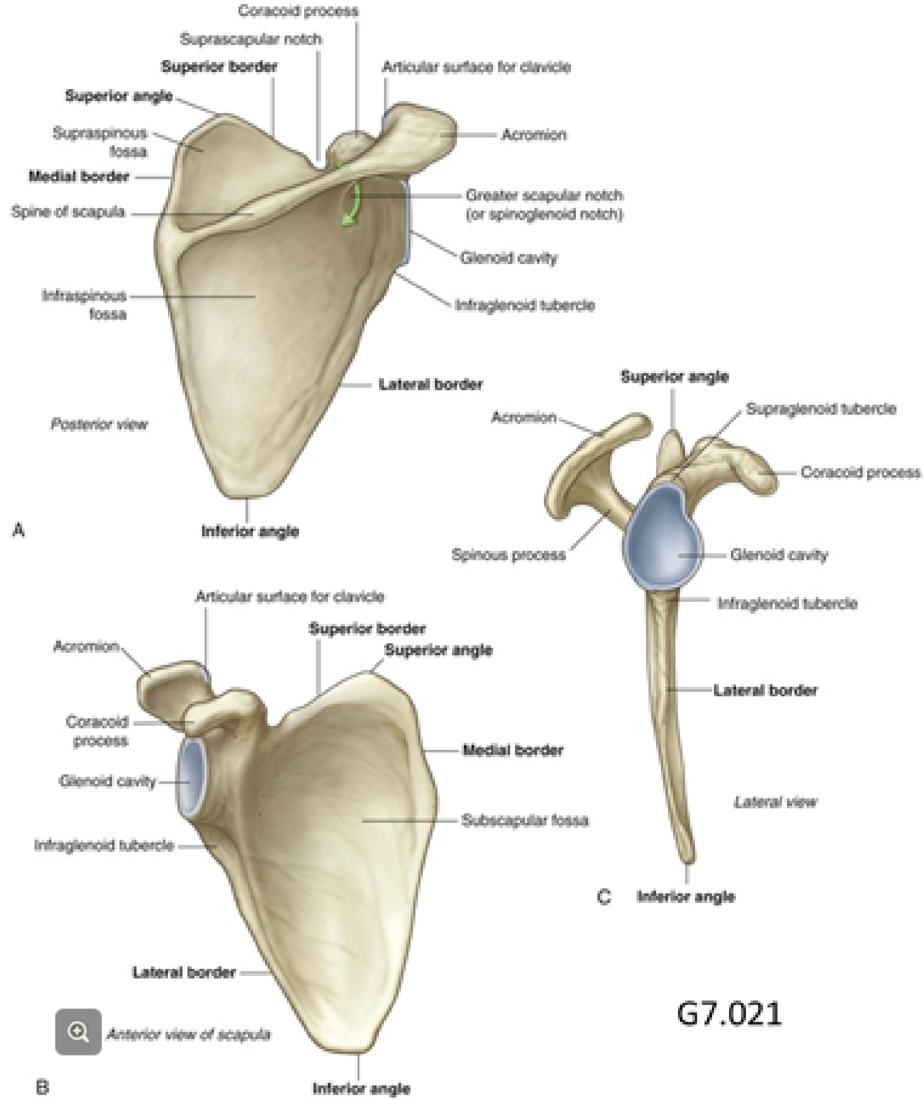
On the clavicle in your hand, differentiate its superior surface from its inferior surface.

Now that you have identified its medial and lateral ends, and differentiated its superior surface from its inferior surface, determine whether you are holding a right or a left clavicle.

T A S K

PICK UP a scapula

and start by differentiating is anterior surface from its posterior surface. Its concave anterior surface, the **subscapular fossa**, accommodates the convex surface of the thorax. Its posterior surface is identified by the prominent **spine of the scapula**.



G7.021

Being roughly triangular, the scapula has three sides and three angles.

TASK

IDENTIFY, on the scapula,

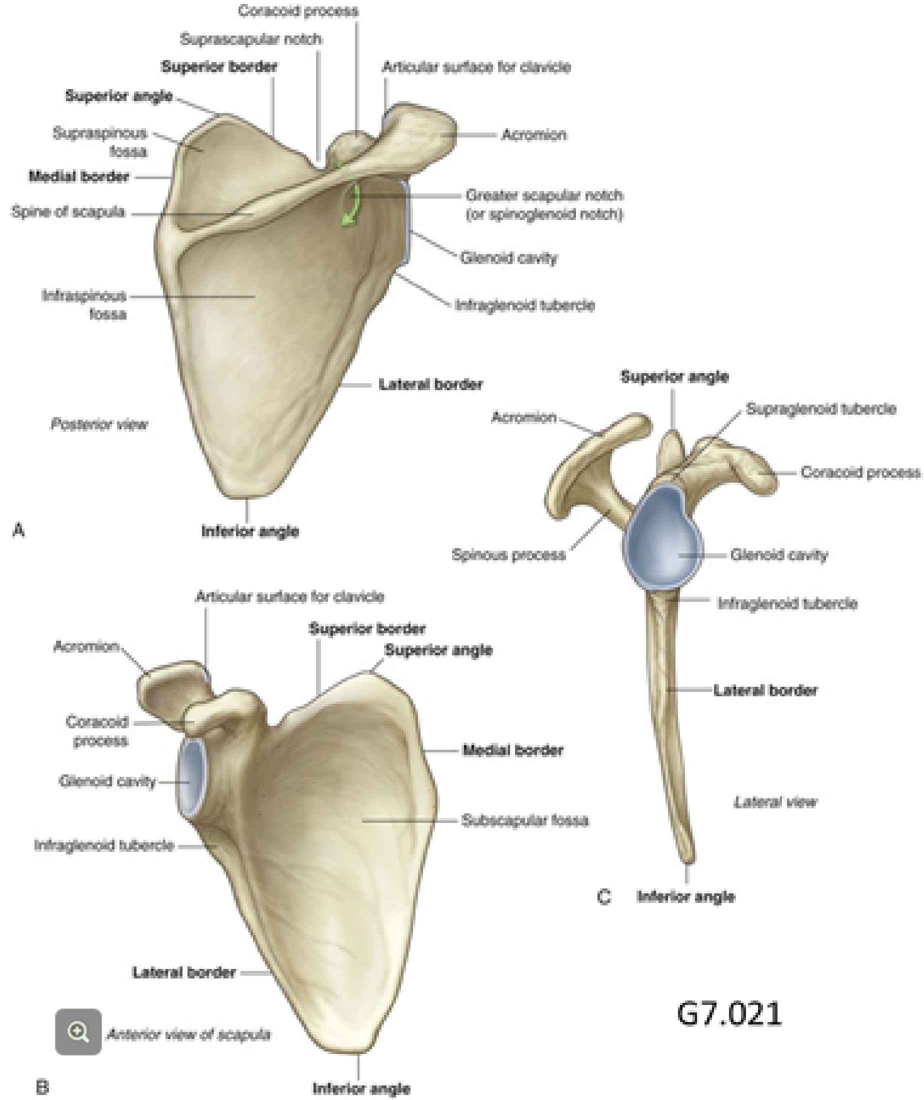
its medial, lateral and superior borders, and its superior inferior and lateral angles.

Identify the glenoid cavity, a feature of its lateral angle, which articulates with the head of the humerus to form the shoulder joint.

Identify the surfaces above and below the spine, aptly named the supraspinous and infraspinous fossae.

Identify the lateral expansion of the spine of the scapula, the acromion process, which articulates with the lateral end of the clavicle to form the acromioclavicular joint.

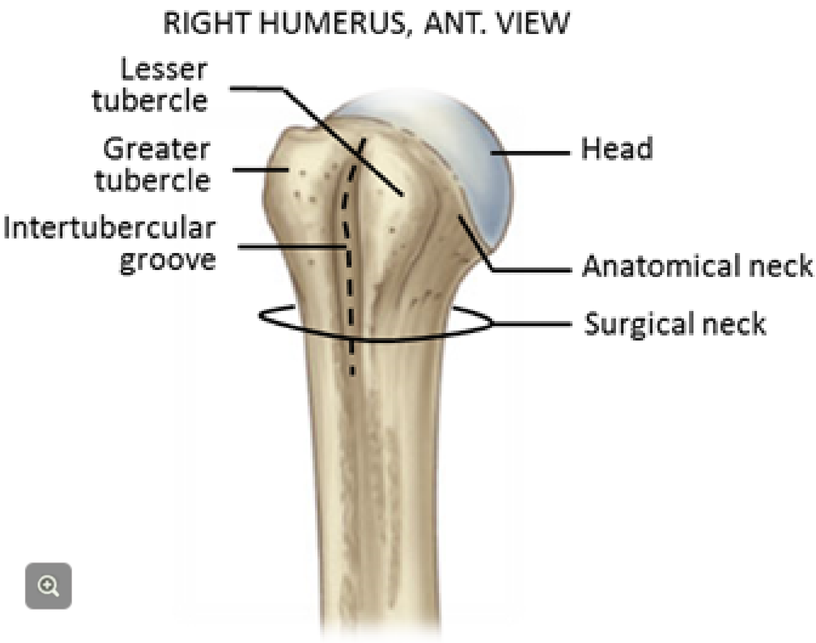
Identify the coracoid process, which extends anteriorly from its lateral angle and serves as a point of attachment for ligament and muscles.

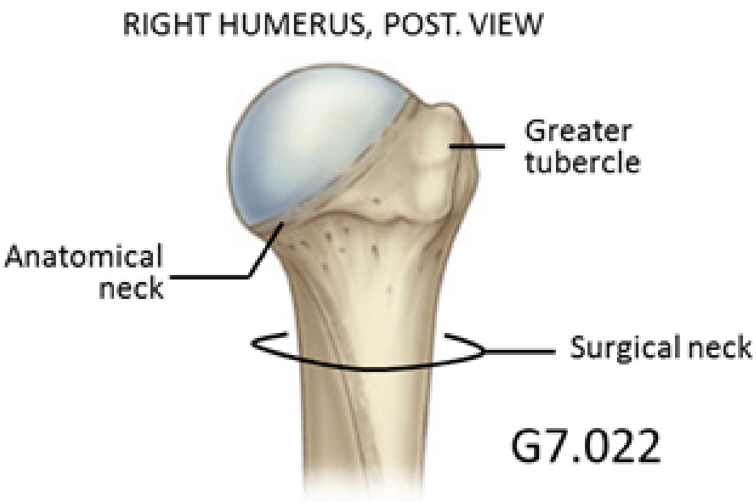


TASK

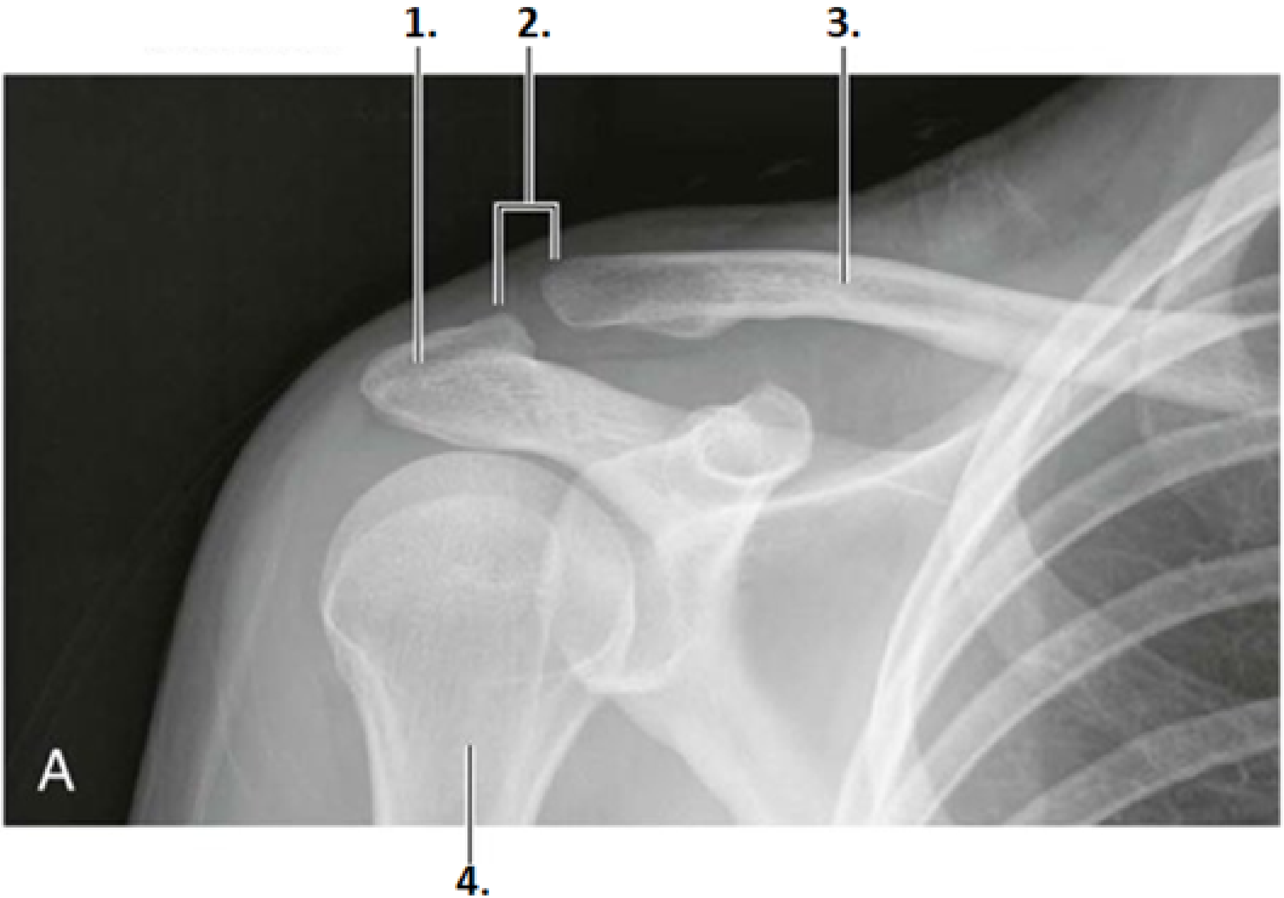
IDENTIFY the head of the humerus,

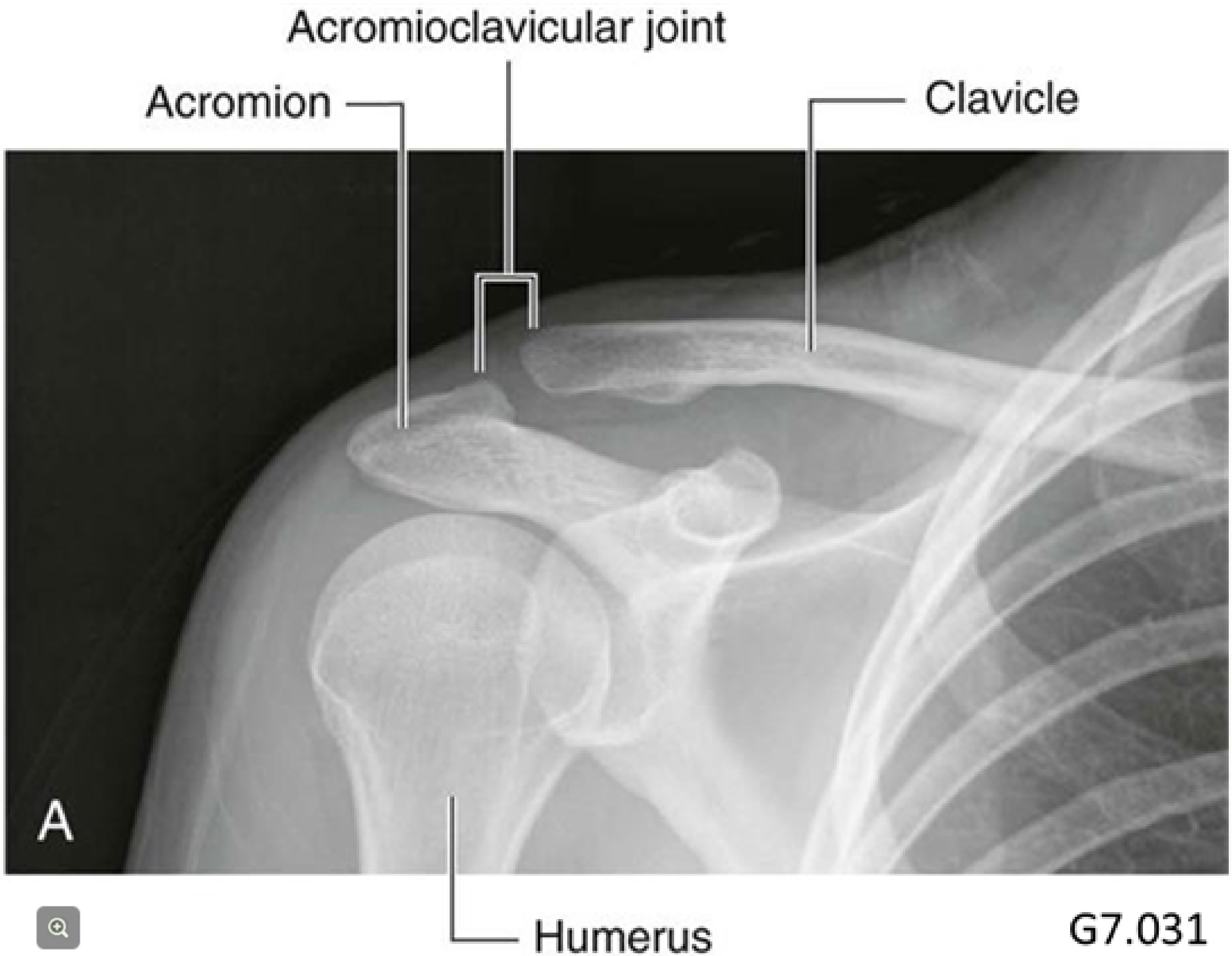
which articulates with the glenoid fossa of the scapula to form the shoulder joint. From the anterior aspect, identify its greater and lesser tubercles. These are traction epiphyses formed by the attachment of the rotator cuff muscles. Between the two tubercles, identify the aptly-named intertubercular groove. There are two, distinct, features of the humerus that are described as its neck: these are the anatomical neck, between its head and tubercles, and the surgical neck, just distal to its tubercles, where the humerus narrows to its shaft. The surgical neck is the most common location of humeral fractures.





G7.022


1.
2.
3.
A
4.



G7.031

Since embarking on this exercise, you have **identified** the following structures and learned the **answers to the following questions**:

- What is the function of the “pectoral girdle”? What bones comprise the pectoral girdle?
- On a bony limb, identify the sternoclavicular and acromioclavicular joints. What is the significance of the sternoclavicular joint?
- Clavicle: identify its medial and lateral ends, its superior and inferior surfaces, and distinguish a right from a left clavicle.
- Scapula: Identify its anterior and posterior surfaces, the subscapular fossa and the spine of the scapula. Identify its three borders and three angles. Identify the glenoid cavity (with what does it articulate?), supraspinous and infraspinous fossae, the acromion process (with what does it articulate?), and coracoid process (function?).
- Proximal humerus: Identify its head (with what does it articulate?), greater and lesser tubercles, intertubercular groove, anatomical neck and surgical neck. What is a “traction epiphysis”? Which of these features are traction epiphyses? What is the significance of the surgical neck?
- Be able to identify the major structures seen in an AP radiograph of the shoulder.

If you are satisfied with your **ability to identify these structures** and **answer these questions**, call your TA over for confirmation and for **permission to move on** to the next stage of the exercise.

The distal humerus articulates with both the ulna and the radius to form the **elbow joint**.

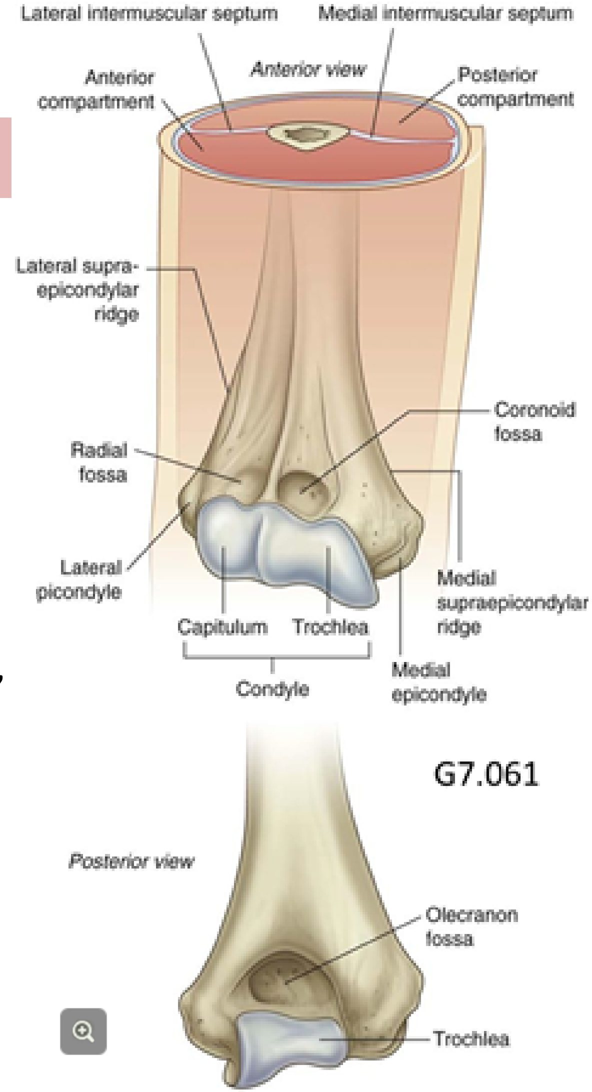
TASK

IDENTIFY the humeral condyle.

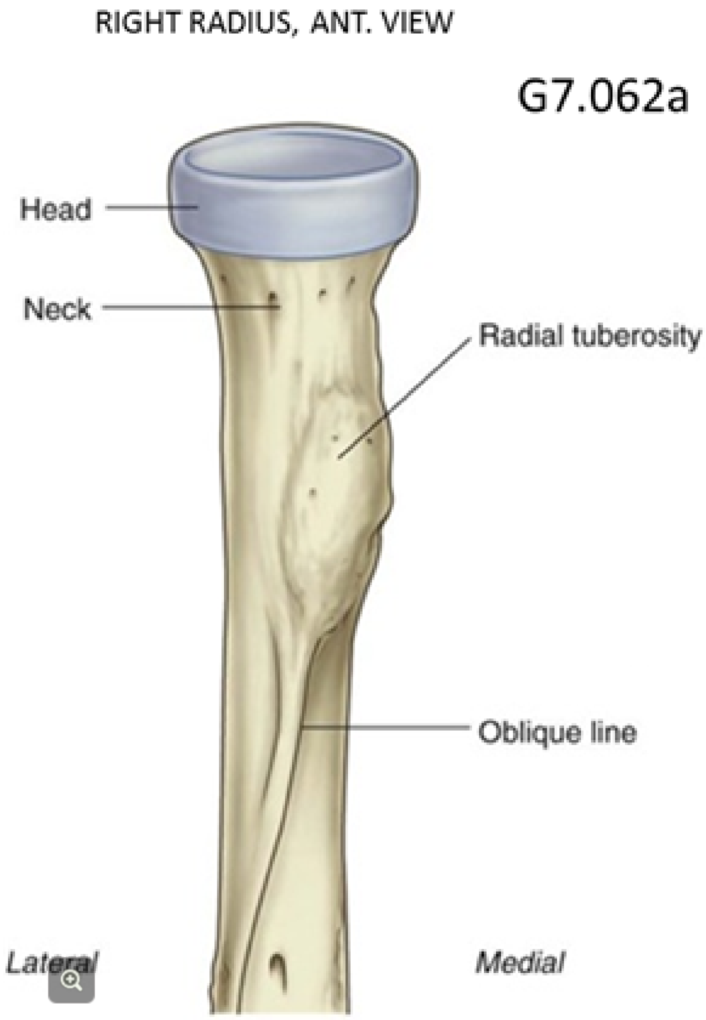
From its anterior aspect, identify the two subdivisions of the condyle, the capitulum, which articulates with the proximal radius, and the trochlea, which articulates with the proximal ulna. Proximal to the capitulum, identify the radial fossa, and proximal to the trochlea, identify the coronoid fossa.

Pick up the articulated bony limb and move the elbow through flexion and extension. Notice that in flexion, these fossae accommodate features of the proximal radius and ulna, respectively. Turn the humerus around, and notice that from the posterior aspect, only the trochlea is seen. Proximal to the trochlea, on its posterior aspect, identify the olecranon fossa. Again, move the articulated bony limb through flexion and extension and notice that the olecranon fossa accommodates the olecranon process, a feature of the proximal ulna.

Finally, identify the medial and lateral epicondyles, and their proximal extensions, the medial and lateral supracondylar ridges. These are traction epiphyses that develop in response to the pull of the forearm muscles that arise here.



G7.061



TASK

CHOOSE the radius

from amongst the disarticulated bones. Identify its head and neck.

The head of the radius contributes to two distinct articulations. The first of these is the humeroradial joint, between the capitulum of the humerus and the concave, superior surface of the radial head. The second is the proximal radioulnar joint, between the rim of the radial head and the radial notch of the ulna.

TASK

IDENTIFY the radial tuberosity,

a traction epiphysis that forms with the pull of the biceps brachii, which attaches here.


1.
2.
3.
4.
5.
6.
7.
8.
G7.062b
B


Humerus
Lateral epicondyle
Medial epicondyle
Capitulum
Trochlea
Head of radius
G7.062b
Radius
Ulna
B

T A S K

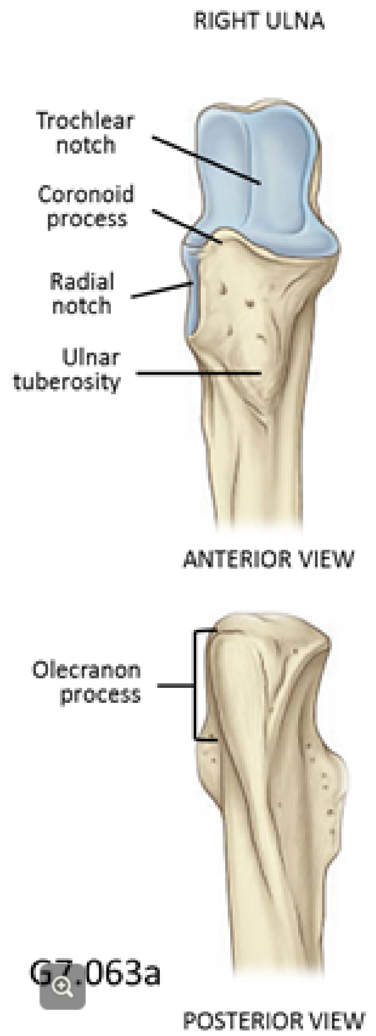
CHOOSE the ulna

from amongst the disarticulated bones. Identify its trochlear notch, coronoid process and olecranon process. Pick up the humerus and articulate the trochlear notch of the ulna with the trochlea of the humerus. Move the bones through flexion and extension. Notice that the coronoid process of the ulna occupies the coronoid fossa of the humerus in flexion. Notice that the olecranon process of the ulna occupies the olecranon fossa of the humerus in extension.

T A S K

On the disarticulated ulna, IDENTIFY:

the radial notch on the lateral aspect of its proximal end. Pick up the radius, and articulate the rim of its head with the radial notch of the ulna. These two surfaces form the proximal radioulnar joint. The head of the radius is held in place by the annular ligament, which surrounds the radial head and holds it against the radial notch of the ulna.




1.
2.
3.
G7.063b
B
© 2015 Elsevier
4.
5.
6.


1.
2.
3.
Radial tuberosity
Capitulum
Humerus
G7.063b
B
© 2015 Elsevier
Coronoid process
Trochlear notch
Olecranon

T A S K

IDENTIFY the distal end of the ulna,

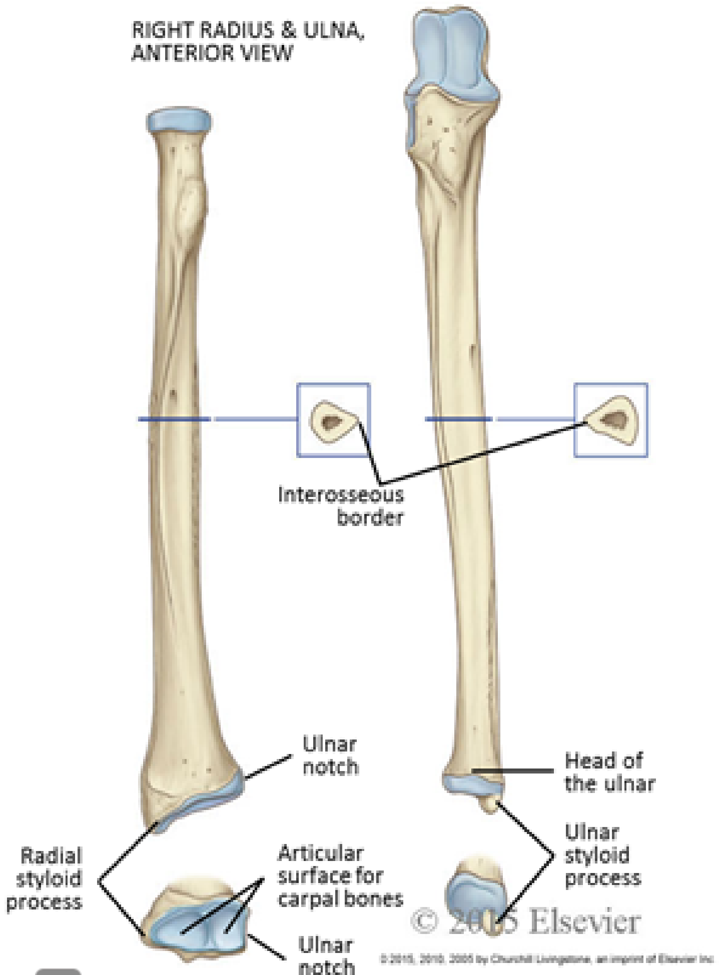
known as its head. Inspect the inferior surface of the distal radius and notice that it is smooth and concave. It articulates with **carpal bones** to form the **radiocarpal or wrist joint**. **Identify, on the medial aspect of its distal end, the ulnar notch of the radius.** It articulates with the head of the ulna in the formation of the **distal radioulnar joint**. **Identify the styloid processes of the radius and of the ulna.** These guide tendons across the distal aspect of the wrist into their points of insertion in the hand.

T A S K

IDENTIFY the

sharp interosseous borders of the radius and ulna. When the radius and ulna are articulated, these borders face each other.

The interosseous borders of the radius and ulna are joined by the **antebrachial interosseous membrane**. Like the crural interosseous membrane that joins the tibia and fibula in the leg, the antebrachial interosseous membrane functions largely to increase surface area for muscular attachment.



G7.078a G7.079

T A S K

IDENTIFY the distal end of the ulna,

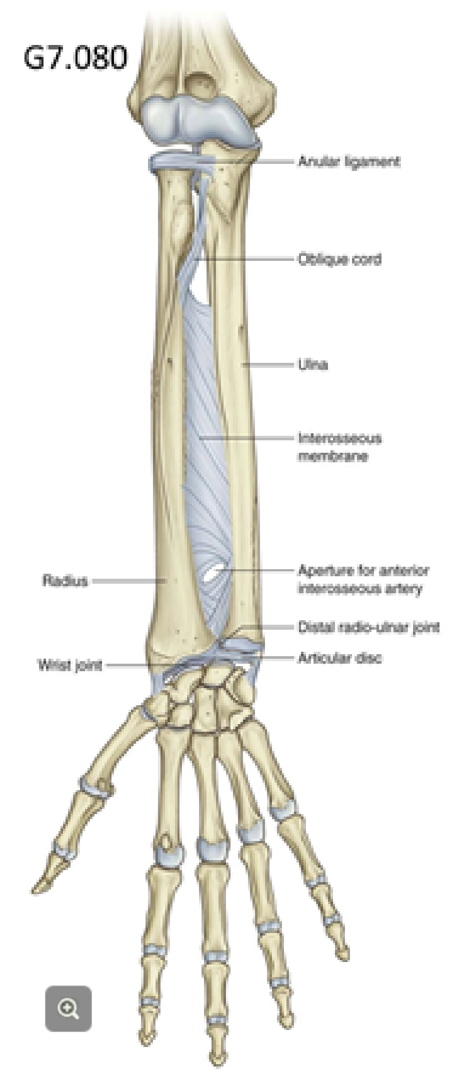
known as its head. Inspect the inferior surface of the distal radius and notice that it is smooth and concave. It articulates with **carpal bones** to form the **radiocarpal or wrist joint**. **Identify, on the medial aspect of its distal end, the ulnar notch of the radius.** It articulates with the head of the ulna in the formation of the **distal radioulnar joint**. **Identify the styloid processes of the radius and of the ulna.** These guide tendons across the distal aspect of the wrist into their points of insertion in the hand.

T A S K

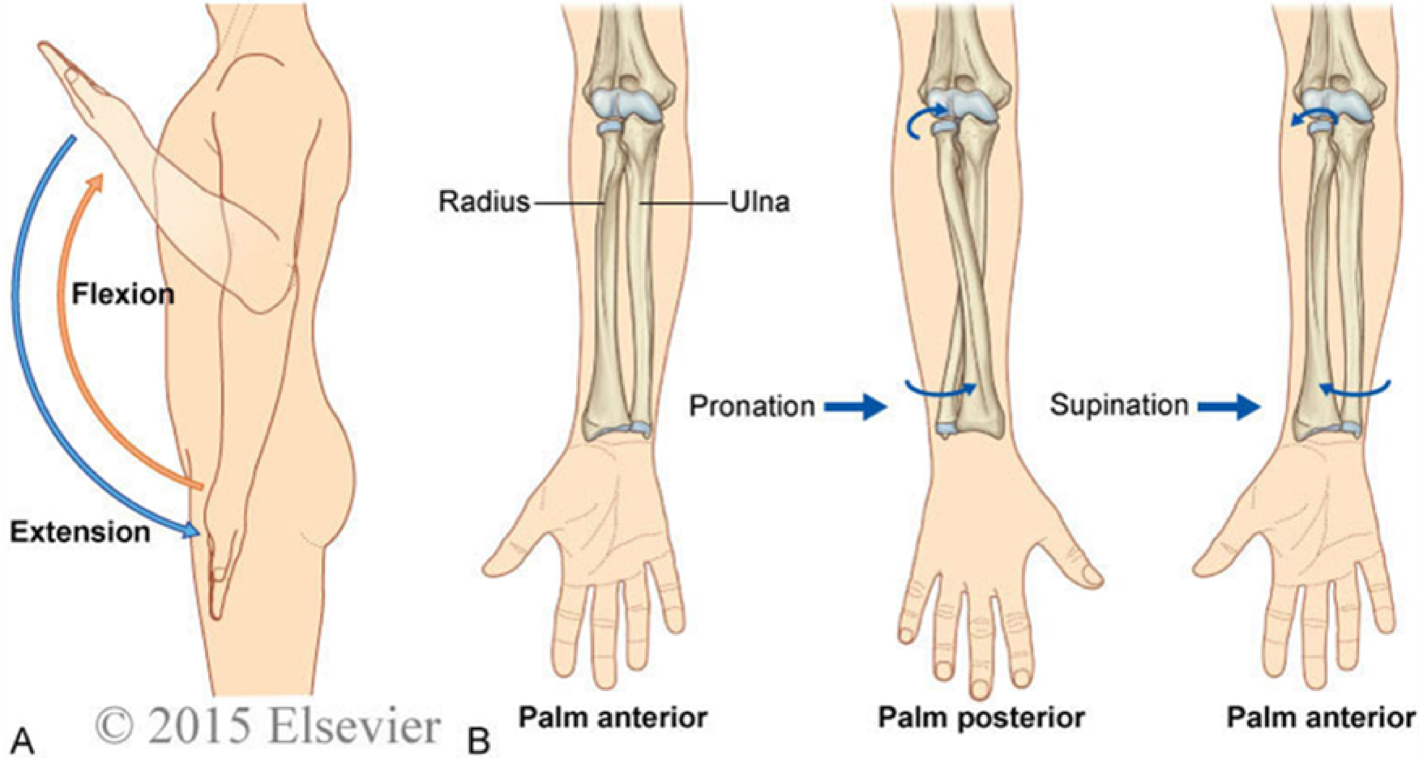
IDENTIFY the

sharp interosseous borders of the radius and ulna. When the radius and ulna are articulated, these borders face each other.

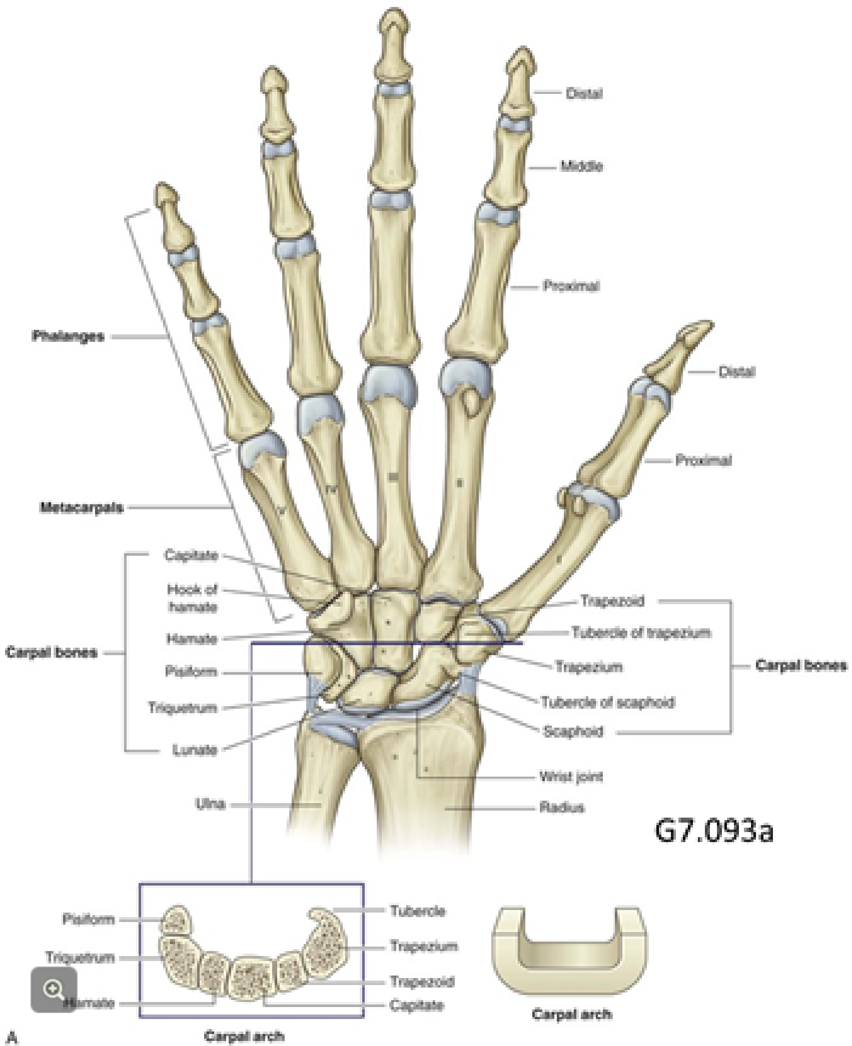
The interosseous borders of the radius and ulna are joined by the **antebrachial interosseous membrane**. Like the crural interosseous membrane that joins the tibia and fibula in the leg, the antebrachial interosseous membrane functions largely to increase surface area for muscular attachment.



Flexion and extension are the only movements that occur at the elbow joint. In **supination and pronation**, the radius rotates around the stationary ulna so as to turn the palm **anteriorly and posteriorly, respectively**. These movements occur at the **proximal and distal radioulnar joints**.



G7.005



G7.093a

TASK

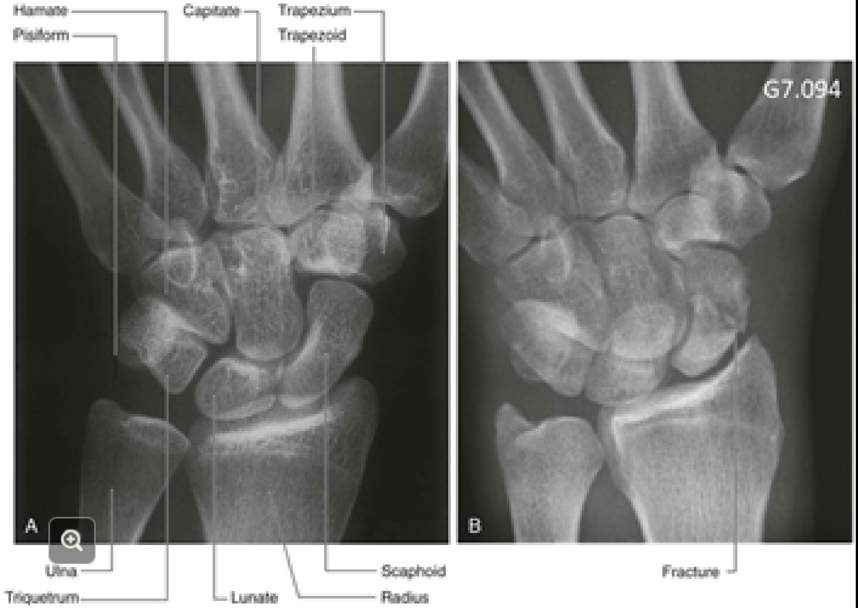
USING the articulated hand

with which you've been provided, look at the eight carpal bones and notice that they are arranged in two rows of four bones. Identify the bones of the proximal row: from lateral to medial they are the scaphoid, lunate, triquetrum, and anterior to the triquetrum is the pisiform. Identify the tubercles of the trapezium and scaphoid projecting anteriorly from the lateral aspect of the wrist. Identify the bones of the distal row: from lateral to medial they are the trapezium, trapezoid, capitate and hamate. Identify the hook of the hamate projecting anteriorly from the medial aspect of the wrist.

I N F O

Fracture of the Scaphoid

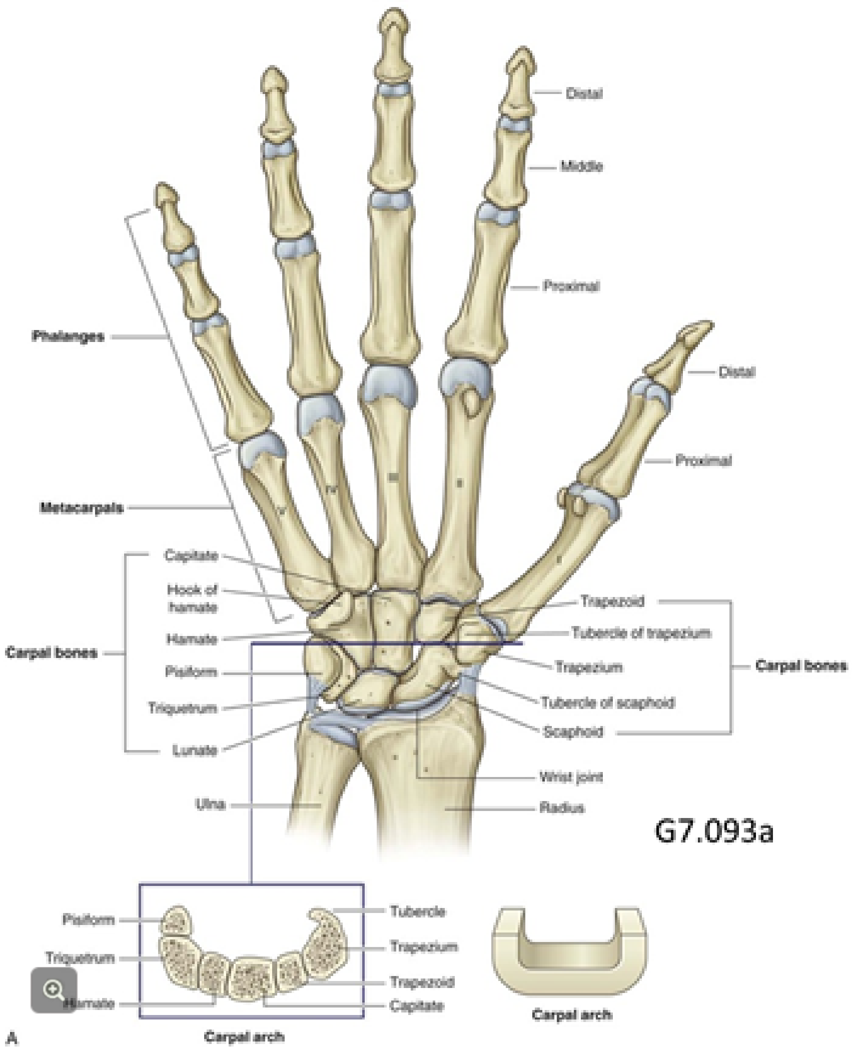
The scaphoid is by far the most commonly fractured carpal bone. In about 10% of individuals the blood supply to the scaphoid bone is derived from a single artery that enters the distal aspect of the bone and traverses it to supply its proximal portion. If this artery is damaged in a fracture of the scaphoid bone, **avascular necrosis** occurs.



T A S K

USING the articulated hand

with which you've been provided, look at the eight carpal bones and notice that they are arranged in two rows of four bones. Identify the bones of the proximal row: from lateral to medial they are the scaphoid, lunate, triquetrum, and anterior to the triquetrum is the pisiform. Identify the tubercles of the trapezium and scaphoid projecting anteriorly from the lateral aspect of the wrist. Identify the bones of the distal row: from lateral to medial they are the trapezium, trapezoid, capitate and hamate. Identify the hook of the hamate projecting anteriorly from the medial aspect of the wrist.



TASK

NOTICE that anteriorly,

the carpal bones form a concave surface, the carpal arch, the medial wall of which is formed by the pisiform and hook of the hamate, and the lateral wall of which is formed by the tubercles of the trapezium and scaphoid.

TASK

IDENTIFY the bones of the hand,

the metacarpals, enumerated I to V, lateral to medial. Identify the base (proximal end) and head (distal end) of each.

Identify the bones of the thumb and digits, the phalanges. There are two phalanges in the thumb, proximal and distal, while there are three phalanges in each digit, proximal, middle and distal. Identify the base and head of each.

In the accompanying X-ray, find as many features of the bones of the hand as possible. Remember that X-rays superimpose structures that are in front / behind each other.

NOTICE that anteriorly,

TASK

the carpal bones form a concave surface, the carpal arch, the medial wall of which is formed by the pisiform and hook of the hamate, and the lateral wall of which is formed by the tubercles of the trapezium and scaphoid.

IDENTIFY the bones of the hand,

TASK

the metacarpals, enumerated I to V, lateral to medial. Identify the base (proximal end) and head (distal end) of each.

Identify the bones of the thumb and digits, the phalanges. There are two phalanges in the thumb, proximal and distal, while there are three phalanges in each digit, proximal, middle and distal. Identify the base and head of each.

In the accompanying X-ray, find as many features of the bones of the hand as possible. Remember that X-rays superimpose structures that are in front / behind each other.

TASK

NOTICE that anteriorly,

the carpal bones form a concave surface, the carpal arch, the medial wall of which is formed by the pisiform and hook of the hamate, and the lateral wall of which is formed by the tubercles of the trapezium and scaphoid.

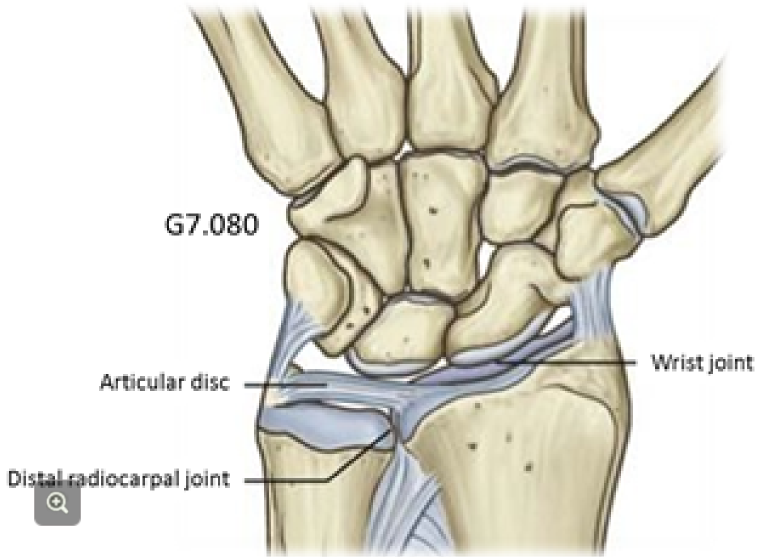
TASK

IDENTIFY the bones of the hand,

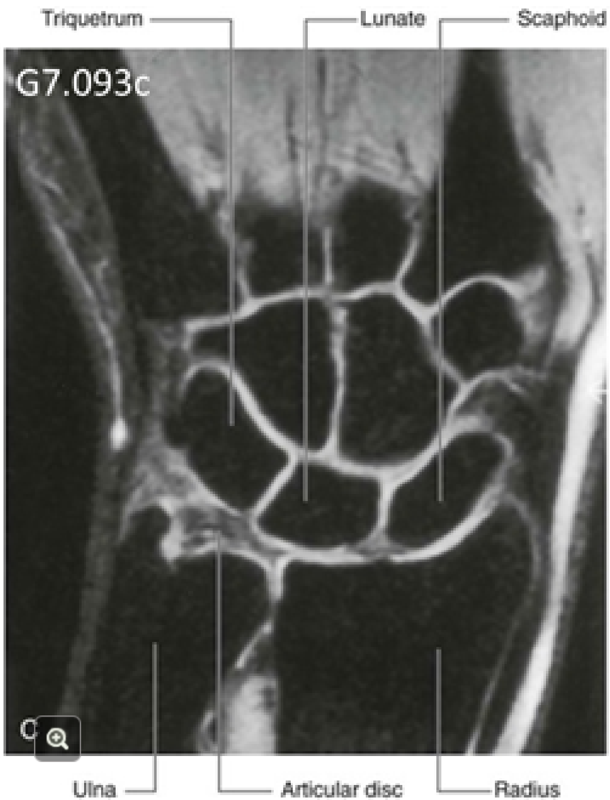
the metacarpals, enumerated I to V, lateral to medial. Identify the base (proximal end) and head (distal end) of each.

Identify the bones of the thumb and digits, the phalanges. There are two phalanges in the thumb, proximal and distal, while there are three phalanges in each digit, proximal, middle and distal. Identify the base and head of each.

In the accompanying X-ray, find as many features of the bones of the hand as possible. Remember that X-rays superimpose structures that are in front / behind each other.

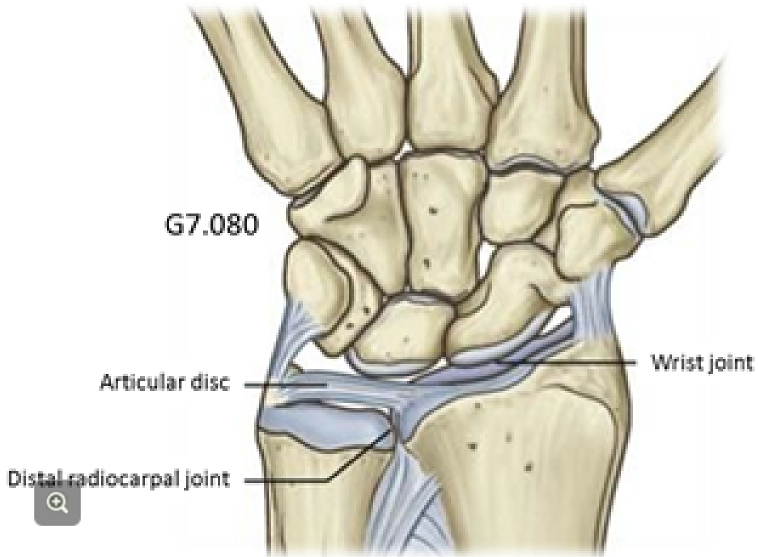


The wrist joint is properly called the **radiocarpal joint**. Notice that the ulna is not part of this name! That's because the ulna does not articulate directly with the carpal bones in the formation of this joint. The hand is carried, via the carpal bones, on the distal radius.

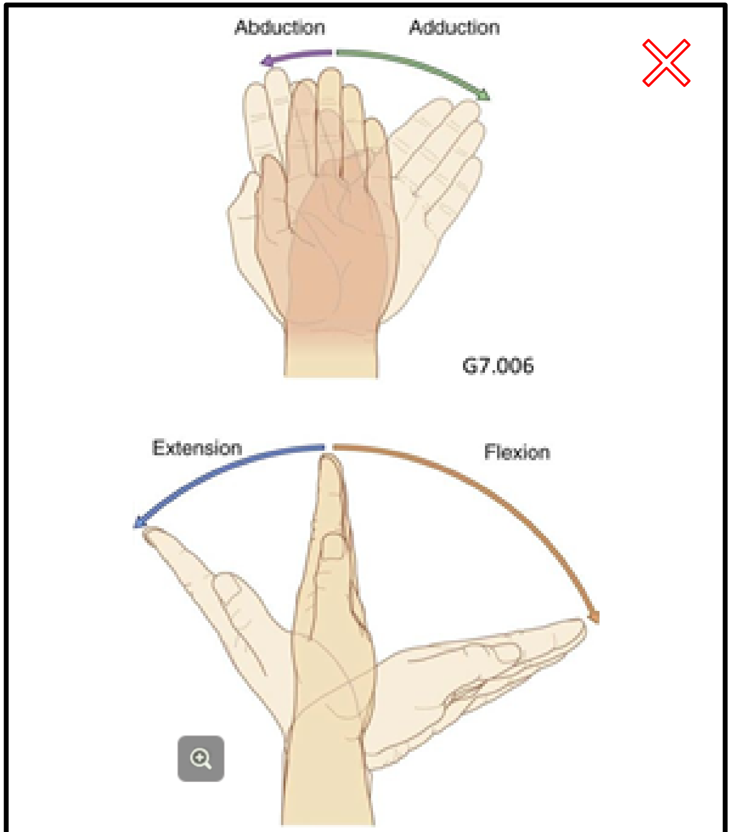


Notice in both of the accompanying figures that a fibrocartilagenous **articular disc** is identified lying between the distal ulna and the triquetrum. This disc extends from the medial aspect of the distal radius to the styloid process of the ulna. It excludes the ulna from articulating with the proximal row of carpal bones. Notice further that the concave surface of the radius and articular disc articulates with the convex surface formed by the proximal row of carpal bones.

This joint permits flexion / extension and abduction / adduction to occur at the wrist.



The wrist joint is properly called the **radiocarpal joint**. Notice that the ulna is not part of this name! That's because the ulna does not articulate directly with the carpal bones in the formation of this joint. The hand is carried, via the carpal bones, on the distal radius.



Notice in both of the accompanying figures that a fibrocartilagenous **articular disc** is identified lying between the distal ulna and the triquetrum. This disc extends from the medial aspect of the distal radius to the styloid process of the ulna. It excludes the ulna from articulating with the proximal row of carpal bones. Notice further that the concave surface of the radius and articular disc articulates with the convex surface formed by the proximal row of carpal bones.

This joint permits flexion / extension and abduction / adduction to occur at the wrist.

Since embarking on this exercise, you have **identified** the following structures and learned the **answers to the following questions**:

- Distal humerus: identify the humeral condyle, capitulum, trochlea, and the medial and lateral epicondyles and supracondylar ridges. Which of these are traction epiphyses? Identify the radial fossa, coronoid fossa and olecranon fossa. What occupies each of these fossae in flexion / extension?
- Proximal radius: identify the radial head and neck. In what two articulations does the radial head participate? Identify the radial tuberosity.
- Proximal ulna: identify the trochlear notch, coronoid process and olecranon process. What articulates with the trochlear notch? How are the coronoid and olecranon processes accommodated in flexion and extension, respectively? Identify the radial notch of the ulna. With what does it articulate? What ligament stabilizes this articulation?
- Be able to identify the major structures seen in AP and lateral radiographs of the elbow.
- Distal radius and ulna: identify the ulnar head and styloid process. Identify the articular surface of the distal radius and its styloid process. With what bones does the distal radius articulate? Identify the interosseous borders of the radius and ulna. What attaches here and what is the function of this structure? Demonstrate the movements that occur between the radius and ulna.
- Identify the eight carpal bones, the tubercle of the scaphoid and the hook of the hamate. What structures form the medial and lateral walls of the carpal arch?
- Identify metacarpals I - V, the phalanges associated with each digit and the bases and heads of each.
- Be able to identify the major structures seen in an AP radiograph of the wrist and hand.

If you are satisfied with your **ability to identify these structures** and **answer these questions**, call your TA over for confirmation and for **permission to move on**.