



University of
Lancashire

Thorax, Mediastinum, & Diaphragm

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Where opportunity creates success

Lecture Plan

- Part 1 – Thorax
 - Surface Anatomy
 - Structure
 - Neurovasculature
- Part 2 – Mediastinum
 - Divisions
 - Clinical Relevance
- Part 3 – Diaphragm
 - Structure

➤ Macro Learning Outcomes:

- M2.I.COR.ANA1 – Describe the osteology, musculature, and neurovascular supply of the chest wall.
- M2.I.RES.ANA3 – Describe the contents and boundaries of the thorax and identify associated clinical abnormalities.

➤ Micro Learning Outcomes:

- Demonstrate knowledge of the surface landmarks associated with the thorax and relate them to underlying structures.
- Describe the structure of the thoracic cage, including associated muscles and neurovascular structures.
- Describe select pathology and treatments associated with the thoracic cage.
- Describe the divisions of the mediastinum and recall their contents.
- Describe select clinical conditions associated with the mediastinum and how changes in the mediastinum can be seen with imaging.
- Review the anatomy of the diaphragm and its movement during inspiration and expiration.
- Describe select clinical conditions related to the diaphragm, including referred pain.

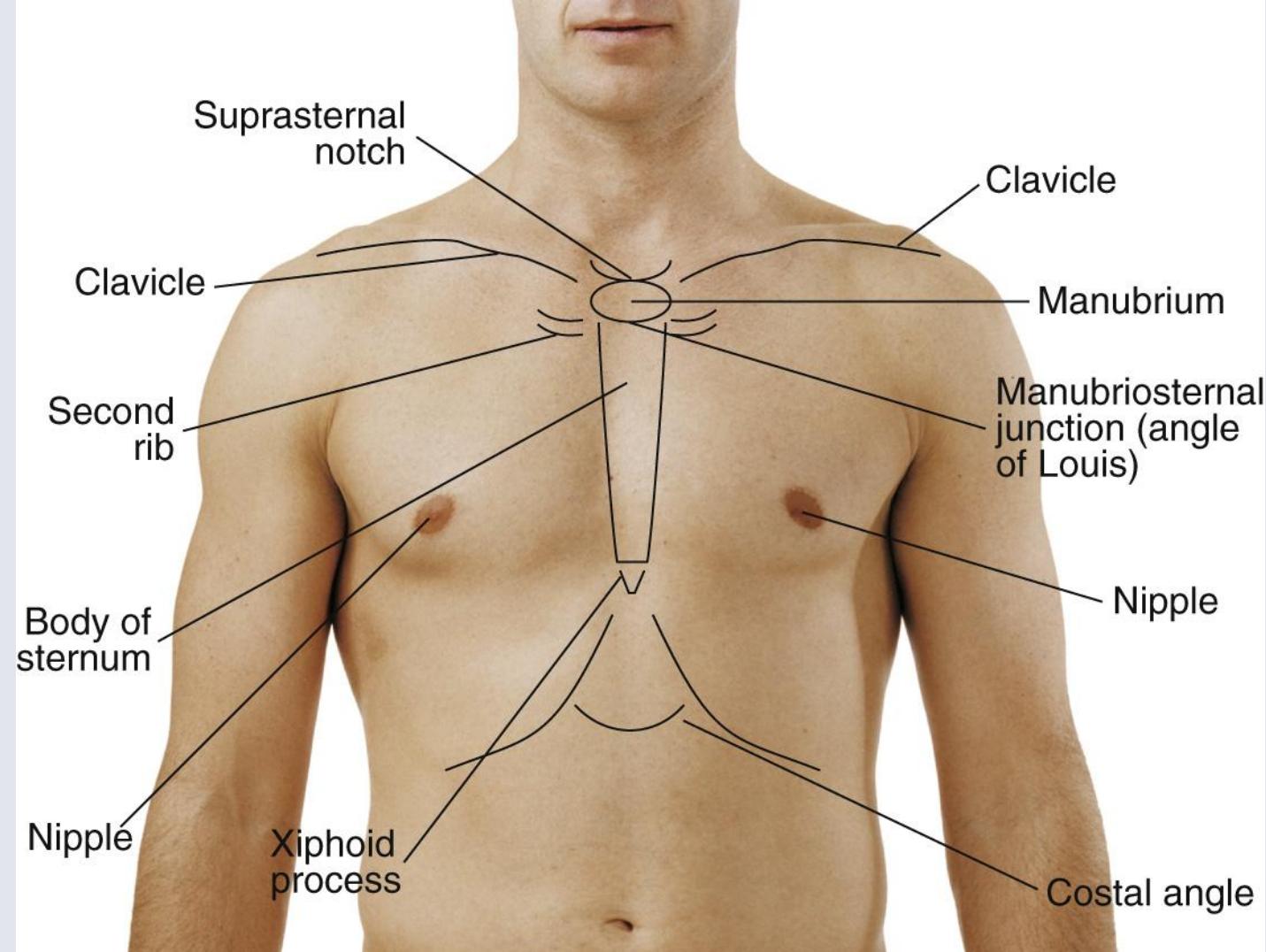
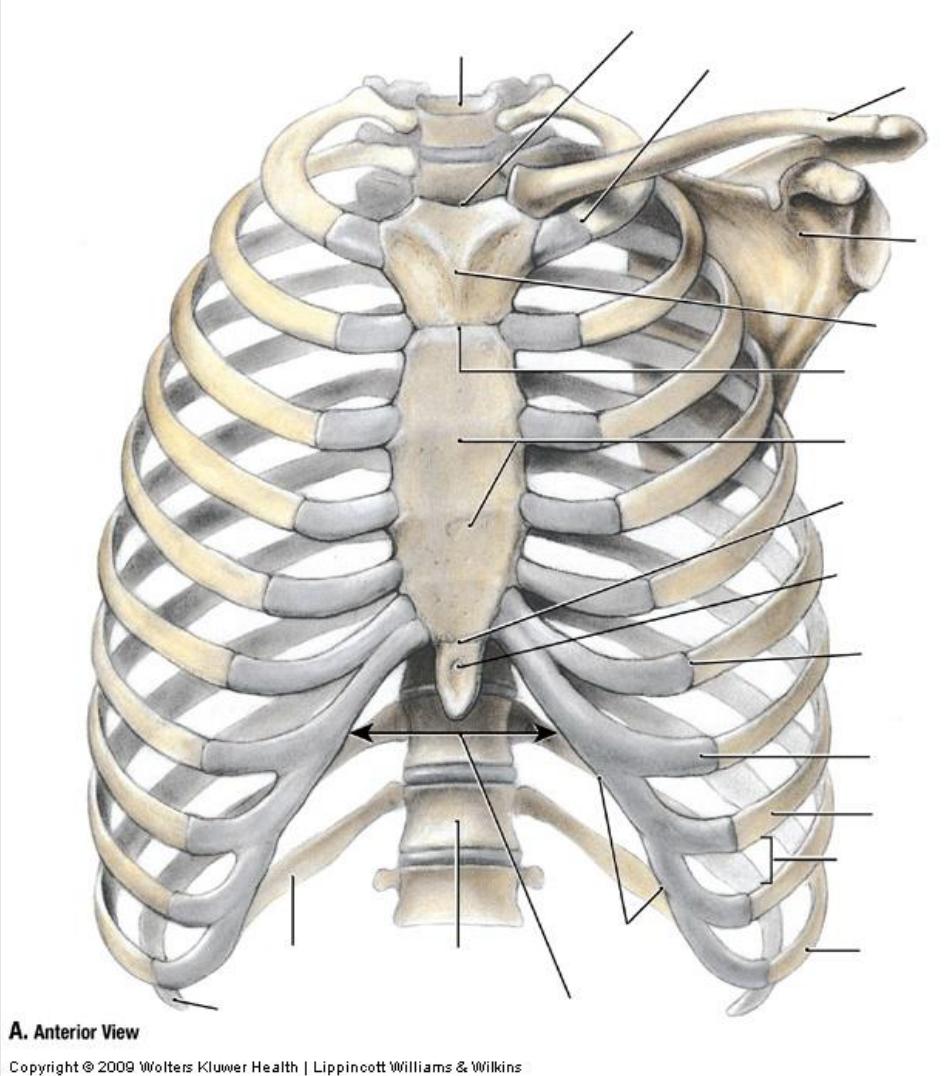
Learning Outcomes

Part 1 – Thorax

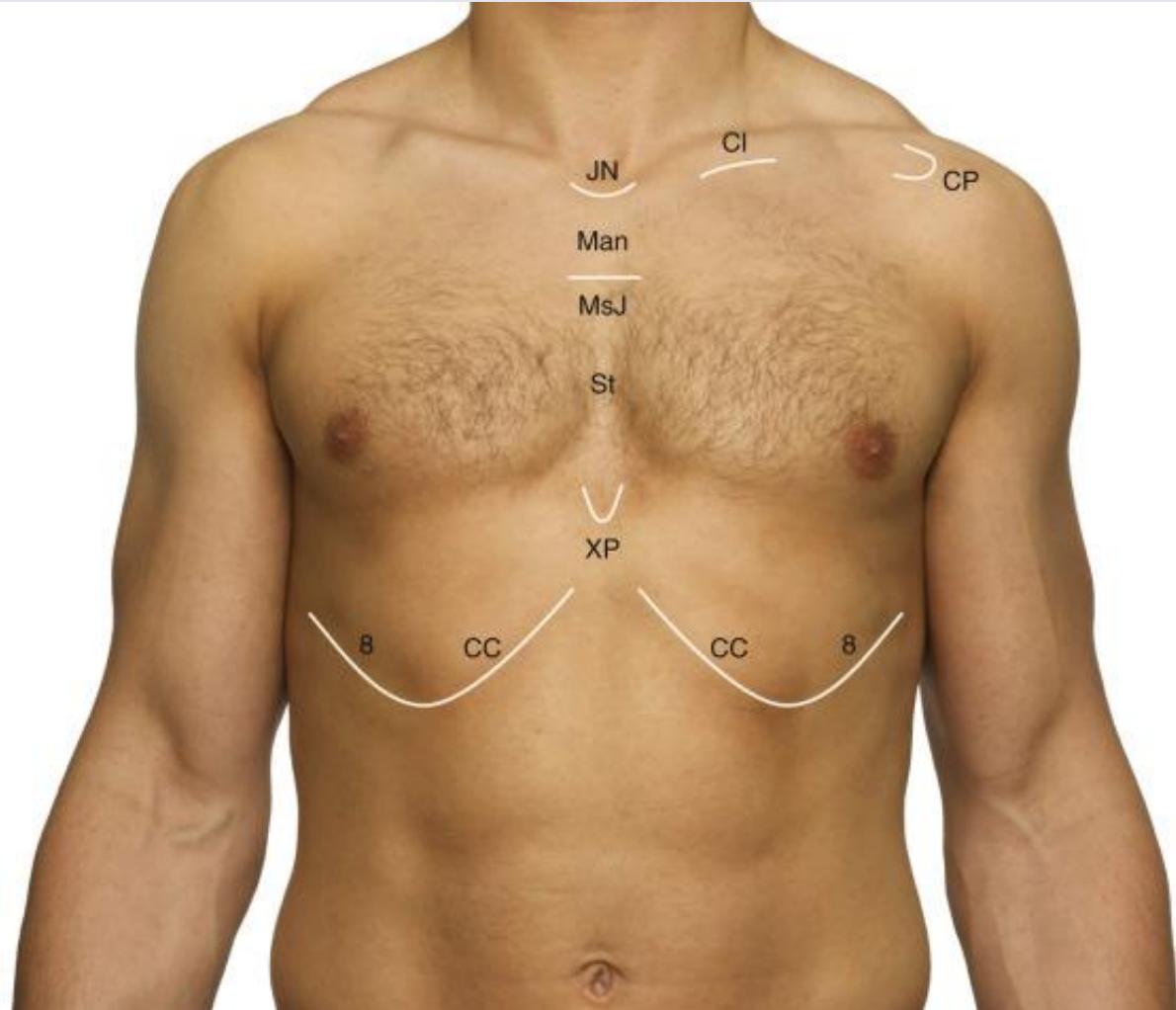
Surface Anatomy

Surface Anatomy: Palpable Landmarks

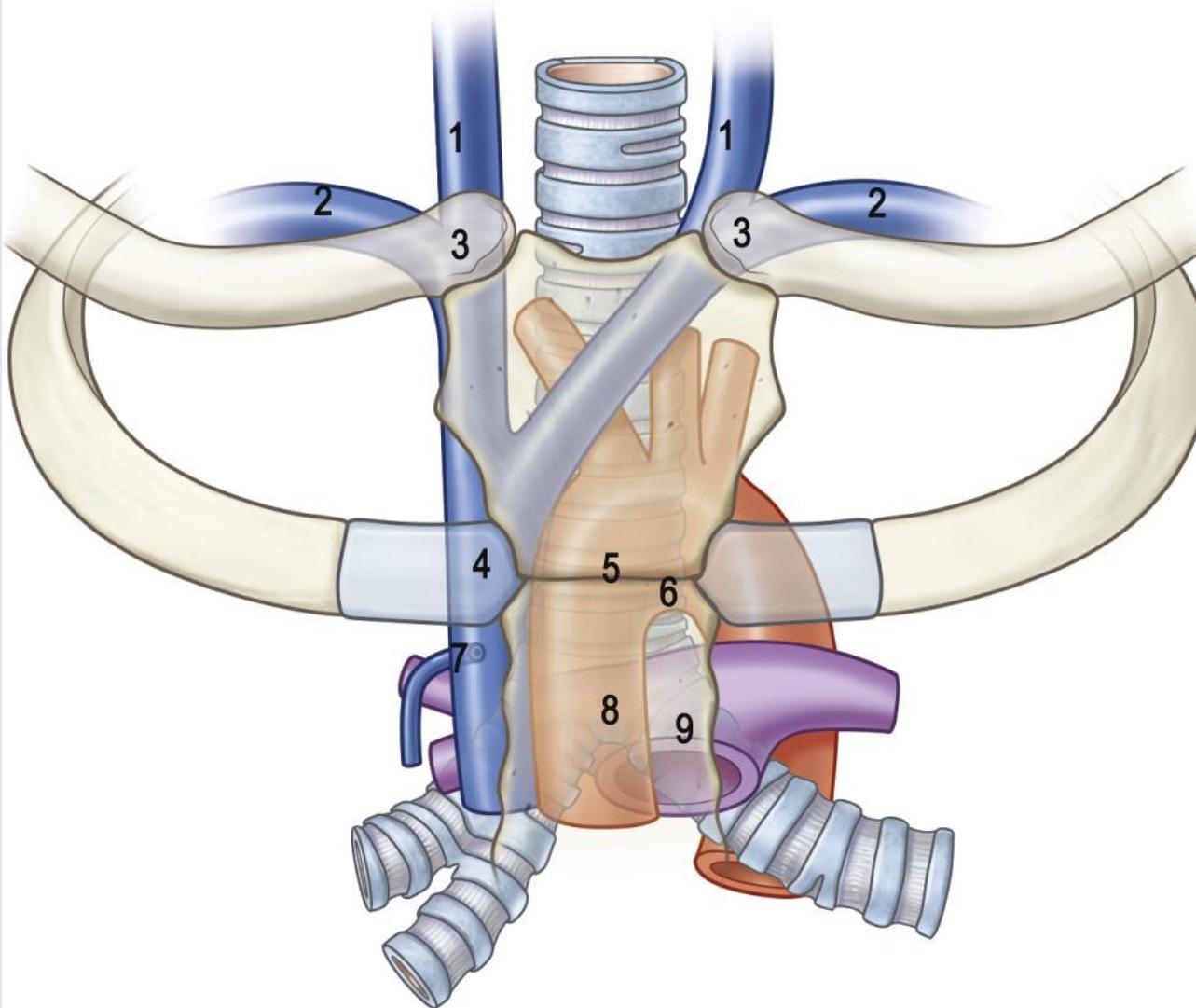
Bony palpable landmarks of the thoracic cage are useful to locate underlying structures.



Surface Anatomy: Palpable Landmarks



Surface Anatomy: Sternal Angle



What structures lie at the sternal angle?

R – Rib 2

A – Aortic arch

T – Tracheal bifurcation (Carina)

P – Pulmonary trunk

L – Ligamentum arteriosum

A – Azygous vein drains into SVC

N – Nerves (cardiac plexus, loop of recurrent laryngeal etc.)

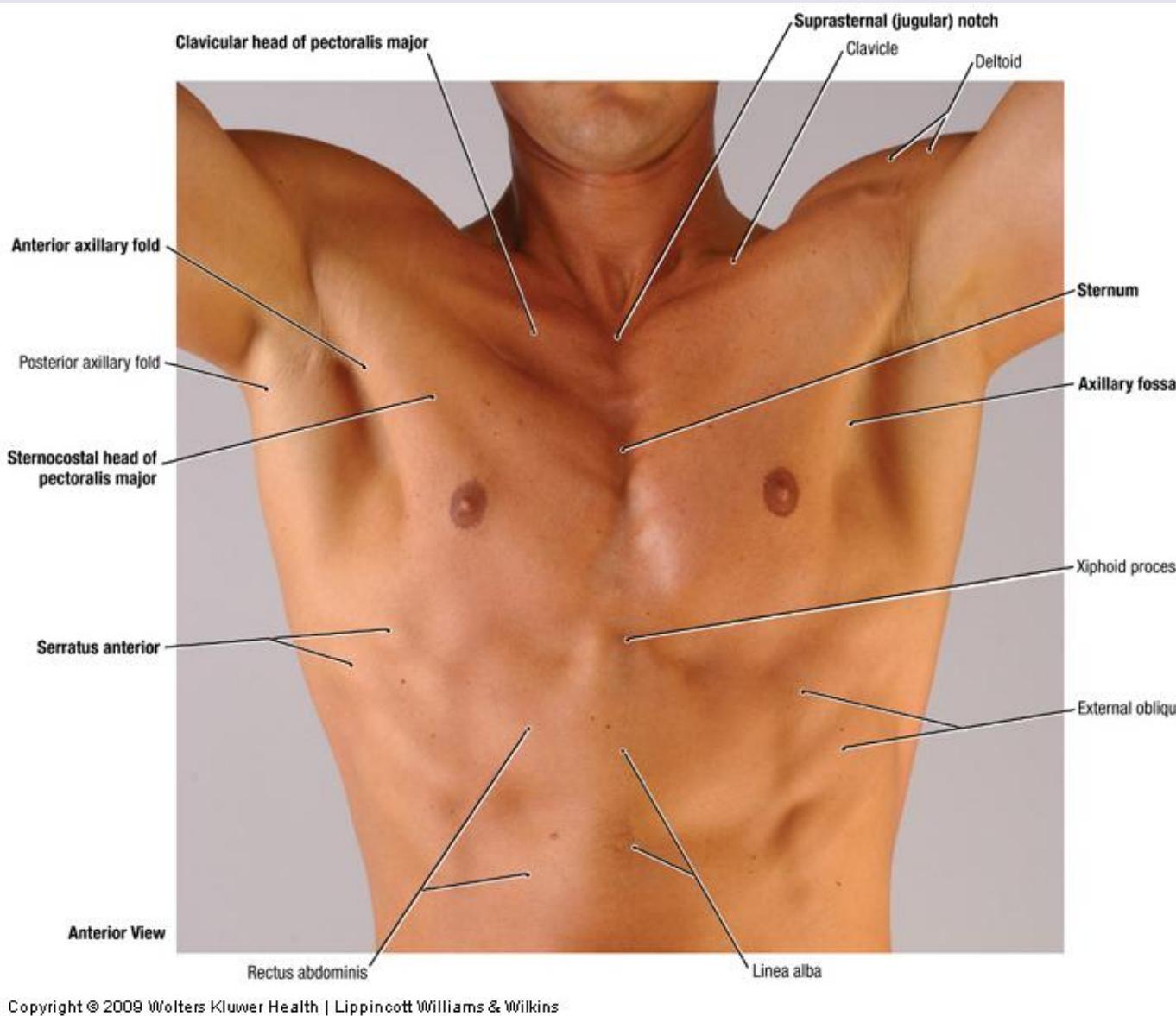
T – Thoracic duct (right-to-left movement before exiting thoracic inlet)

Others:

- Pre-vertebral and pre-tracheal fascia of the neck end
- Oesophagus continues past sternal angle

Other acronyms include CLAPTRAP.

Surface Anatomy: Observable Landmarks



What landmarks can be seen here?

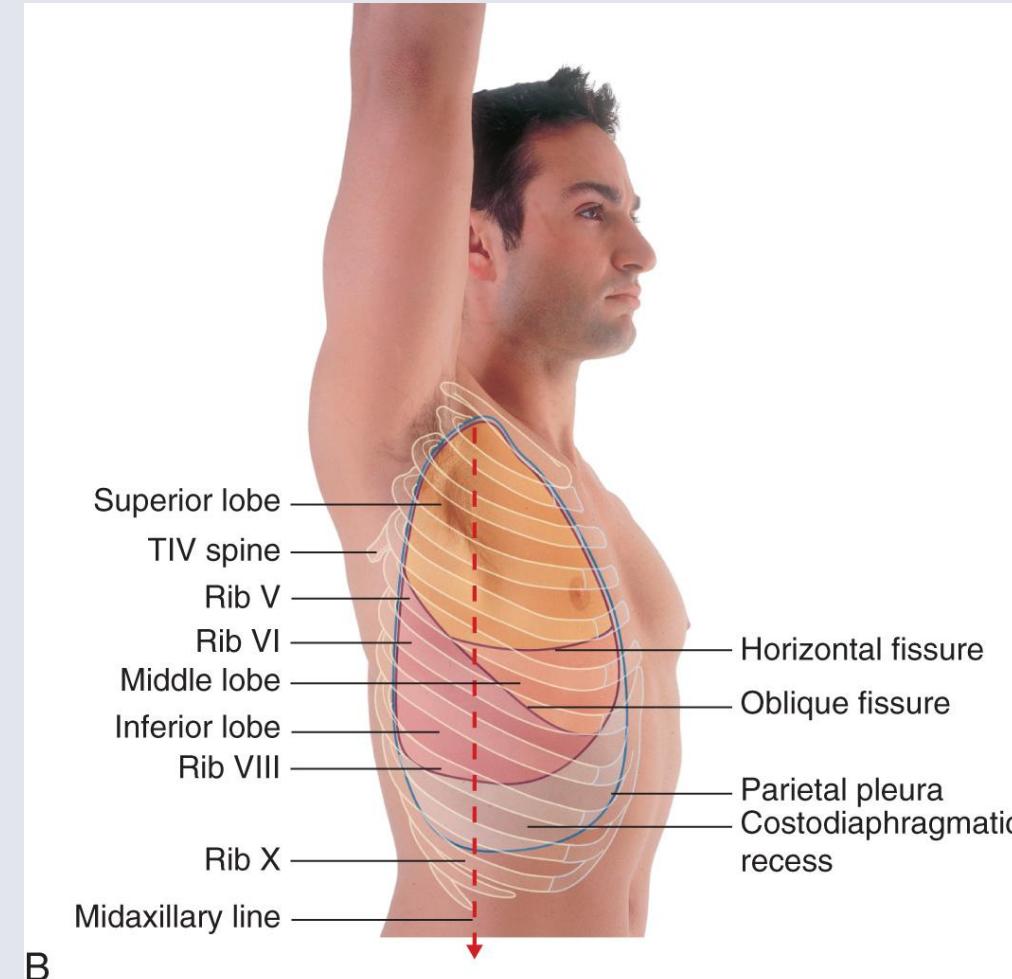
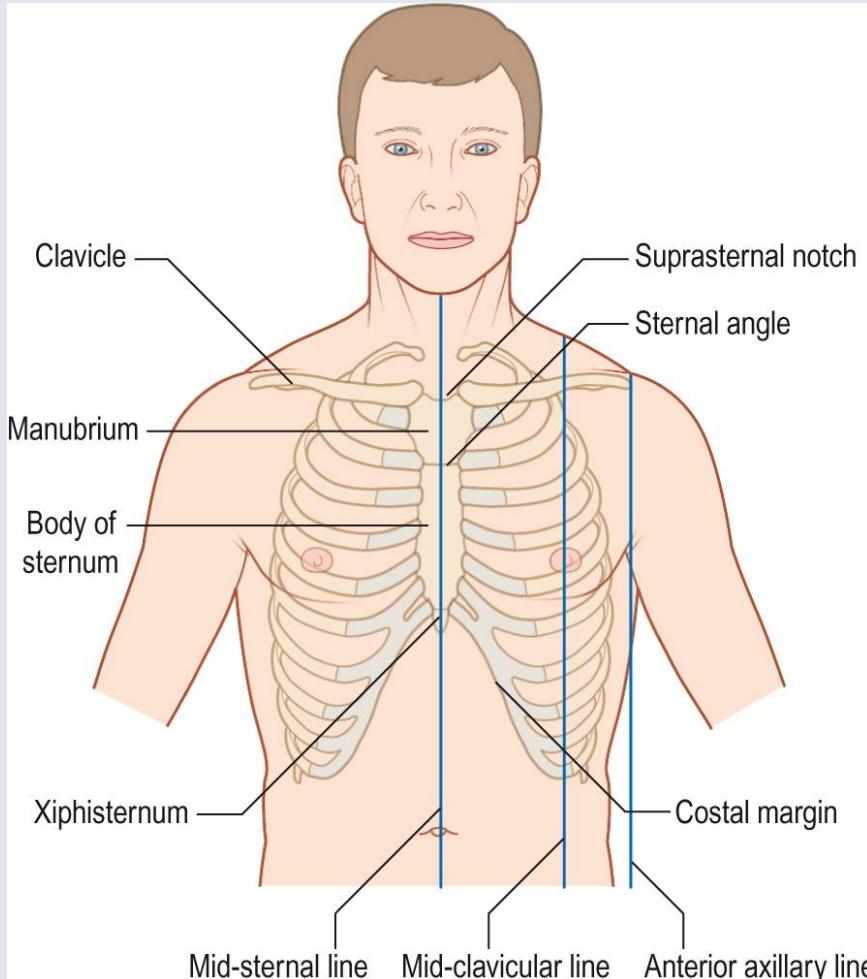
Things such as:

- Anterior axillary fold
- Posterior axillary fold
- Axillary fossa/Axilla
- Jugular notch
- Pectoralis major and other muscles

Surface Anatomy: Lines

Imaginary lines can be drawn on the surface of the thorax in order to orientate yourself.

- These are useful for procedures and also knowing what anatomy is lying below.



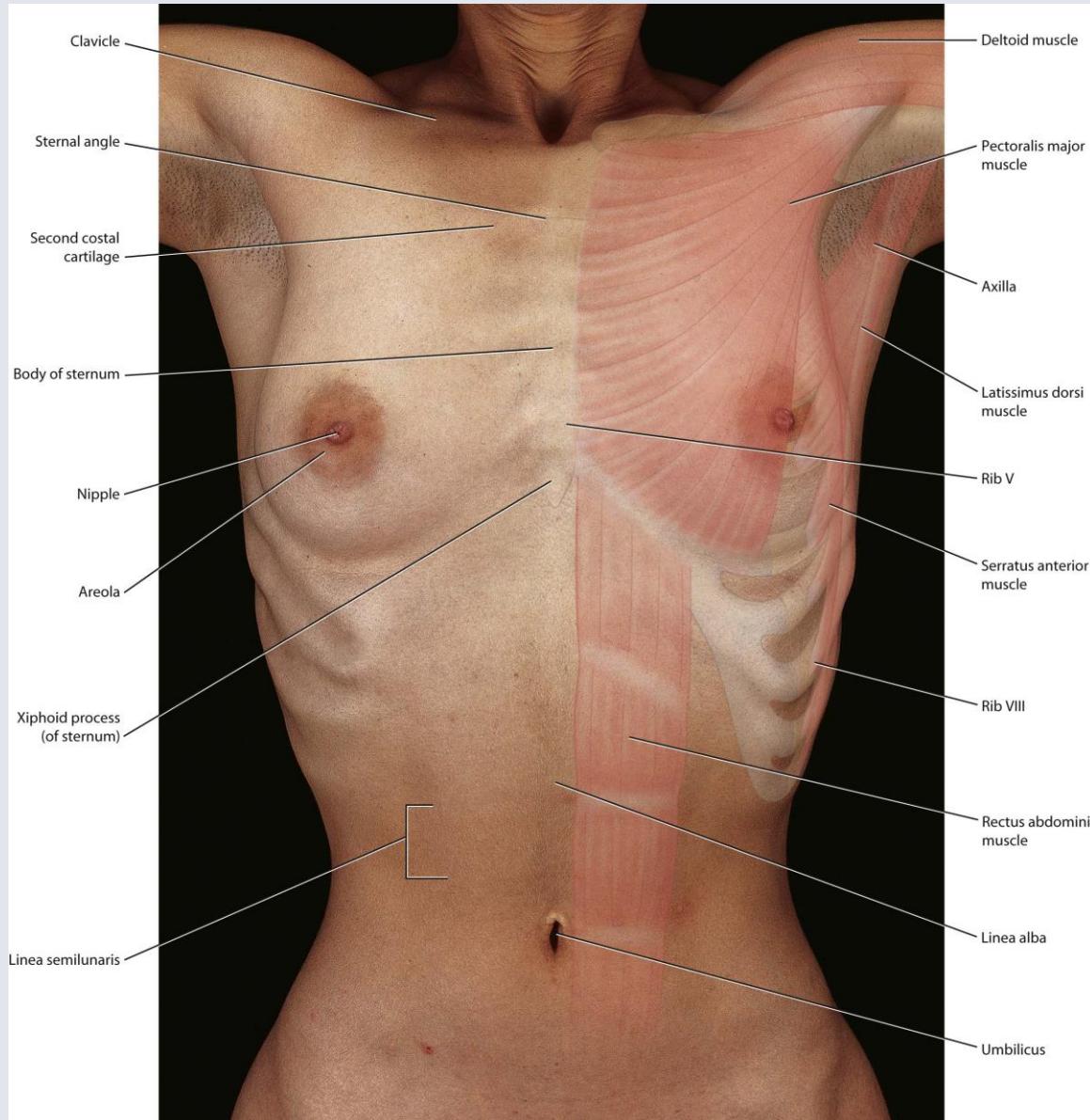
Surface Anatomy: Safe Triangle

The 'Safe Triangle' is an important area to note for where chest drains could be inserted safely.

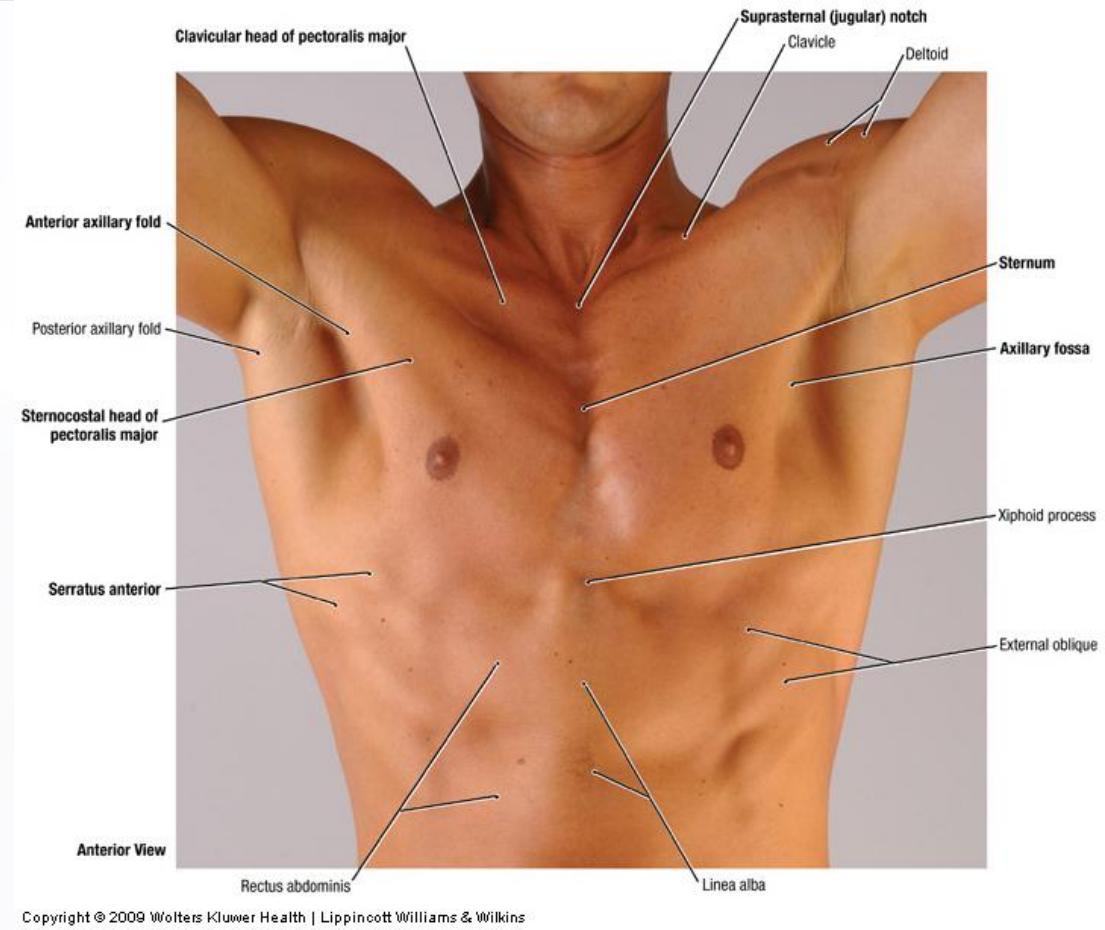
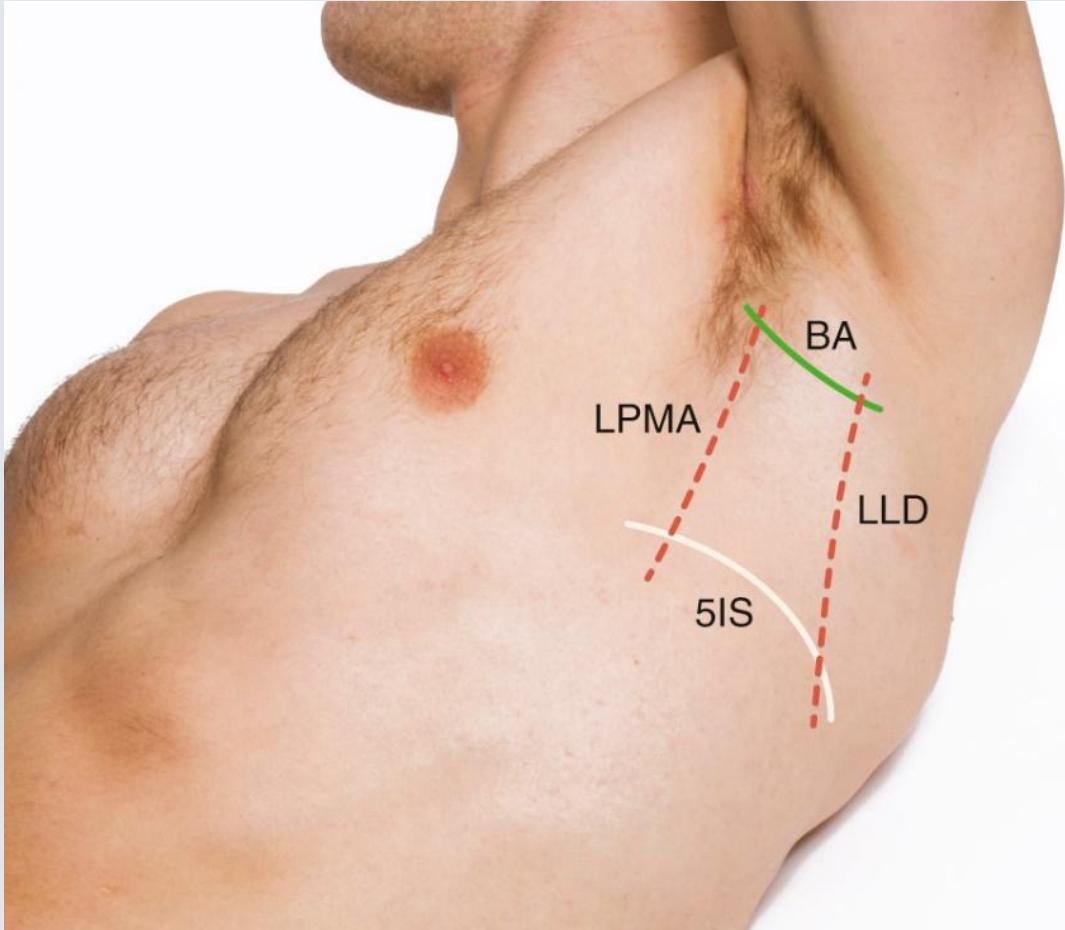
- **Anterior:** Lateral border of pectoralis major muscle.
- **Posterior:** Lateral border of latissimus dorsi muscle.
- **Inferior:** 5th intercostal space

What might be damaged if you go outside this?

Consider what structures are anterior, posterior, inferior, and superior.

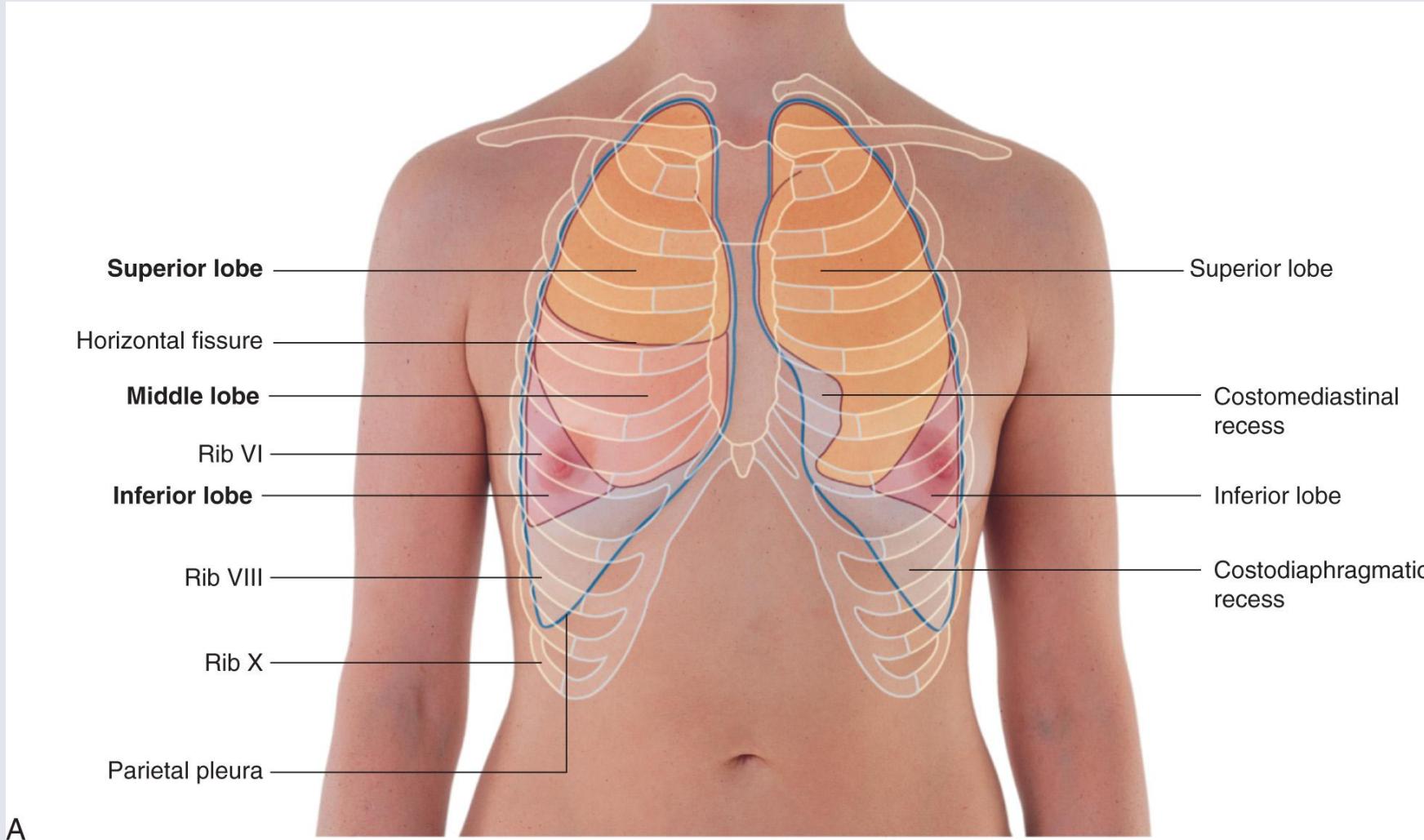


Surface Anatomy: Safe Triangle



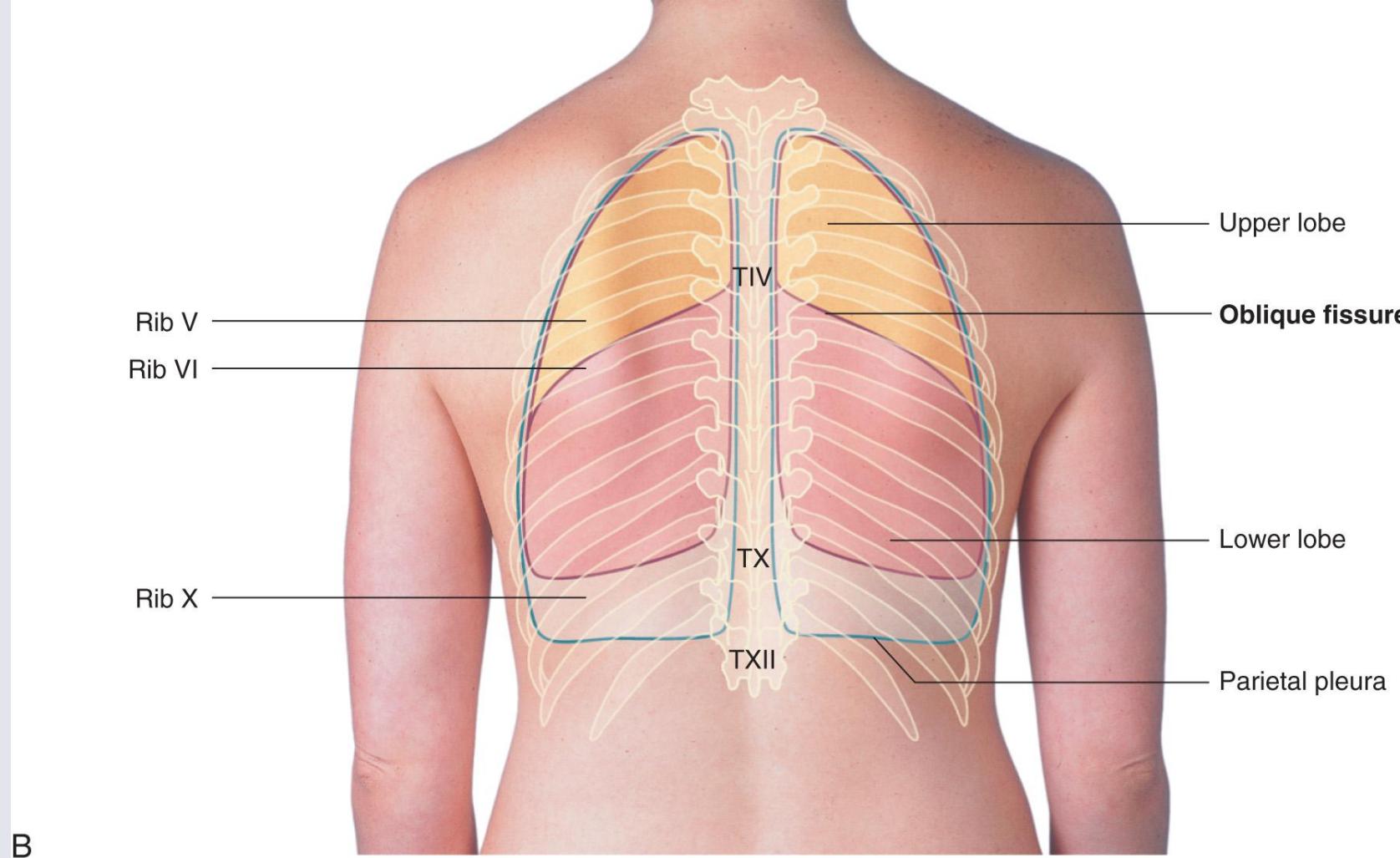
Surface Anatomy: Anterior

LANDMARK	MARGIN OF LUNG	MARGIN OF PLEURA
Midclavicular line	6th rib	8th rib
Midaxillary line	8th rib	10th rib
Midscapular line	10th rib	12th rib



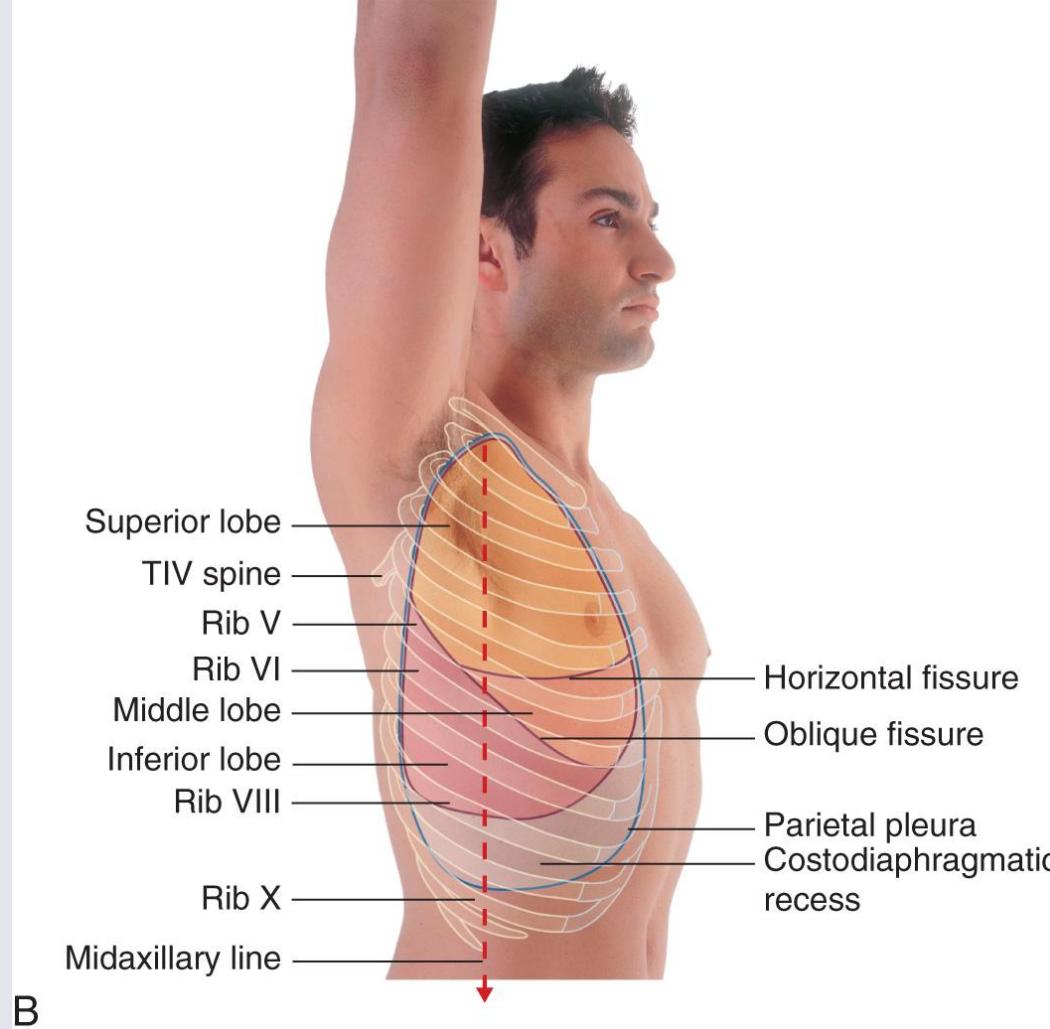
Surface Anatomy: Posterior

LANDMARK	MARGIN OF LUNG	MARGIN OF PLEURA
Midclavicular line	6th rib	8th rib
Midaxillary line	8th rib	10th rib
Midscapular line	10th rib	12th rib



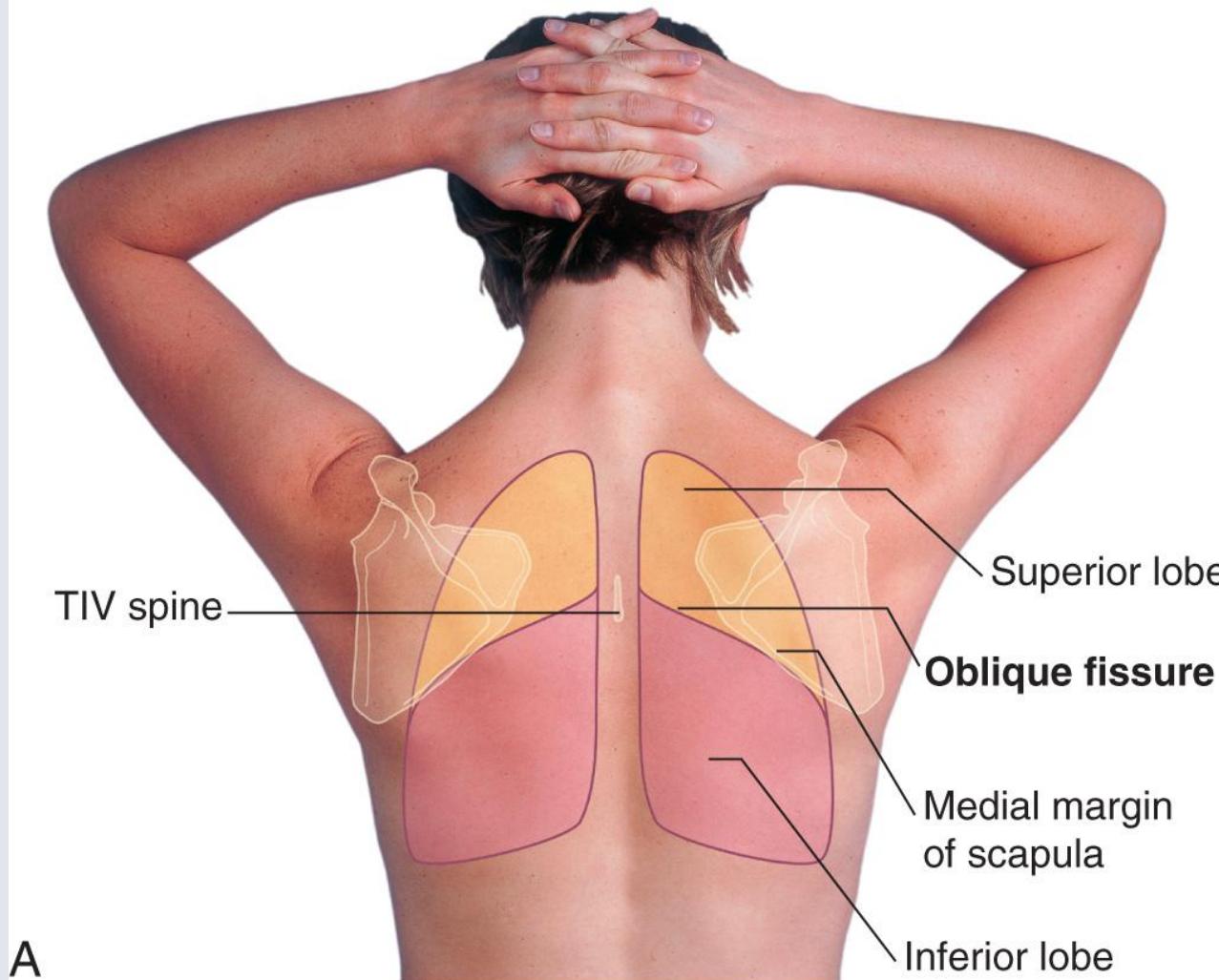
Surface Anatomy: Lateral

LANDMARK	MARGIN OF LUNG	MARGIN OF PLEURA
Midclavicular line	6th rib	8th rib
Midaxillary line	8th rib	10th rib
Midscapular line	10th rib	12th rib

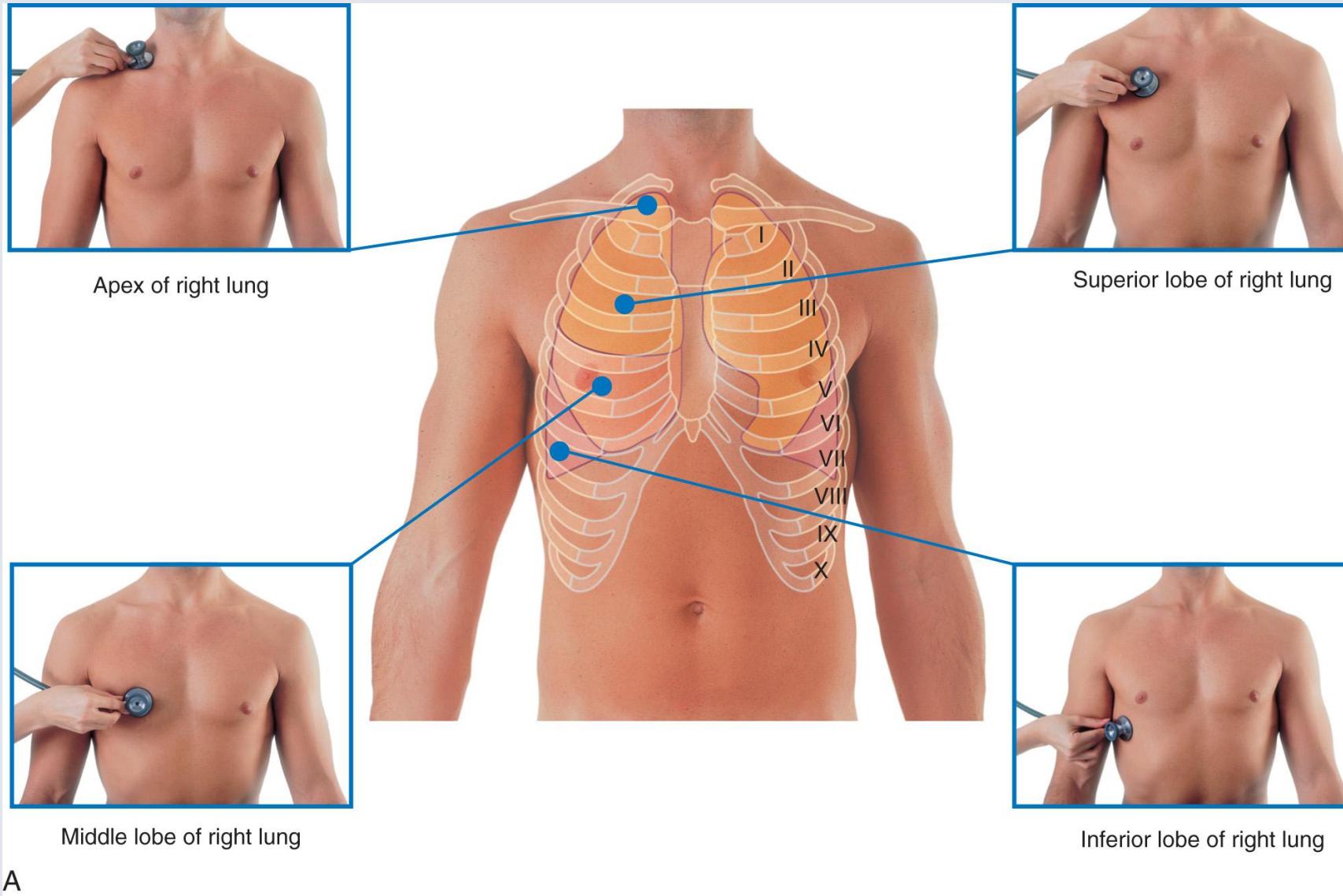


Surface Anatomy: Scapula

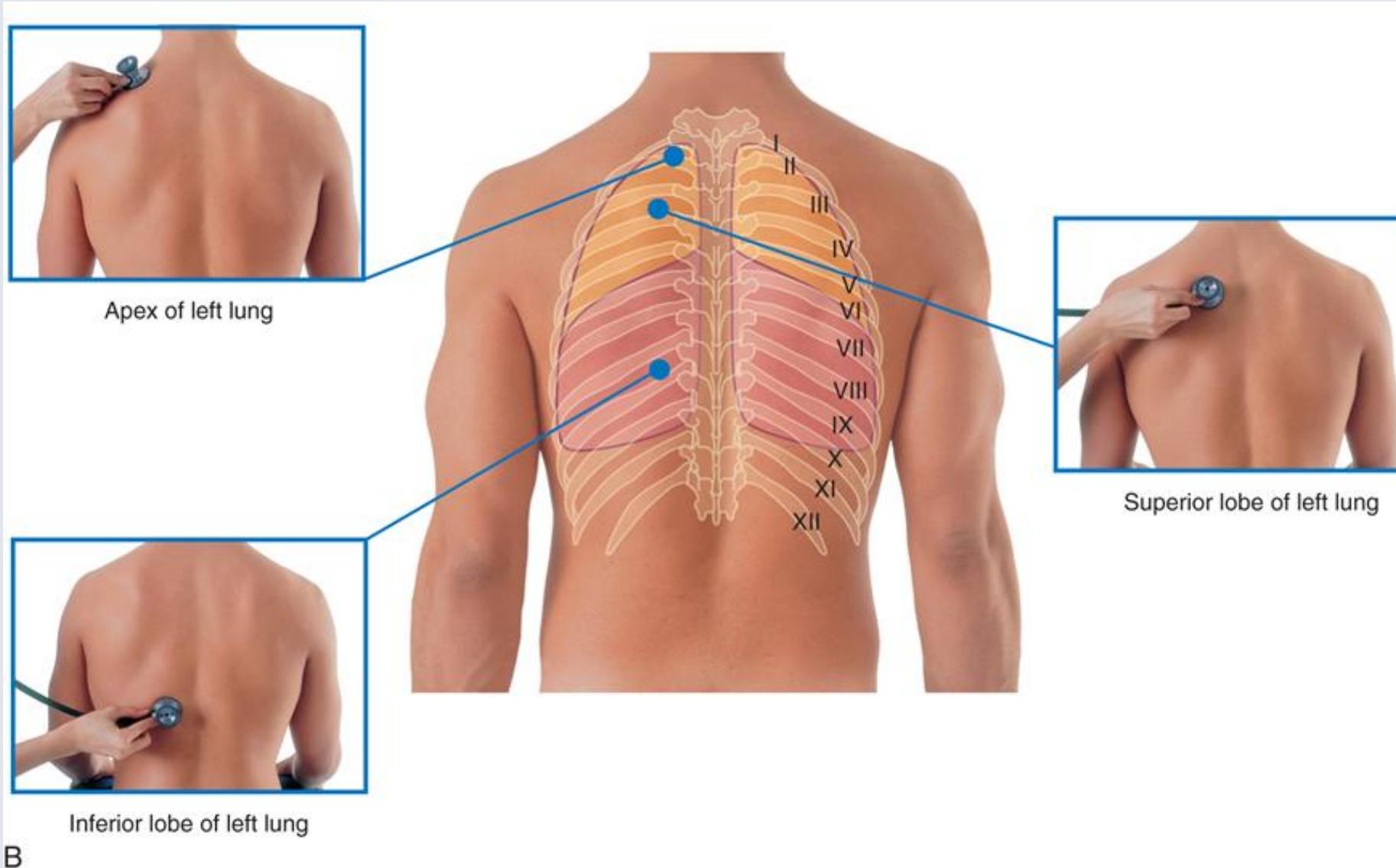
LANDMARK	MARGIN OF LUNG	MARGIN OF PLEURA
Midclavicular line	6th rib	8th rib
Midaxillary line	8th rib	10th rib
Midscapular line	10th rib	12th rib



Auscultation: Anterior



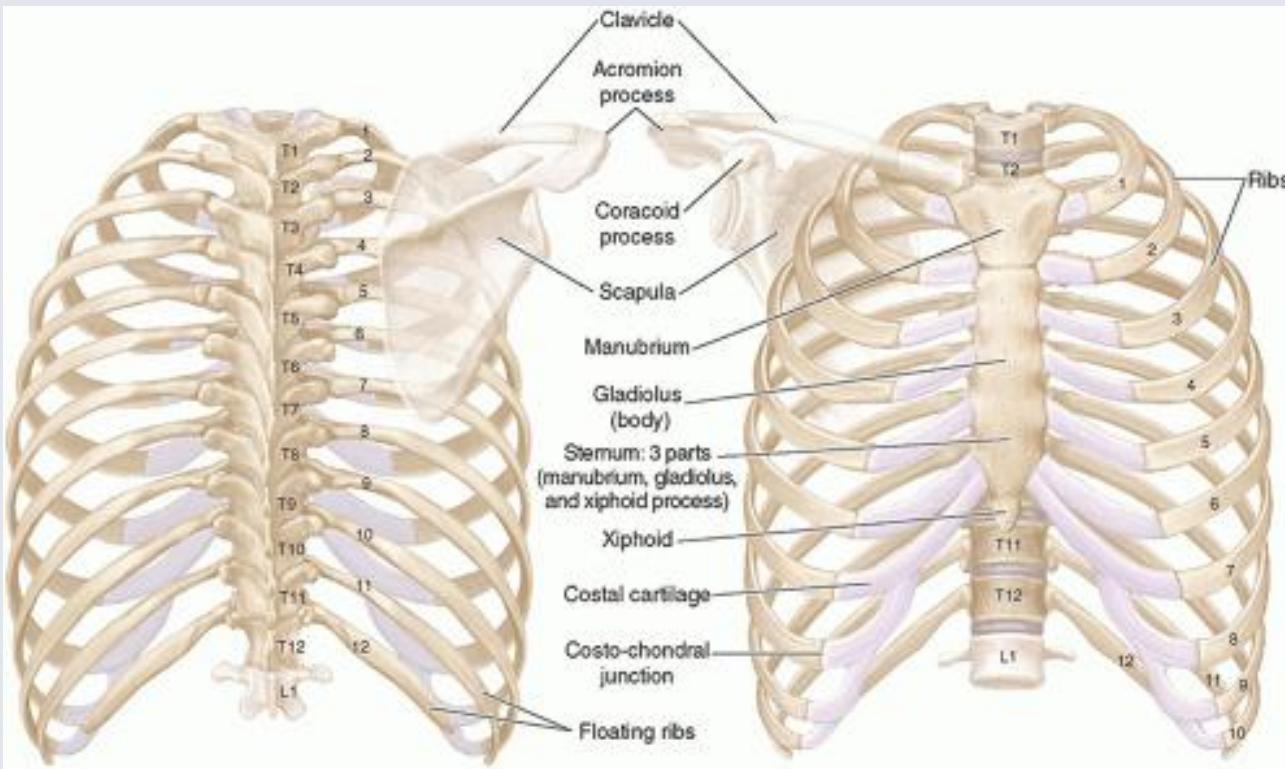
Auscultation: Posterior



B

Part 1 – Thorax Structure

Thorax: Thoracic Cage



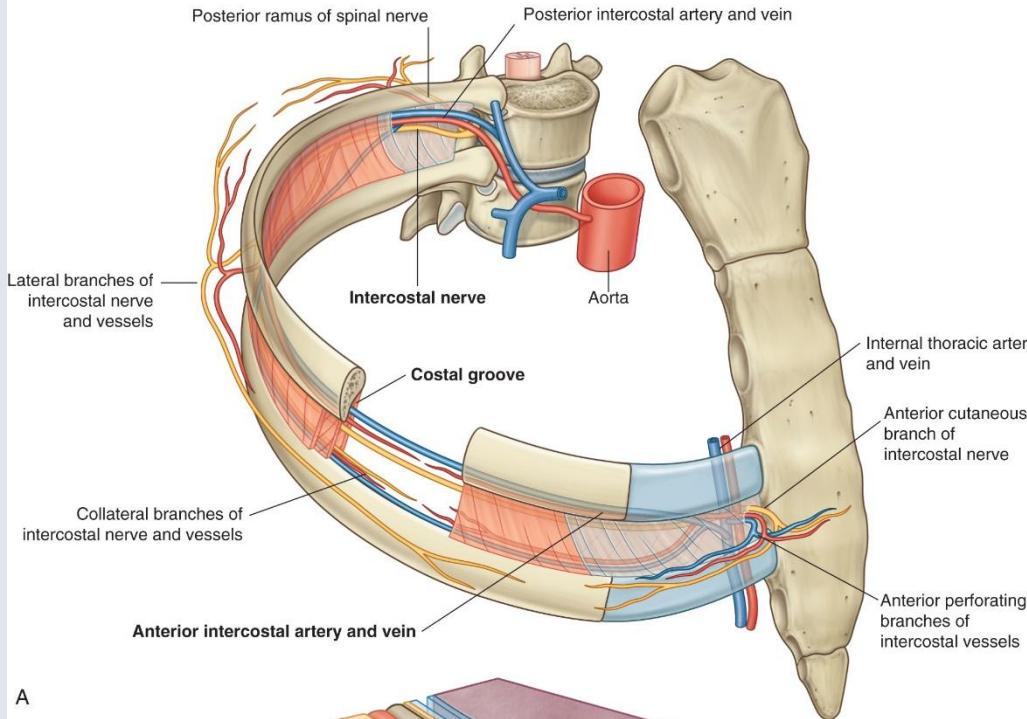
Why do we have a bony thoracic cage?

- Ventilation – Allows muscles to change the thoracic volume and bring about respiration
- Protection – Strong cage to give protection to some vital organs

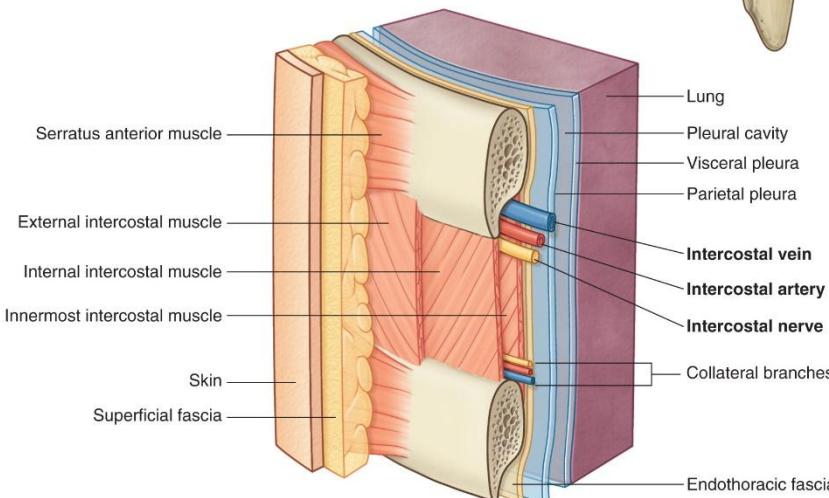
Composed of:

- 12 thoracic vertebrae
- 12 pairs of ribs (i.e. 24 ribs)
- Cartilage structures
- Sternum – 3 parts

Intercostal Space: Contents



A



B

Intercostal spaces exist between each 2 ribs.

- Only 11 intercostal spaces.

Three muscle layers:

- External, Internal, and Innermost

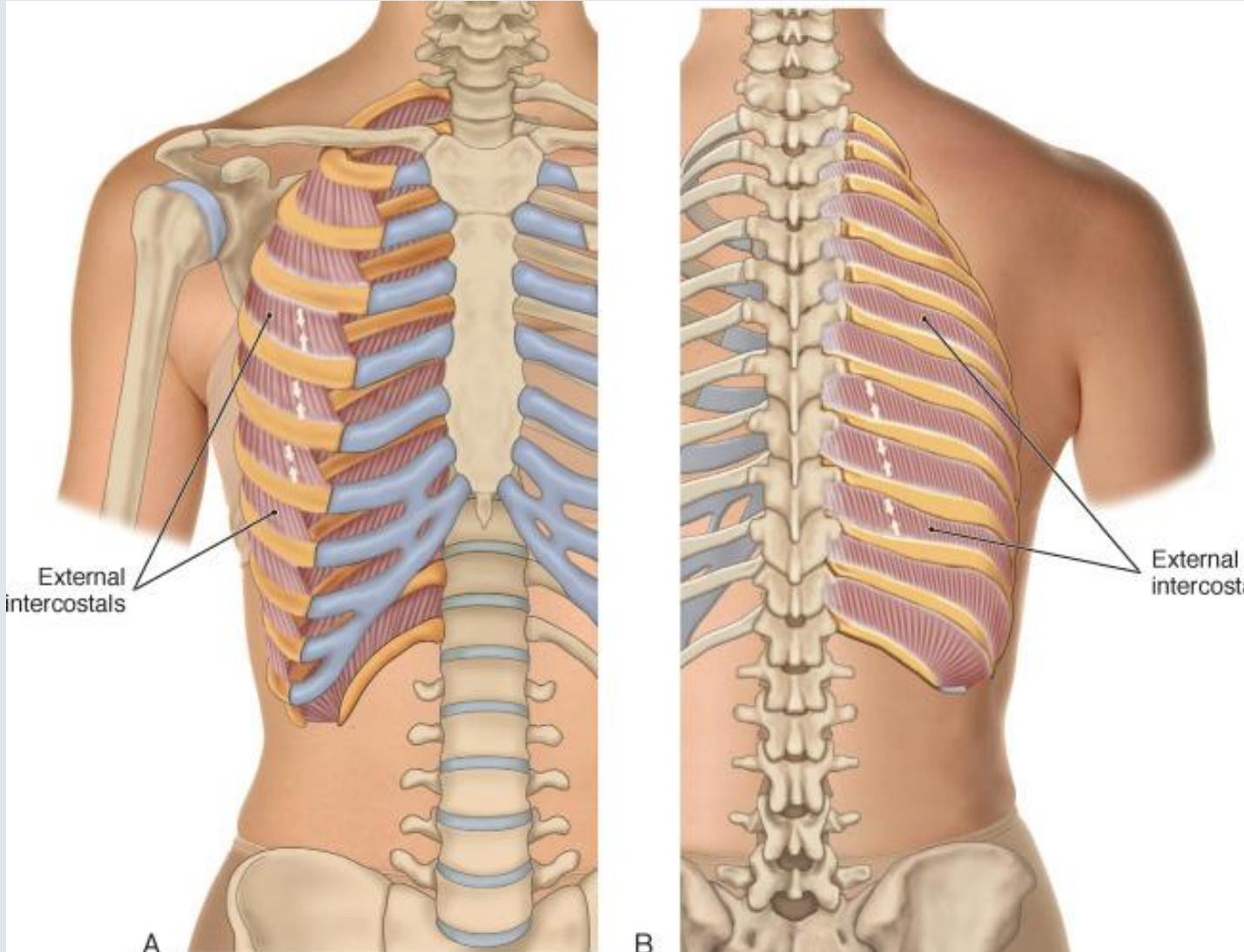
Neurovascular structures:

- Inferior to superior rib in costal groove (mostly):
 - Intercostal artery, Intercostal vein, and Intercostal nerve
- Superior to inferior rib:
 - Collateral branches – still VAN
- Remember location for chest drain.

Blood vessel origin/drainage:

- Artery:
 - Anterior – Internal thoracic artery
 - Posterior – Descending aorta (3-11), costocervical trunk (1-2)
- Vein:
 - Anterior – Internal thoracic vein
 - Posterior – Azygos system

Muscles: External Intercostals



Run from tubercle of ribs posteriorly to the costochondral junctions anteriorly.

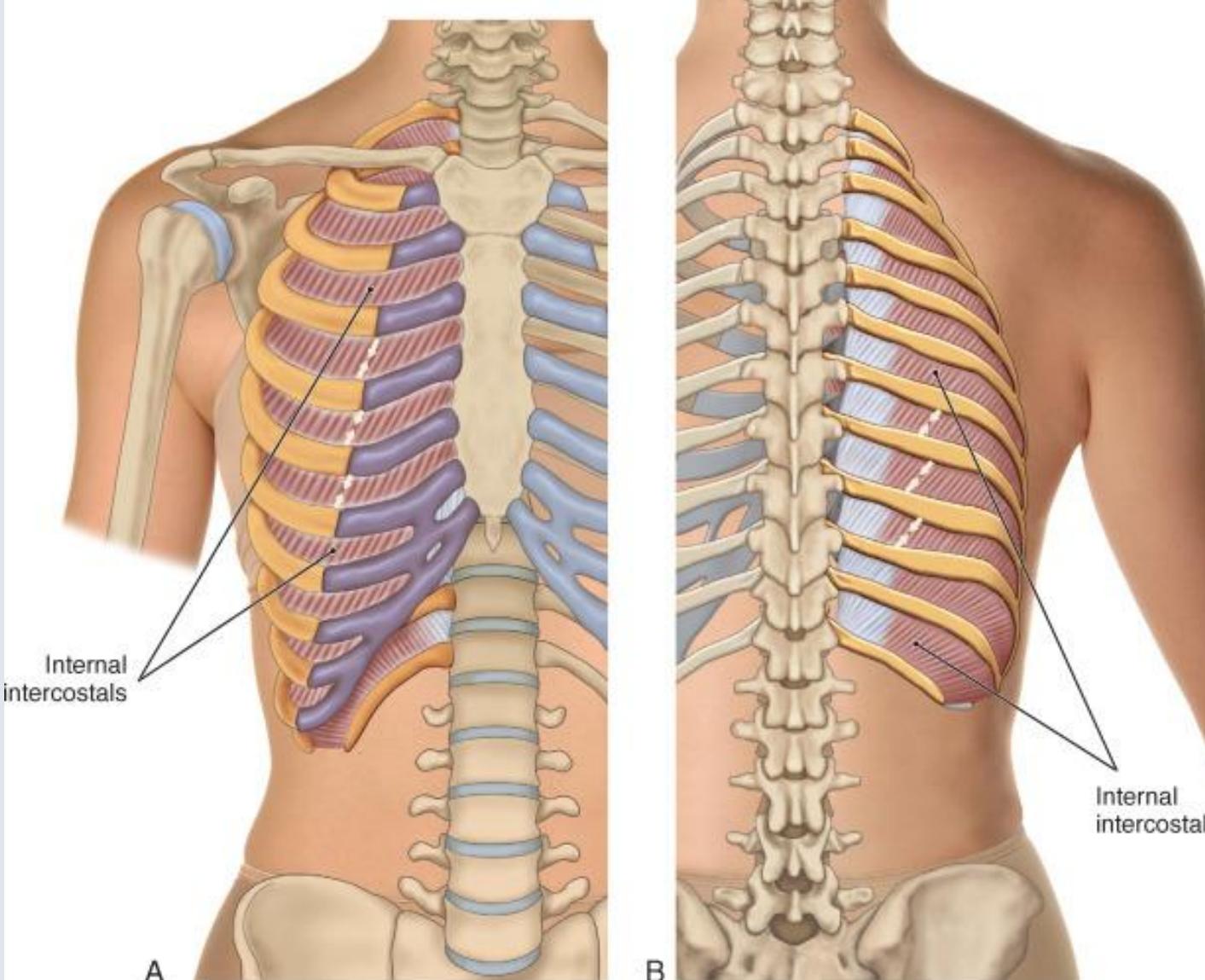
- Ends at the ends of Ribs 11 & 12

Blend with the external intercostal membrane which lies between costochondral junction and sternum.

Fibres run inferiorly and medially from the inferior border of the superior rib to the superior border of the inferior rib.

Function to elevate the ribs during forced inspiration.

Muscles: Internal & Innermost Intercostal



Internal and innermost muscles share most of the same properties.

Neurovascular bundles lie between them in the intercostal tunnel – this makes the internal and innermost muscles distinct from each other.

Run from the lateral border of the sternum/combined costal cartilages (6-10) to the angle of the ribs

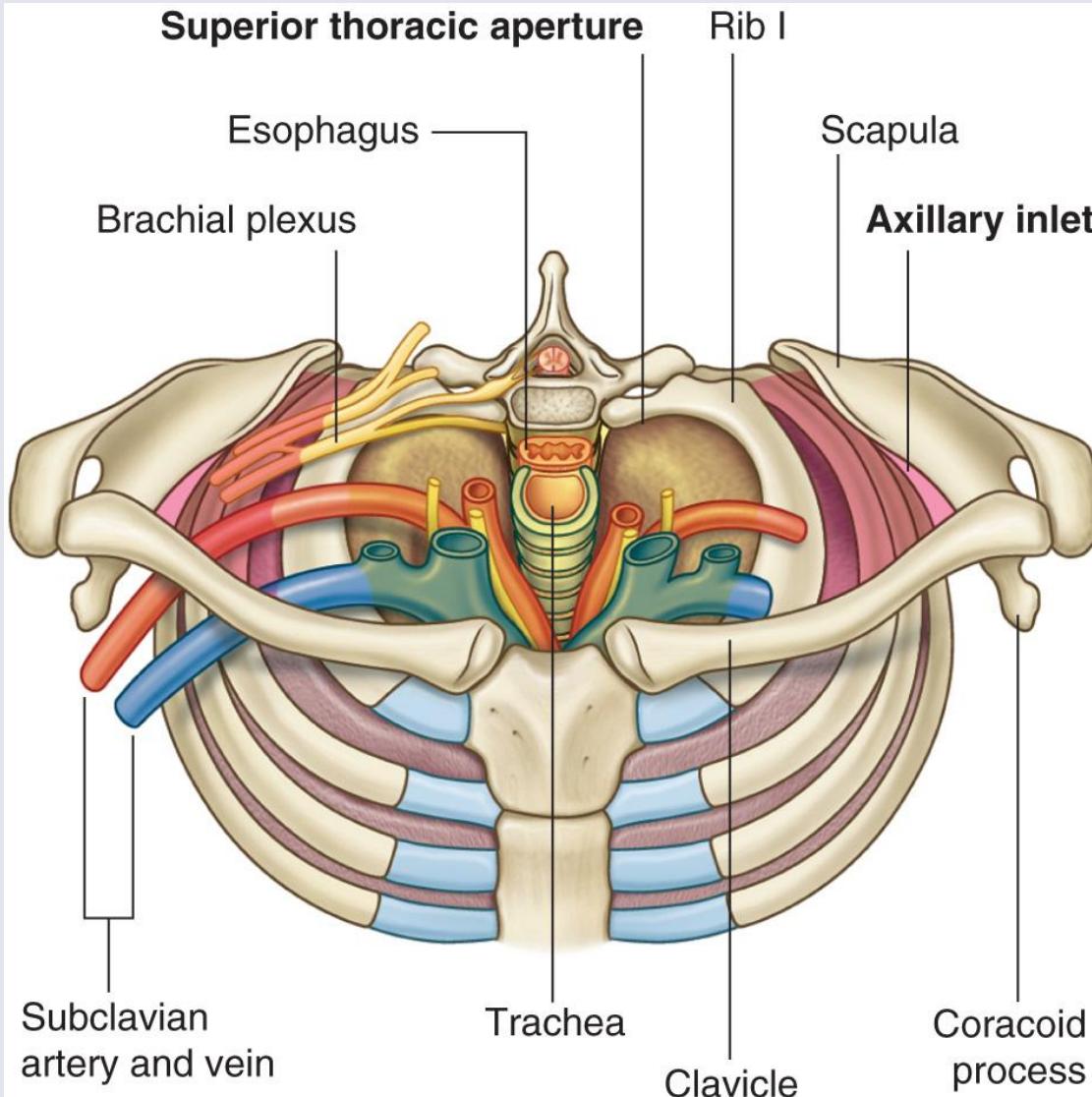
- Ribs 11-12 – Muscles fill the space
- Innermost muscles only fill around the middle two quarters.

Blend with the internal intercostal membrane which lies between angle of rib to vertebral column.

Fibres run posteroinferiorly (laterally anteriorly and medially posteriorly) from the inferior border of the superior rib to the superior border of the inferior rib.

Function to depress the ribs during forced expiration.

Thorax: Thoracic Inlet



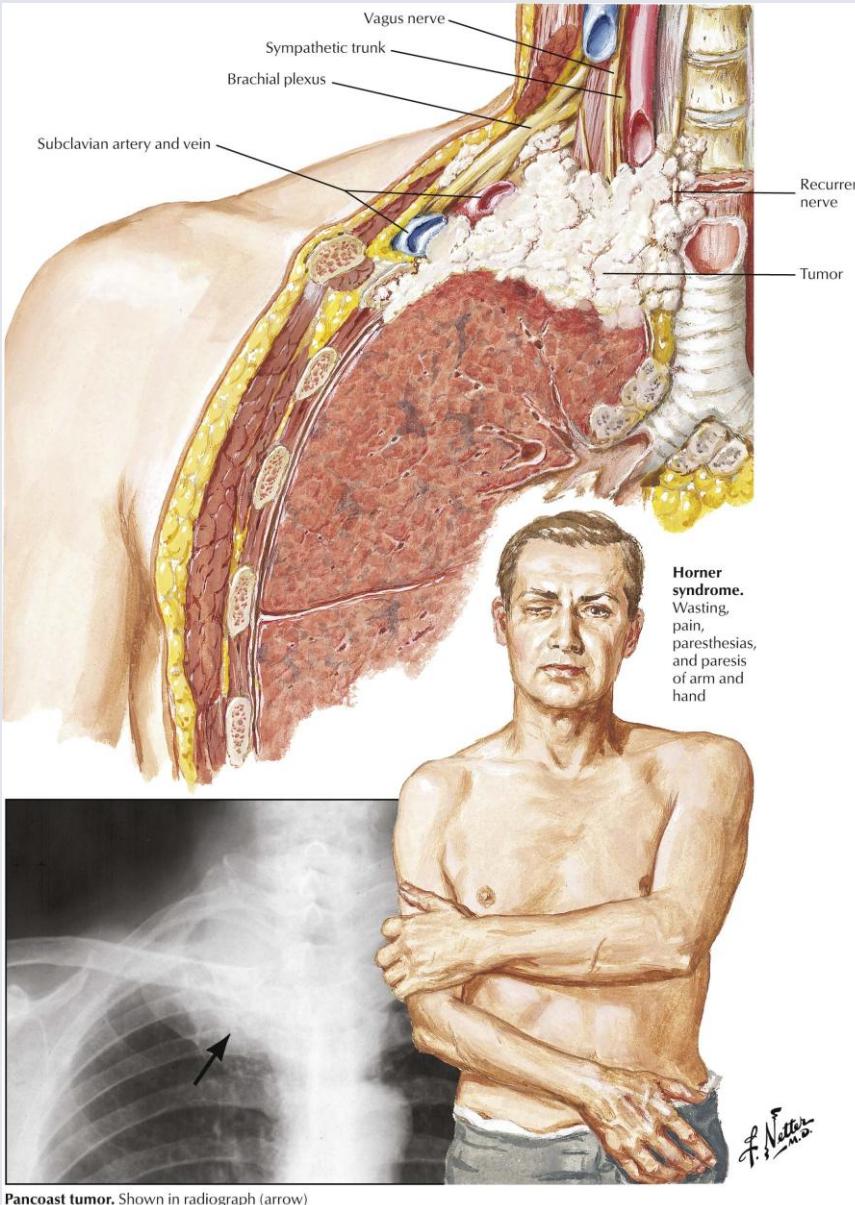
Superior thoracic opening/thoracic inlet/thoracic aperture.

Boundary – Manubrium, rib 1, and T1.

Allows passage for all vital structures of the chest, upper limb, head, and neck.

Important to know clinically as any damage or inflammation here can compress important structures as there is very little space.

Thoracic Inlet: Pancoast Tumour

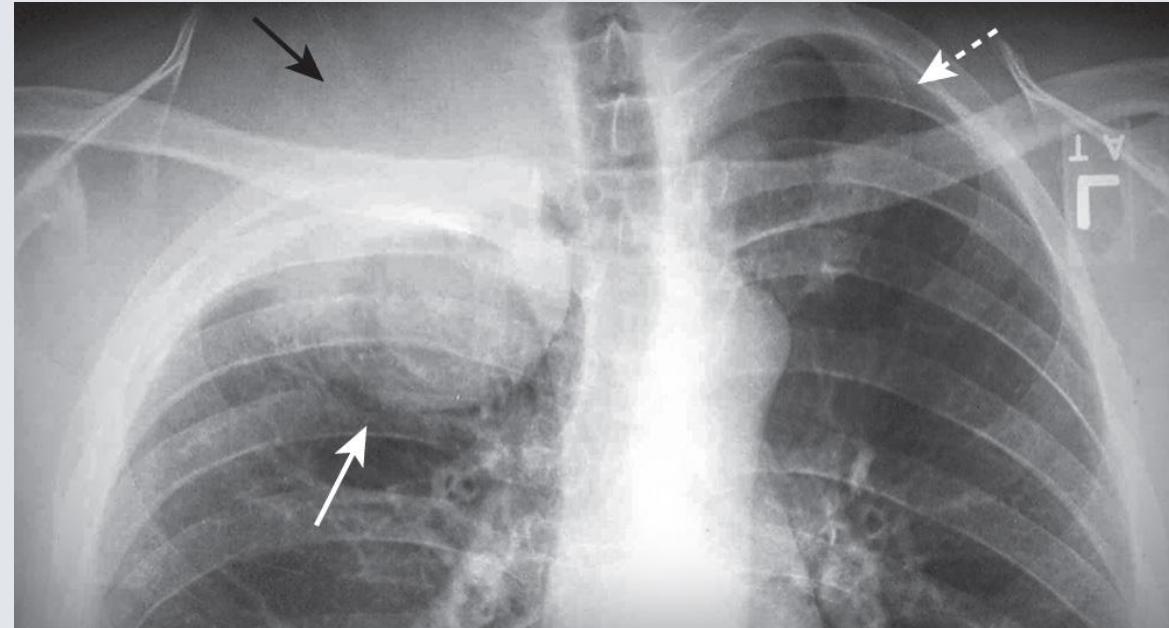


Cancerous tumour at the apex of the lung.

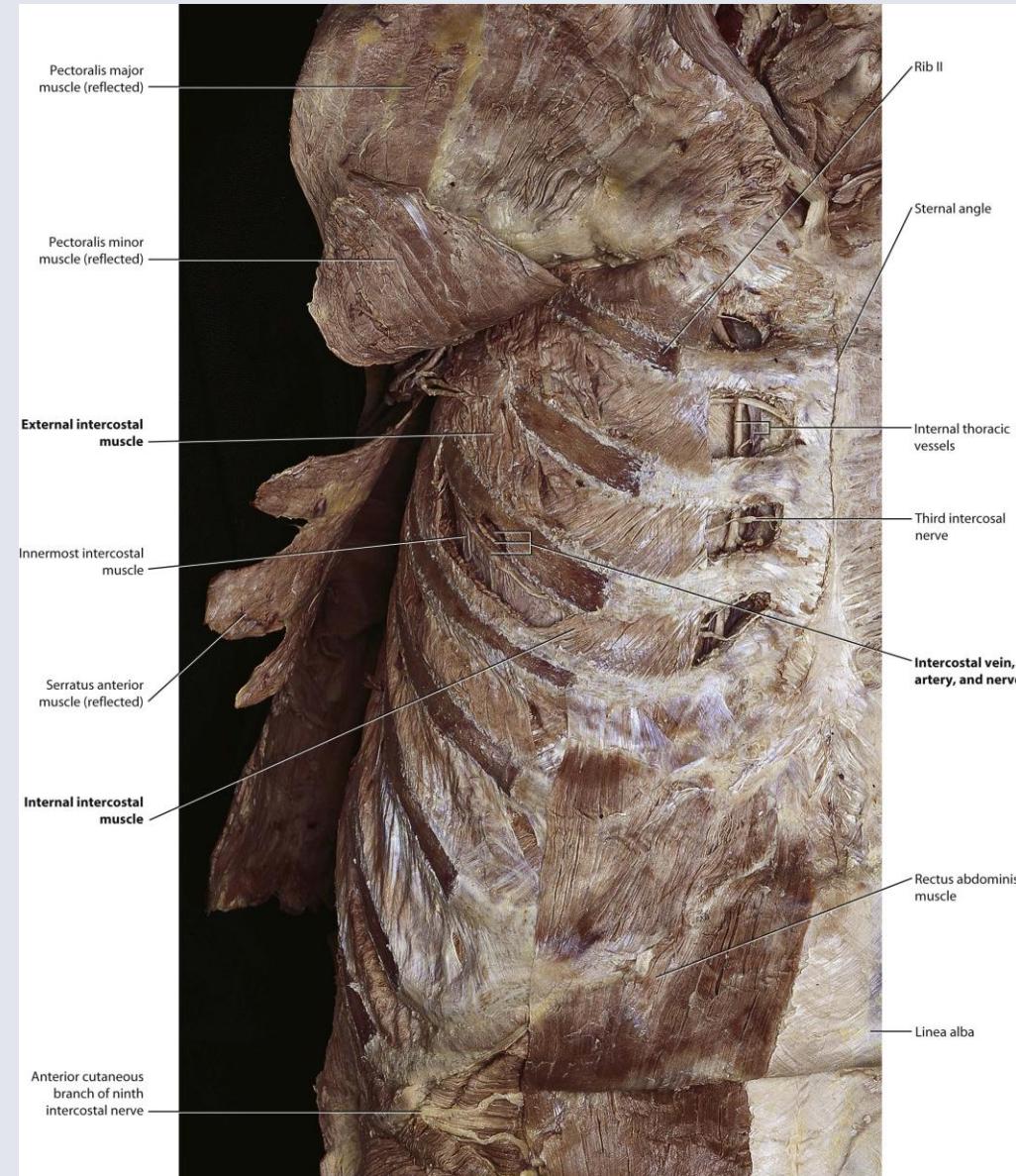
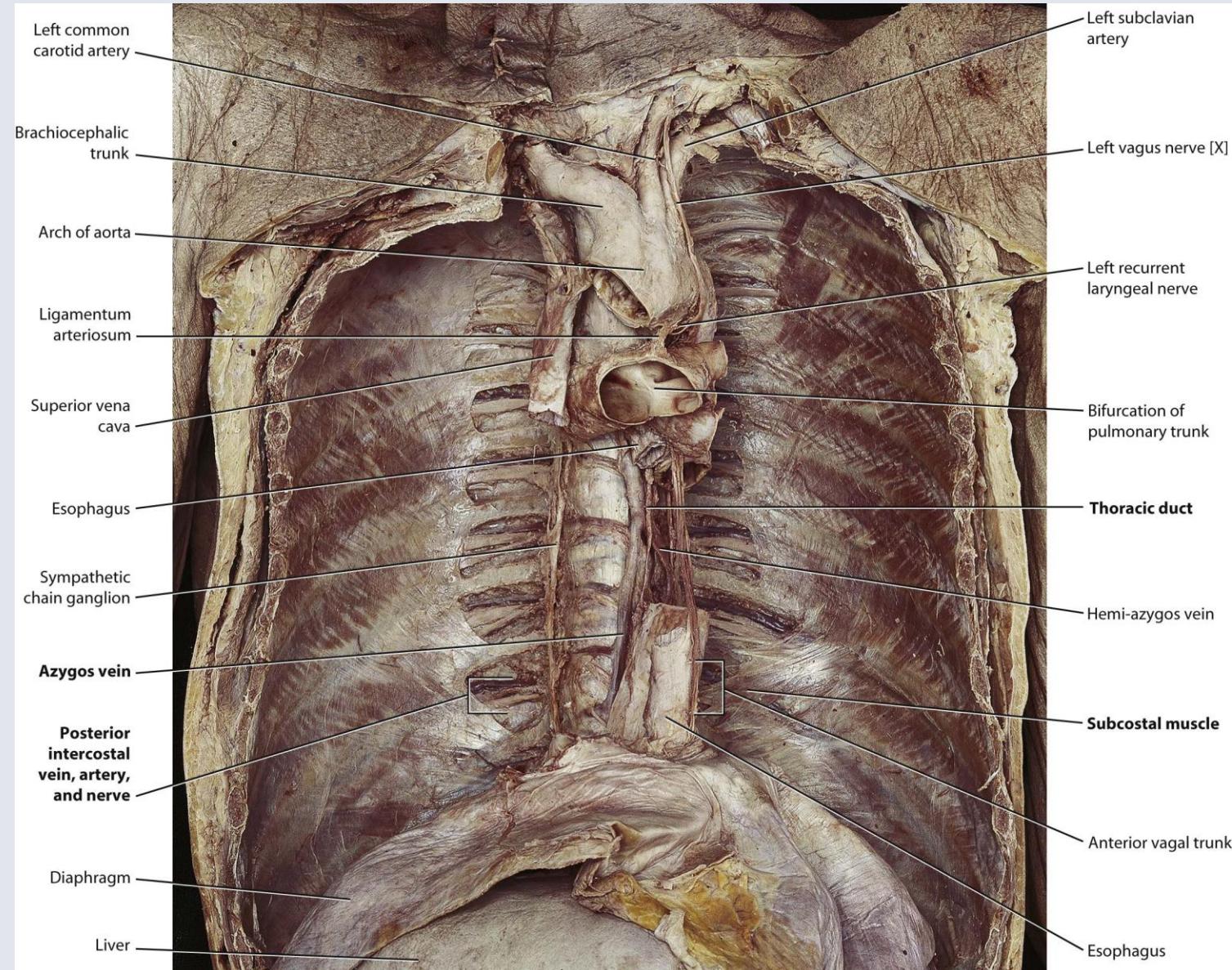
Can press on structures in the thoracic inlet, causing them to be damaged.

- e.g. Horner syndrome – compression of sympathetic trunk
- Partial paralysis and paraesthesia in arm – brachial plexus compressed

Image below: Black arrow – Pancoast tumour, White arrow – bulla in lungs



Thorax: Dissection



Clinical: Rib Fractures (#)

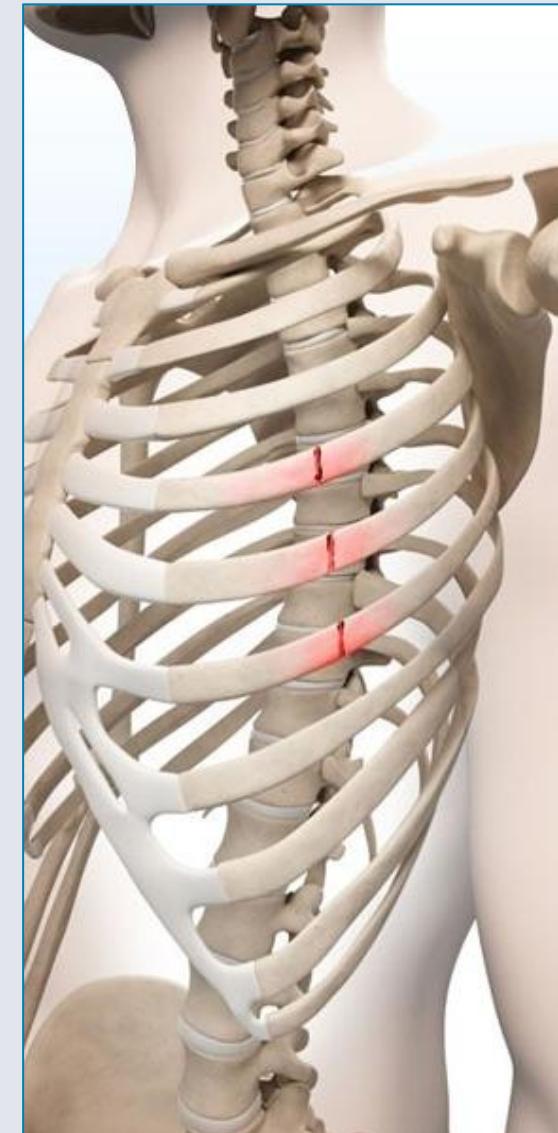
Definition: A break in a rib

Causes include:

- Blunt force trauma (most common)
- Aggressive CPR
- Athletic activities (contact sport, rowing, golf)
- Primary bone tumours (osteochondromas, multiple myeloma)
- Metastatic lesions (lung, prostate, breast, liver)

Co-morbidities include:

- Pneumothorax/haemothorax
- Pulmonary (lung) contusions
- Flail chest (discussed later)

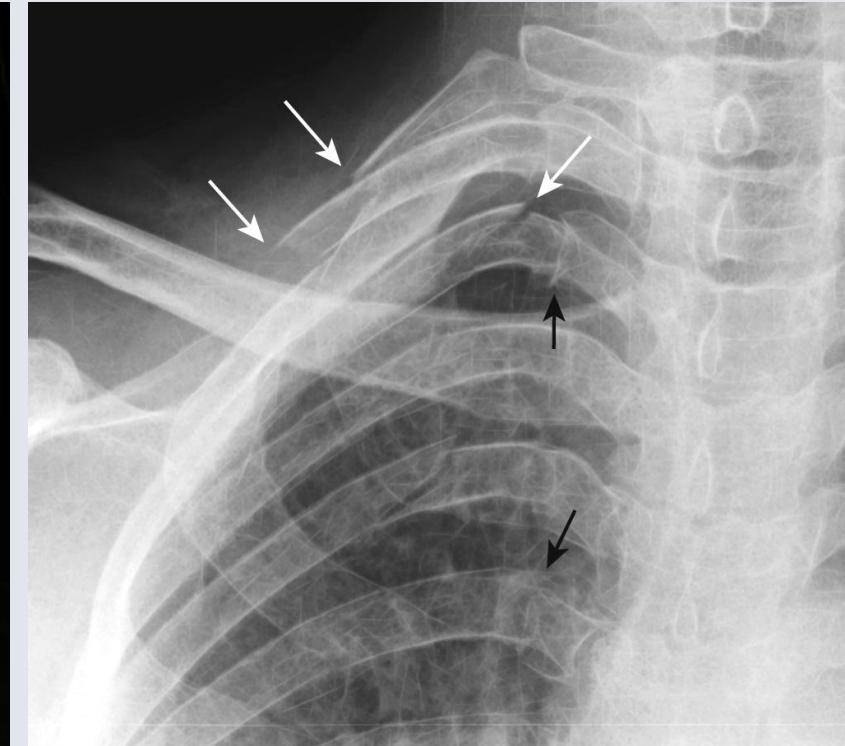
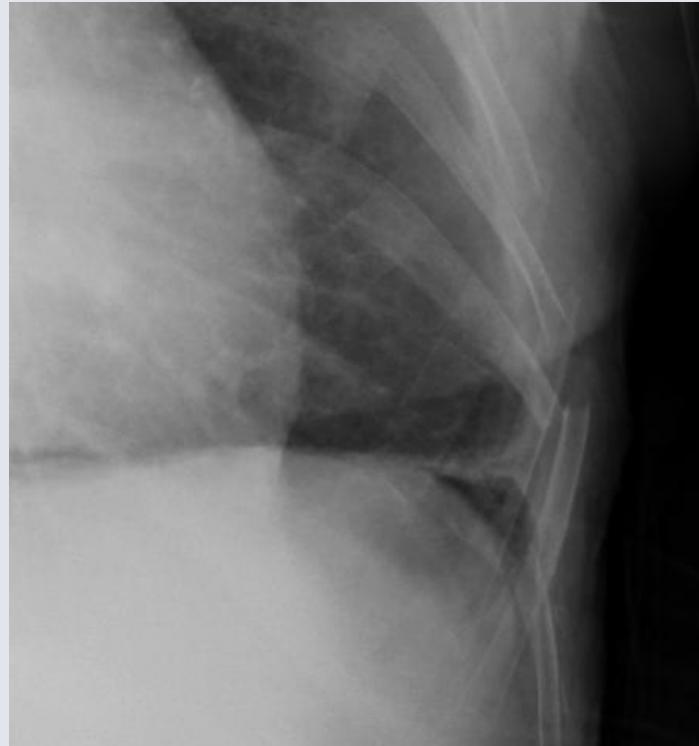


Ribs: Fractures

Ribs 4-10 most commonly fractured.

Ribs 1-3 fracture indicates a high energy trauma – usually sufficient to cause other internal injuries.

How ribs are fractured and where can tell you a lot about the patient (e.g. child abuse, domestic violence).



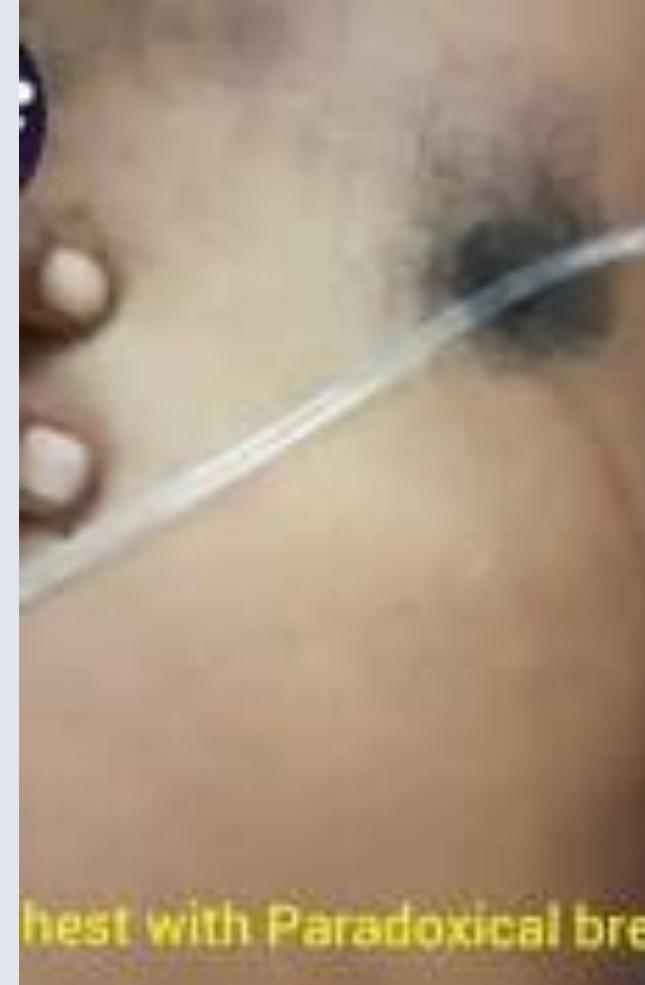
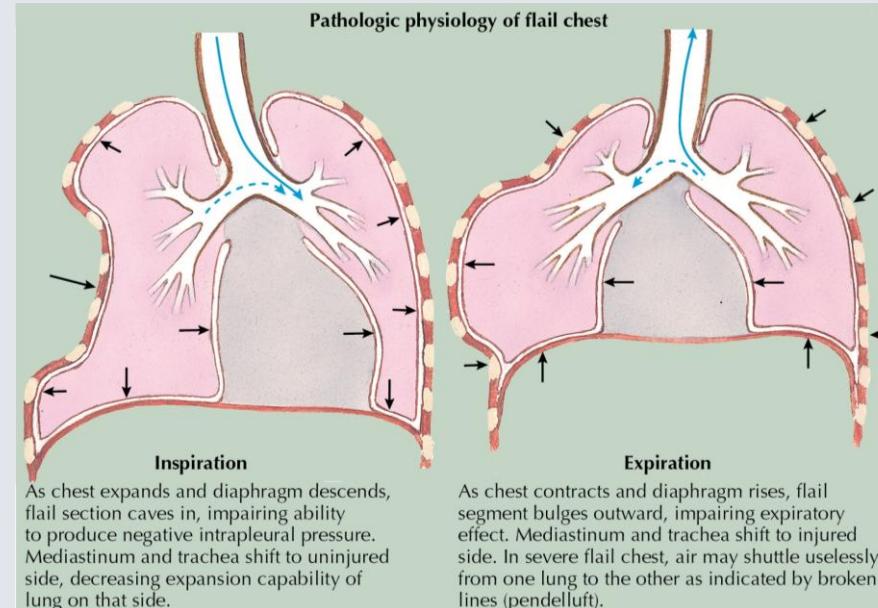
Clinical: Flail Chest

Flail chest: Consecutive, segmental, ipsilateral rib fractures, classically causing paradoxical movement of the chest wall

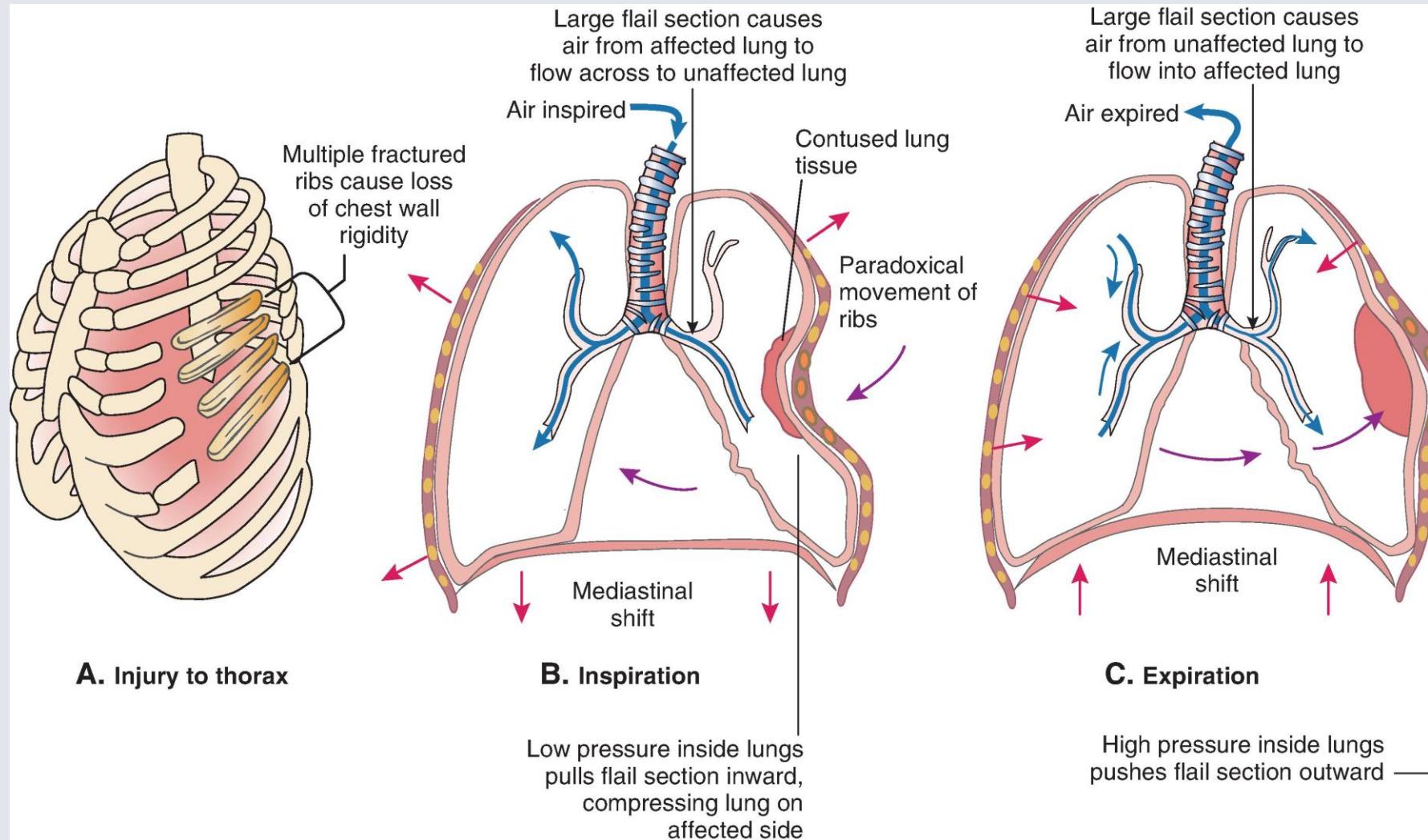
Paradoxical movement: the flail (unstable) segment which is no longer continuous with the chest wall moves **inwards** during inspiration and **outwards** during expiration due to:

- loss of anatomical continuity/ chest wall rigidity
- the effect of pressure inside the lungs acting on the detached segment

Impact: Impaired ventilation leading to respiratory compromise, poor oxygenation, alveolar collapse (atelectasis) and infection (pneumonia).



Clinical: Flail Chest



Clinical: Rib Fractures

Presentation:
Presence of risk factors, pain, dyspnoea

1st line investigations

CXR

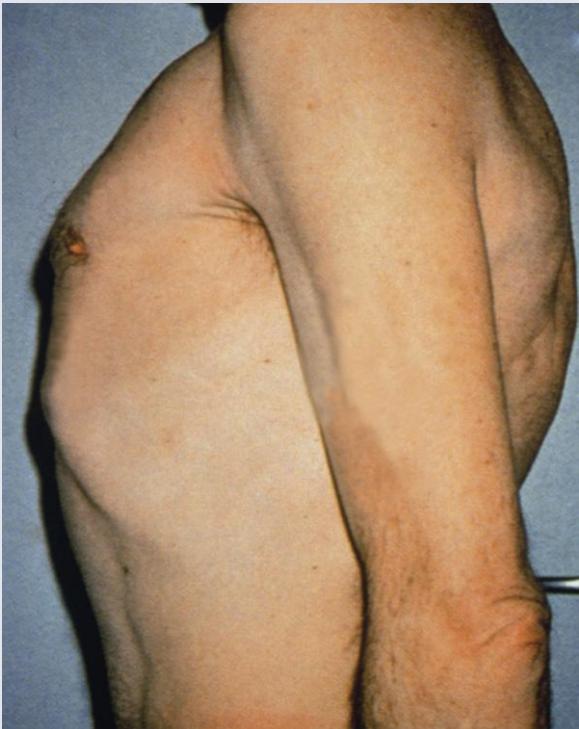
- **Detects:** rib fracture ± associated injury
- First-line imaging modality for trauma pts
- Helps to detect rib #s, but can miss 50%

CT Chest (with contrast)

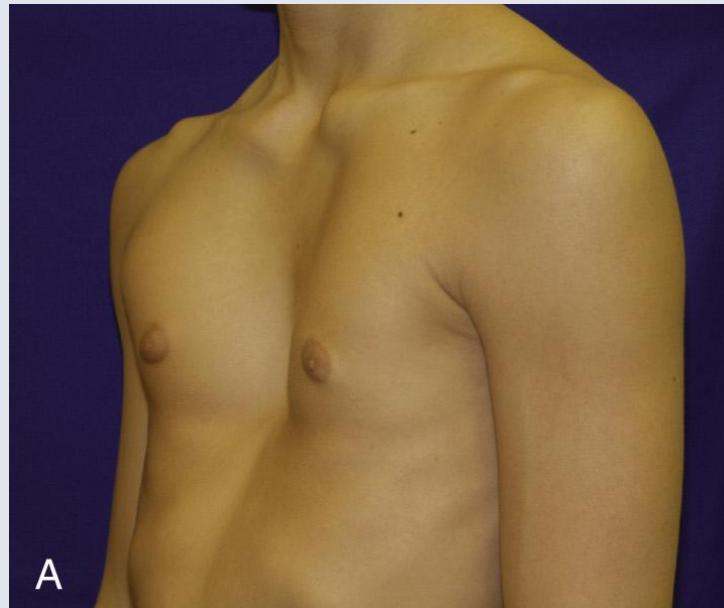
- **Detects:** rib fracture ± associated injury
- Can improve detection sensitivity
- Consider if there are clinical features suggestive of rib fracture and there is the potential for improved patient care by detecting suspected pathology

Other investigations to consider: Extended focussed assessment with USS, CT of head, cervical spine, abdomen and pelvis, ECHO, skeletal survey, CT head (children)

Thorax: Chest Wall Variations



Barrel chest

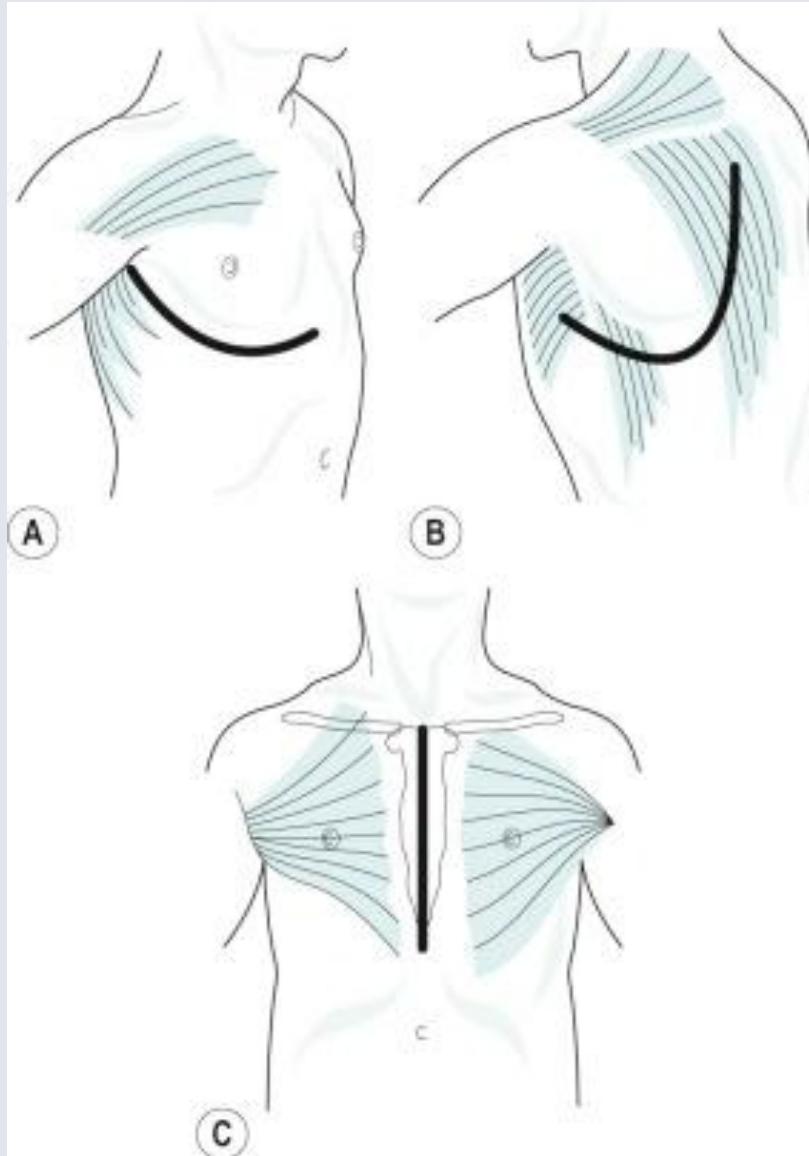


Pectus excavatum



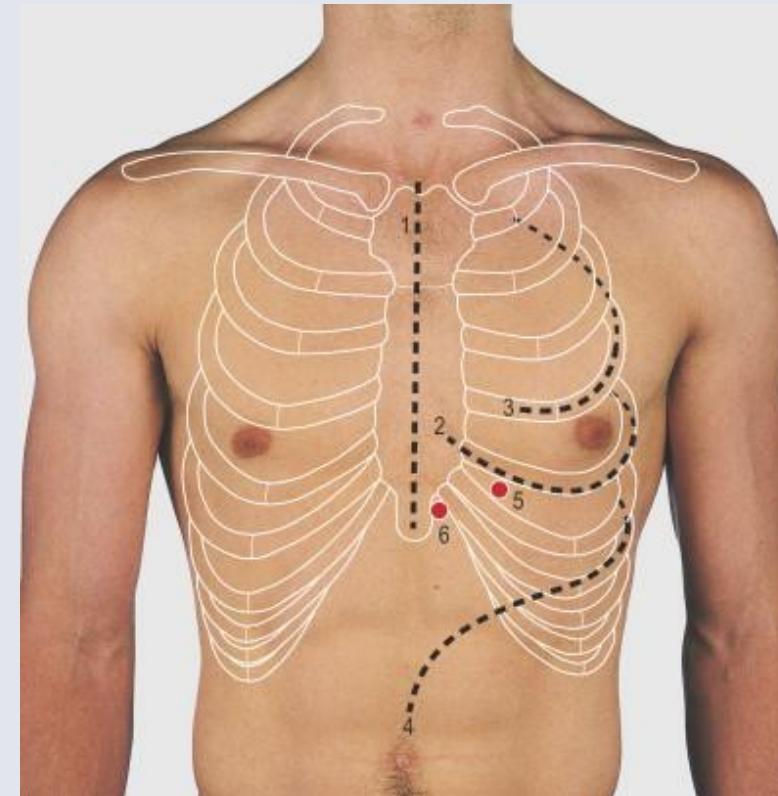
Pectus carinatum

Thoracic Surgery: Approaches



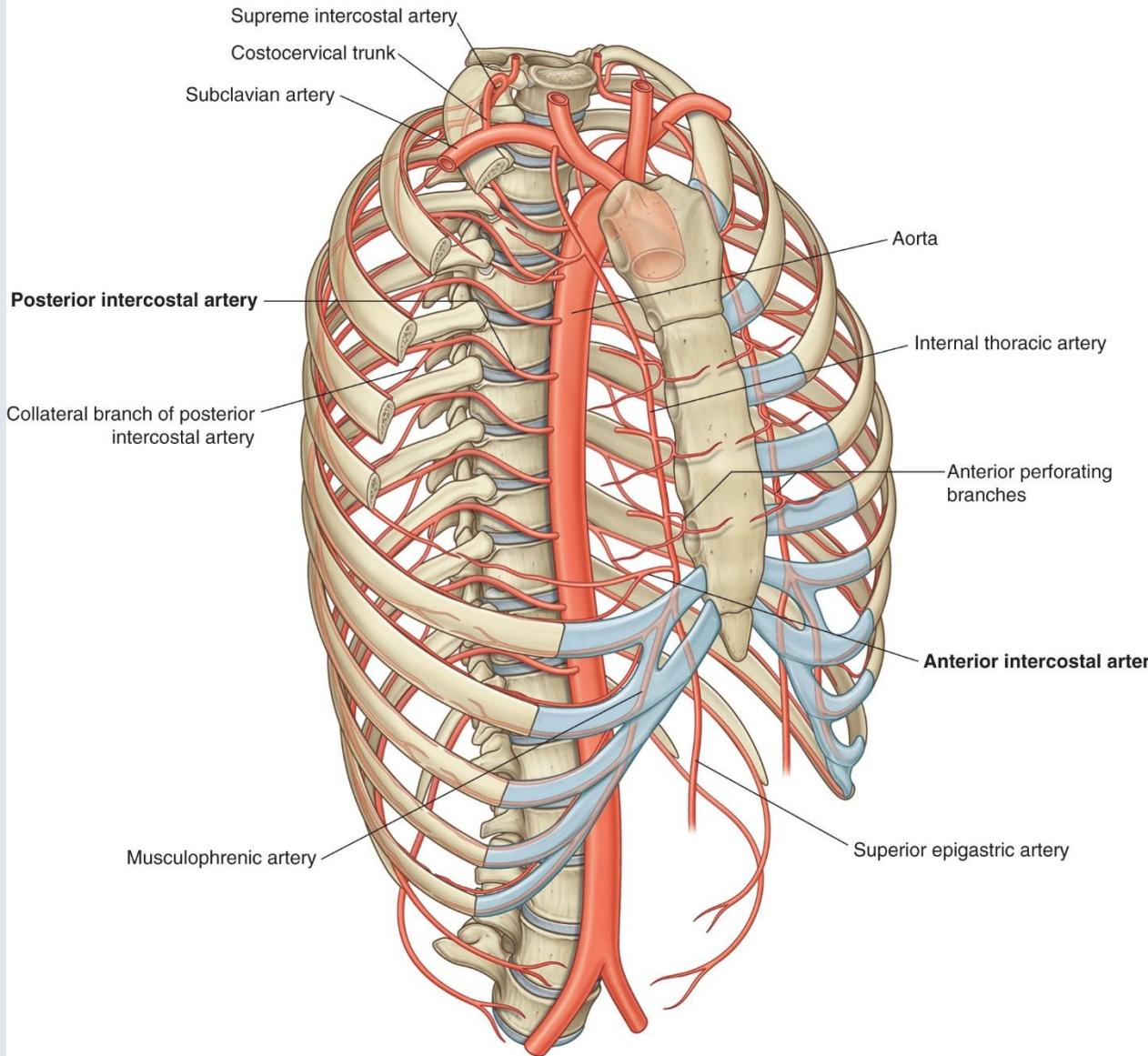
Thoracic Approaches:

- Anterolateral thoracotomy
- Posterolateral thoracotomy
- Median sternotomy
- Left thoraco-laparotomy



Part 1 – Thorax Neurovascular

Thorax: Arterial Supply



Which major arteries supply the intercostal arteries?

Thoracic Aorta:

- Post. 3-11
- Also Subcostal A. under Rib 12

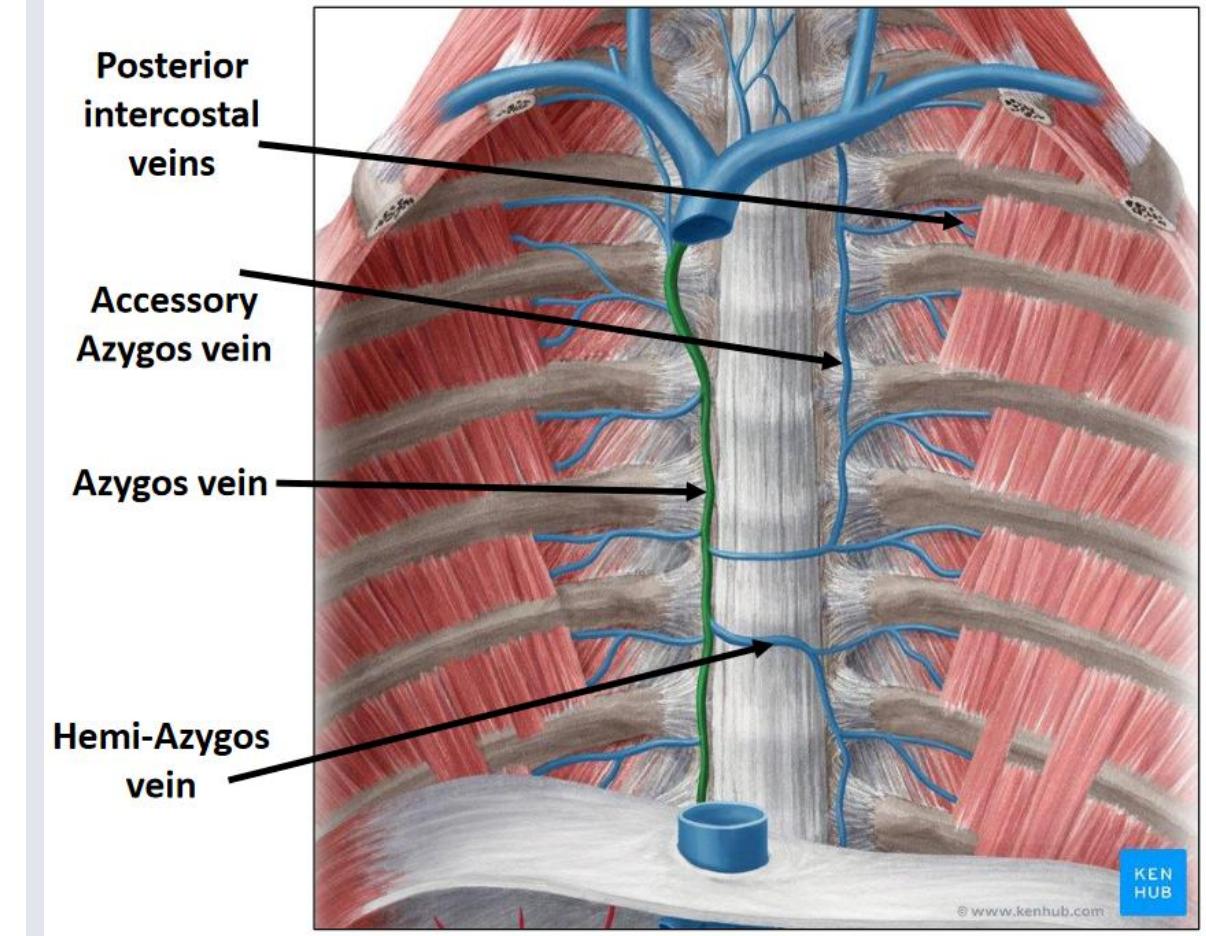
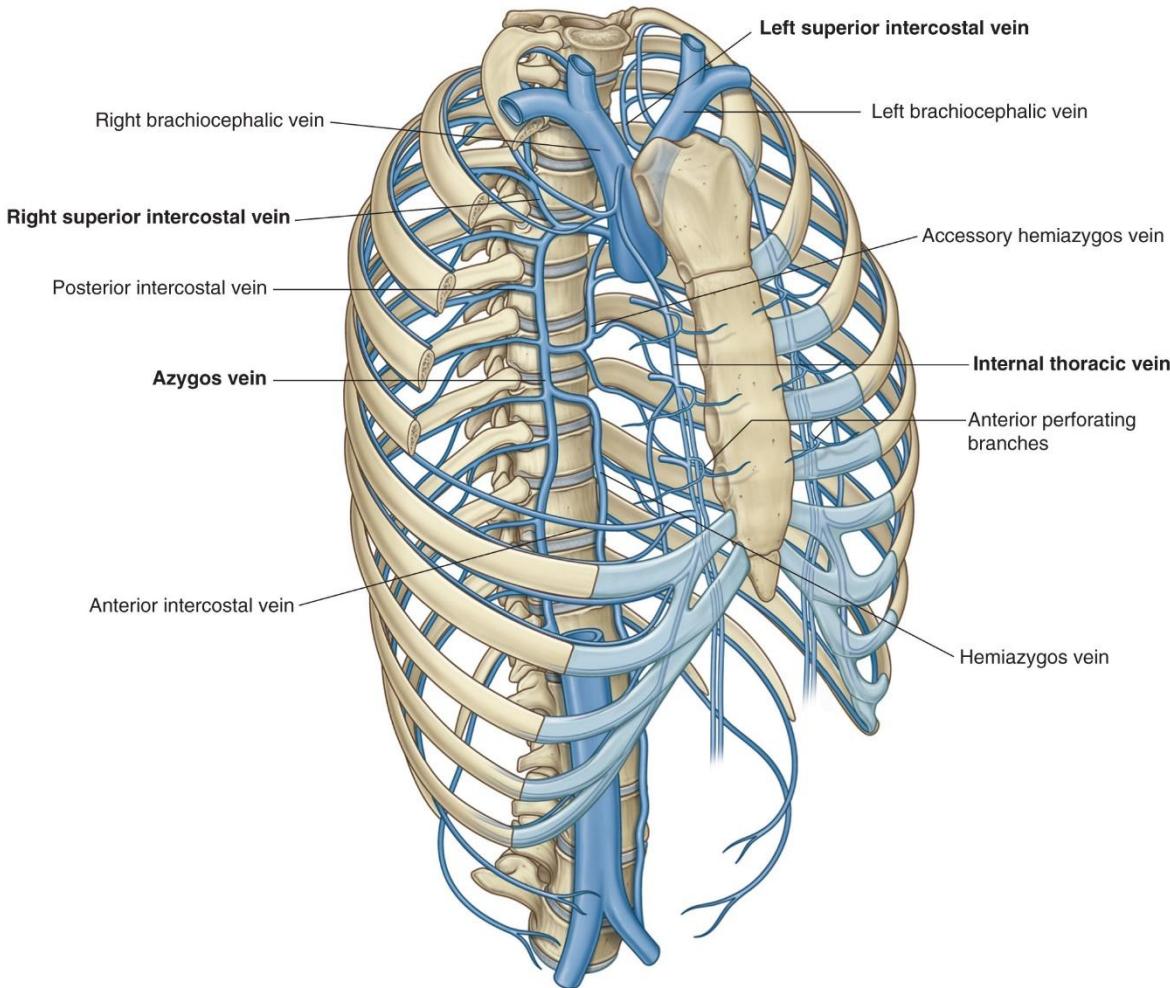
Left Subclavian A.:

- Internal Thoracic A.
 - Ant. 1-6
 - Musculophrenic
 - Ant. 7-9
- Costocervical Trunk
 - Supreme Intercostal A.
 - Post. 1 & 2
 - Does anastomose with Post. 3

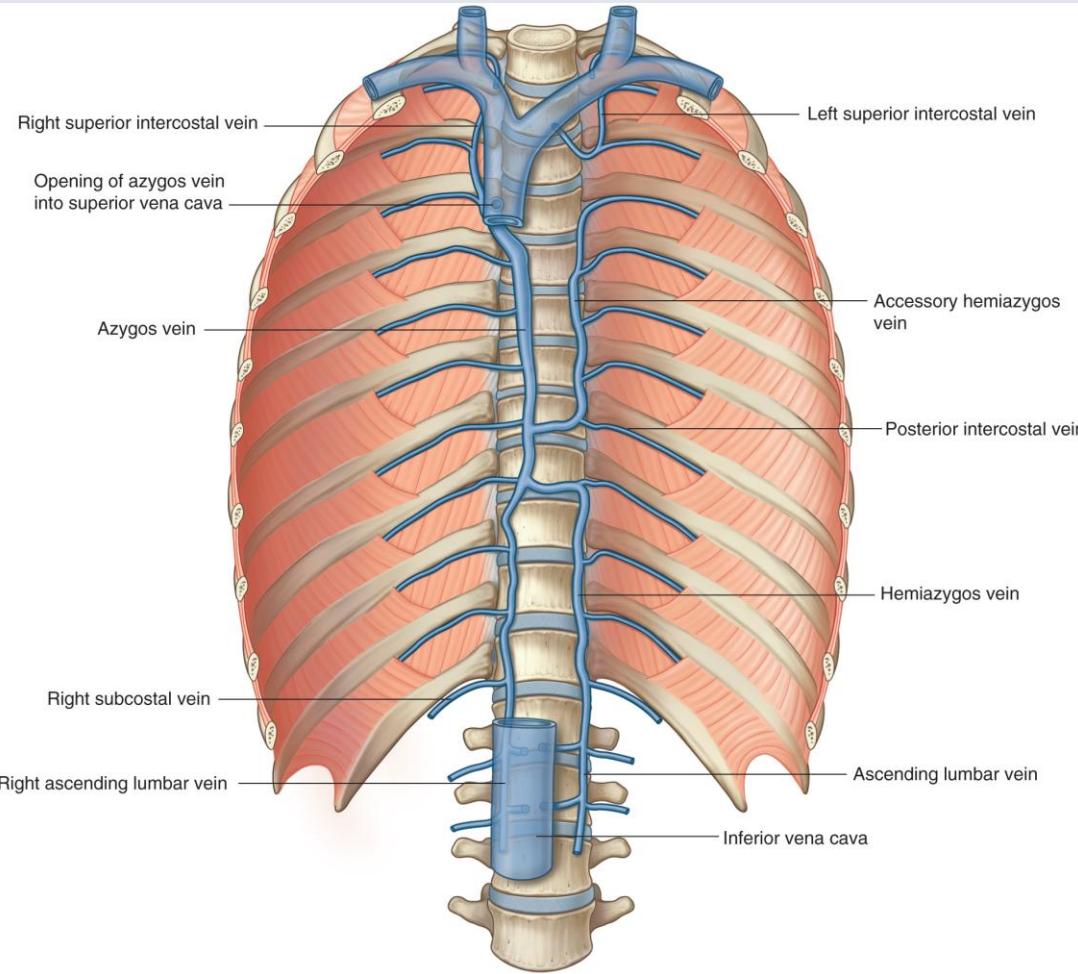
Right Subclavian A.:

- Same divisions as Left Subclavian A.

Thorax: Venous Drainage



Thorax: Venous Drainage



Posterior Intercostal Veins (PICVs)

Right Side

- Brachiocephalic vein directly or R. Superior IC vein – Upper PICVs
- Azygos vein - 5th - 11th

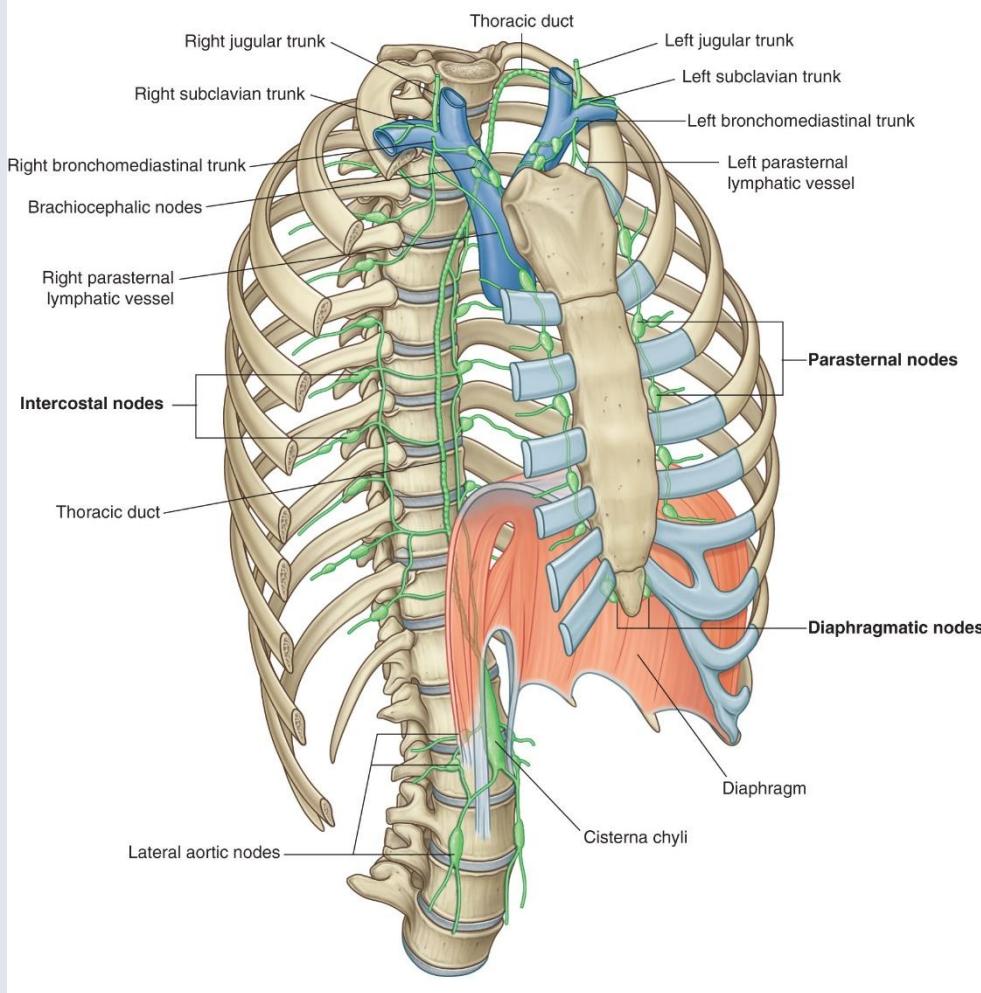
Left Side (pattern variable)

- Brachiocephalic vein directly or L. Superior IC vein – Above T4
- Accessory Hemiazygos – 4th - 8th
- Hemiazygos – 9th - 11th

Surface Anatomy

- T4 - Azygos vein drains into SVC
- T8 – Accessory vein crosses midline to drain into azygos
- T9 – Hemiazygos crosses midline to drain into azygos

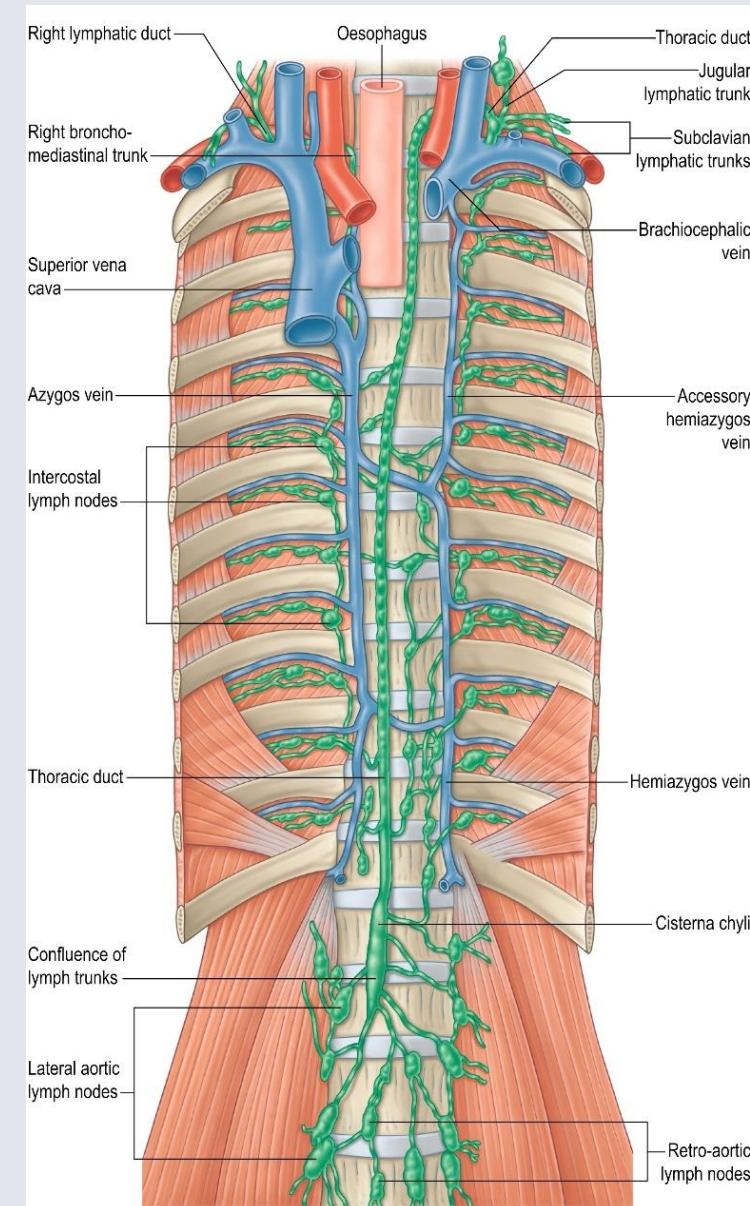
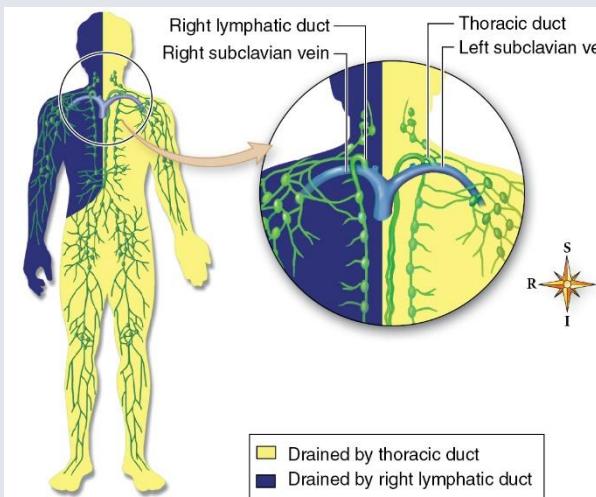
Thorax: Lymphatic System



The lymphatic system terminates in the thorax where it enters the systemic circulation.

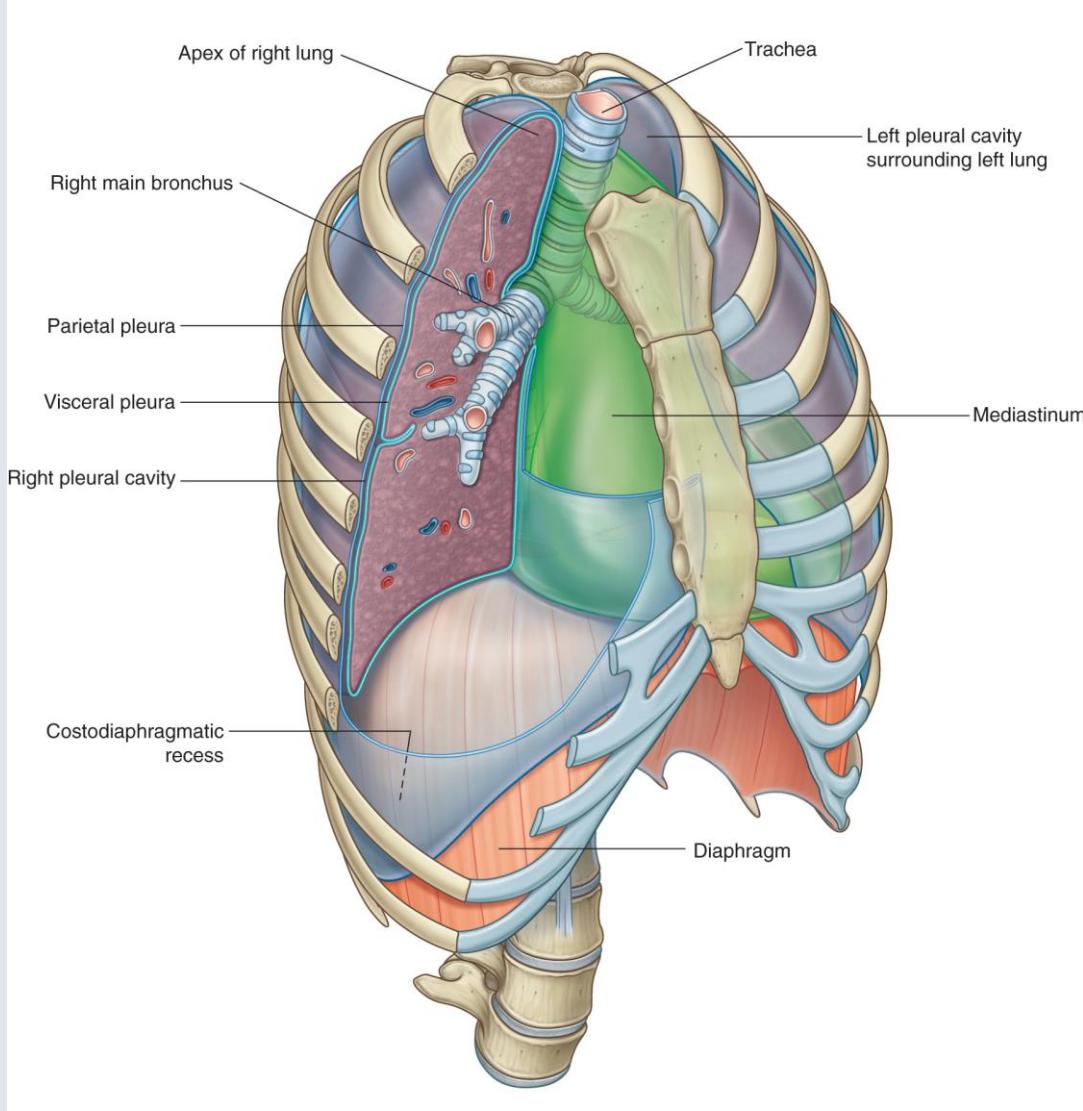
The lymph drainage depends on where in the body it is from:

- Thoracic duct
 - Left head, neck, thorax, and arm + all pelvis and lower limbs
- Right lymphatic duct
 - Right head, neck, thorax, and arm



Part 2 – Mediastinum Divisions

Thorax: Divisions

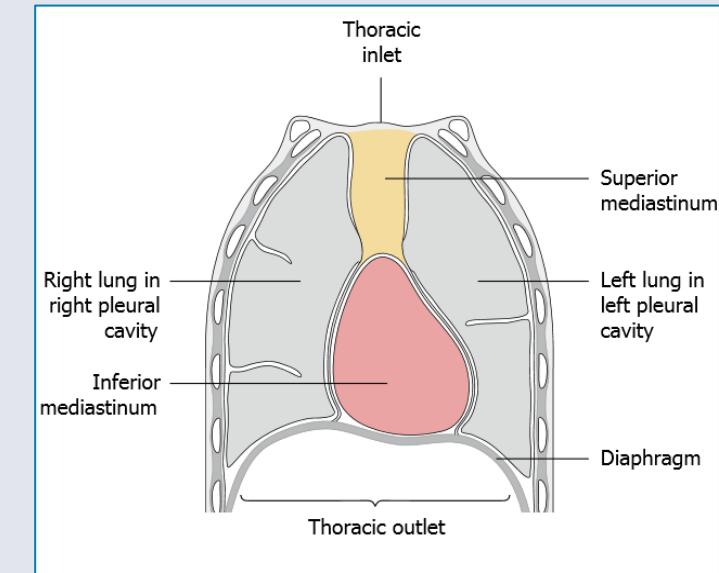
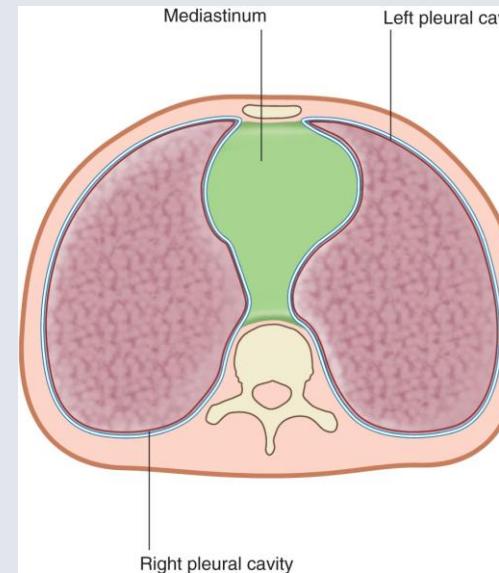


Thorax can be divided into:

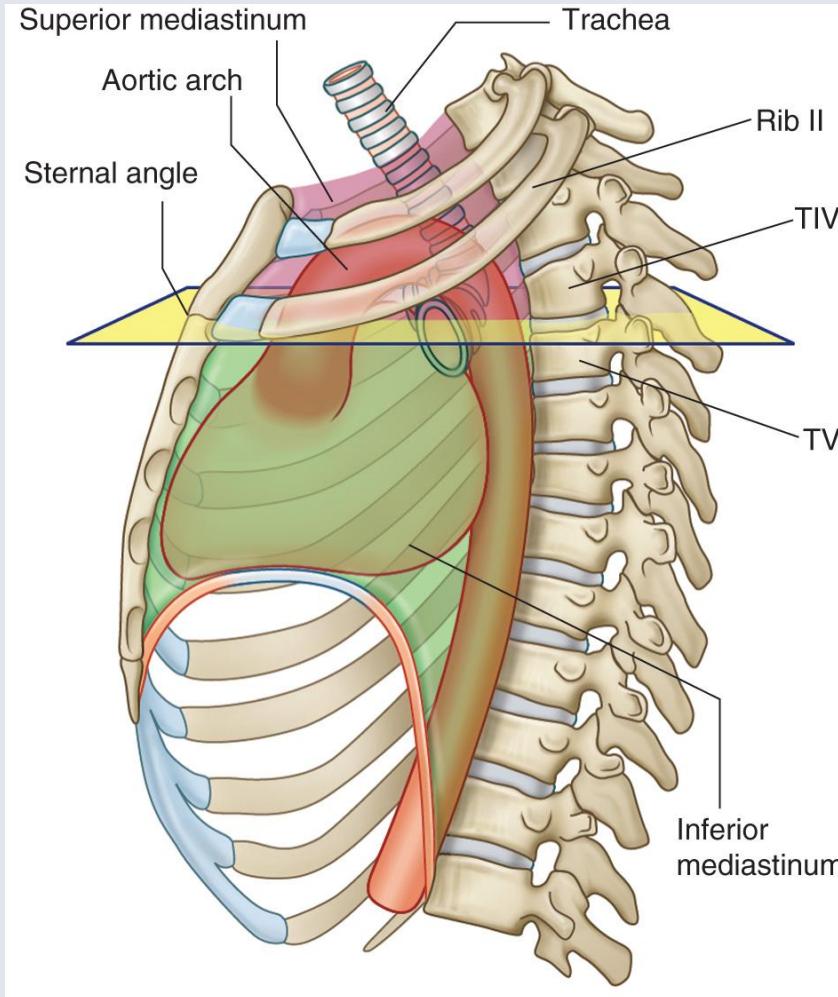
- Right pleural cavity
- Left pleural cavity
- Mediastinum

Mediastinal pleura encapsulates most of the mediastinum.

- Blends with the parietal pleura of the lungs laterally.
- Blends with the pericardium internally.



Mediastinum: Divisions

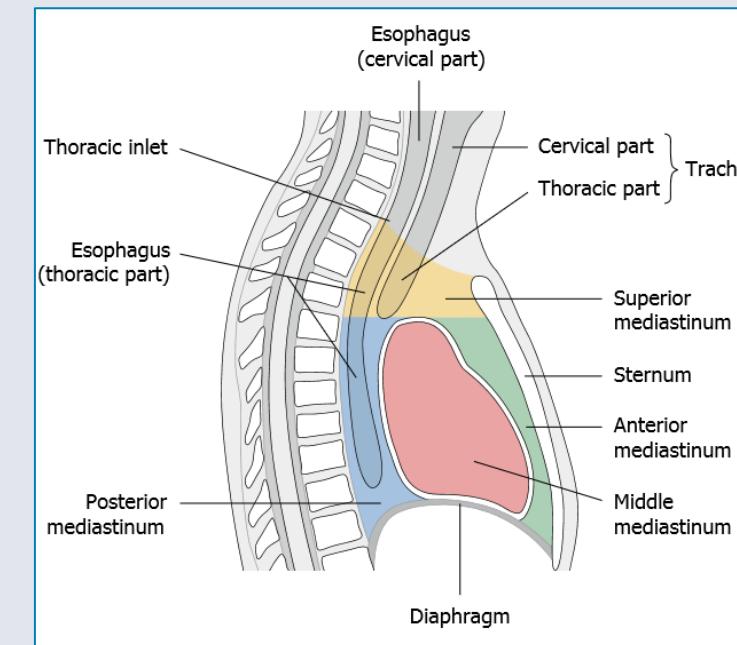


The mediastinum is divided into Superior and Inferior mediastinum.

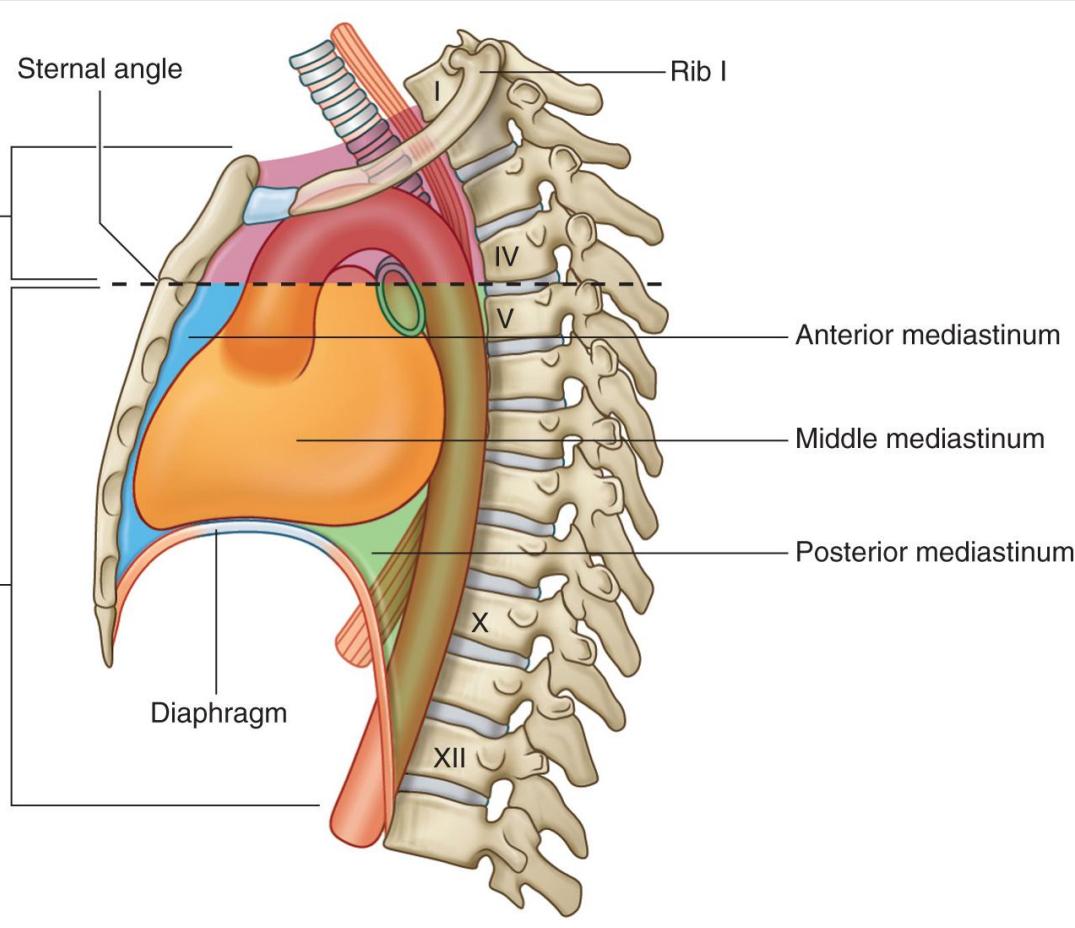
- Divided by an invisible section from the Sternal angle to the intervertebral disc between T4 and T5.

Many structures lie in each area of the mediastinum.

- Quite a few either lie in multiple areas or pass through them.



Divisions: Inferior Mediastinum



The inferior mediastinum is further subdivided into:

- Anterior mediastinum
- Middle mediastinum – Pericardium
- Posterior mediastinum

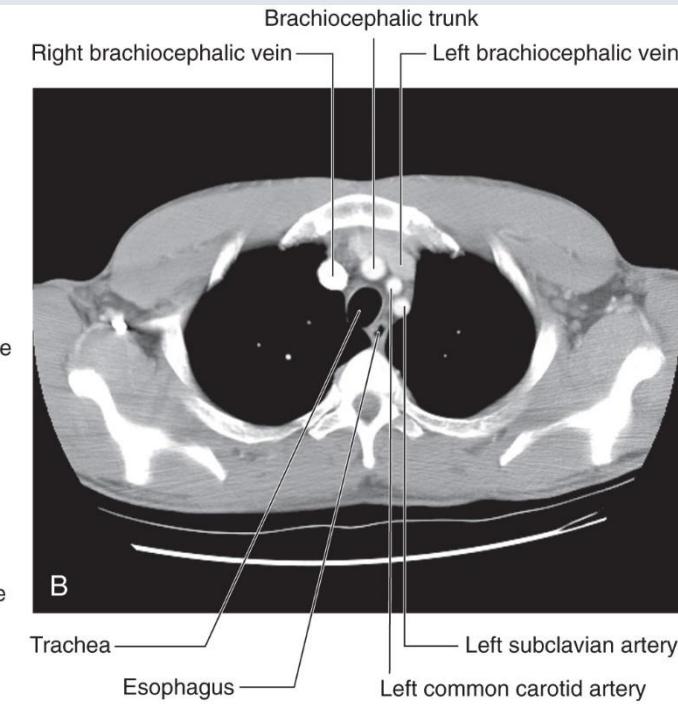
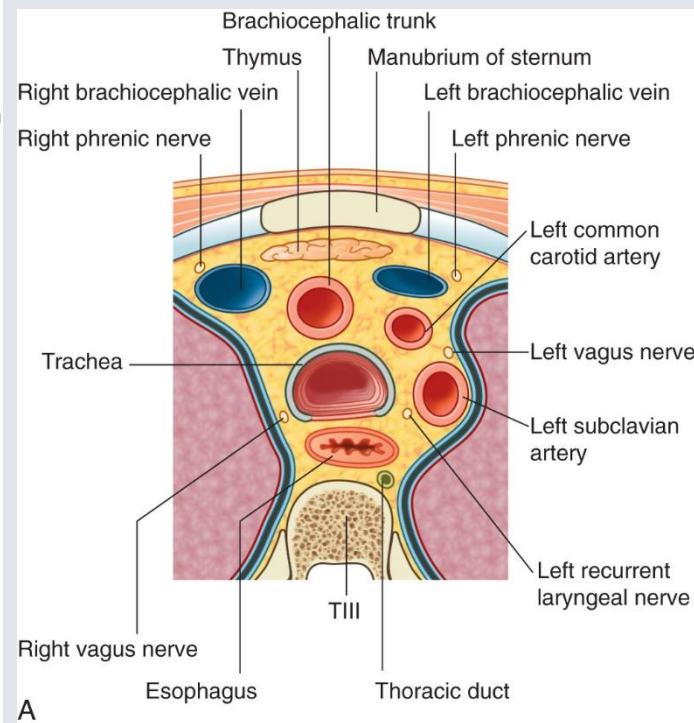
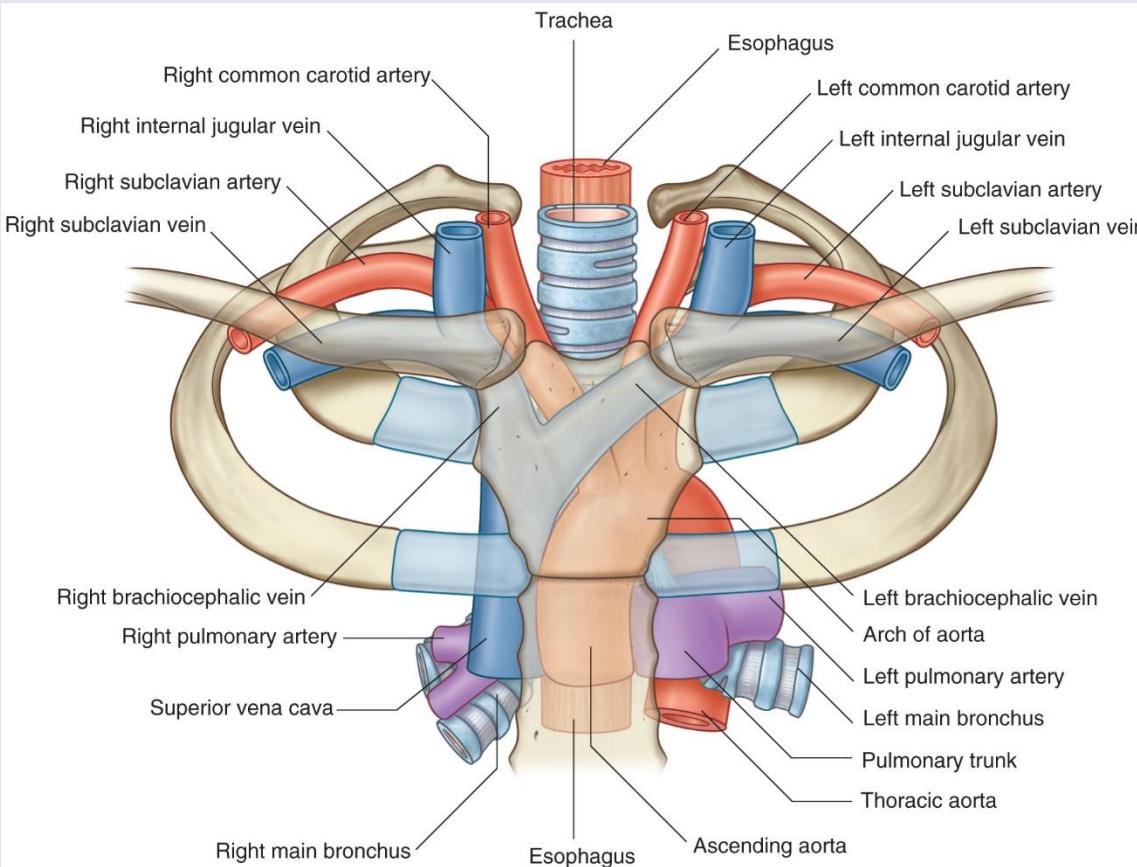
Mediastinum: Contents Overview

Superior	Inferior		
	Anterior	Middle	Posterior
<ul style="list-style-type: none"> • Thymus • Trachea • Oesophagus • Thoracic duct • Aortic arch (and associated branches) • Superior vena cava (and associated convergent veins) • Vagus nerve • Phrenic nerve • Recurrent laryngeal nerve • Sympathetic trunk • Lymphatics • Muscles 	<ul style="list-style-type: none"> • Thymus extends from Superior mediastinum <ul style="list-style-type: none"> • In children – Thymus • In adults – Adipose tissue • Internal thoracic vessels • Lymph nodes – Main important structure 	<p>Main content of the middle mediastinum is the heart in the pericardium.</p> <p>Also contains the beginnings at least of the associated vessels:</p> <ul style="list-style-type: none"> • Ascending aorta • Superior vena cava • Pulmonary trunk <p>Also other structures including:</p> <ul style="list-style-type: none"> • Main/primary bronchi after bifurcation of trachea – structures which go to the hilae of the lungs. • Phrenic nerve • Cardiac plexus • Vagus nerve 	<p>Posterior mediastinum contains lots of major vessels and structures, most of which will go to pierce its inferior border – the diaphragm.</p> <p>Contents:</p> <ul style="list-style-type: none"> • Descending aorta and its branches • Azygos venous network • Thoracic duct (ascending) • Oesophagus • Sympathetic trunk • Nerves: <ul style="list-style-type: none"> • Oesophageal plexus • Vagus nerve branches

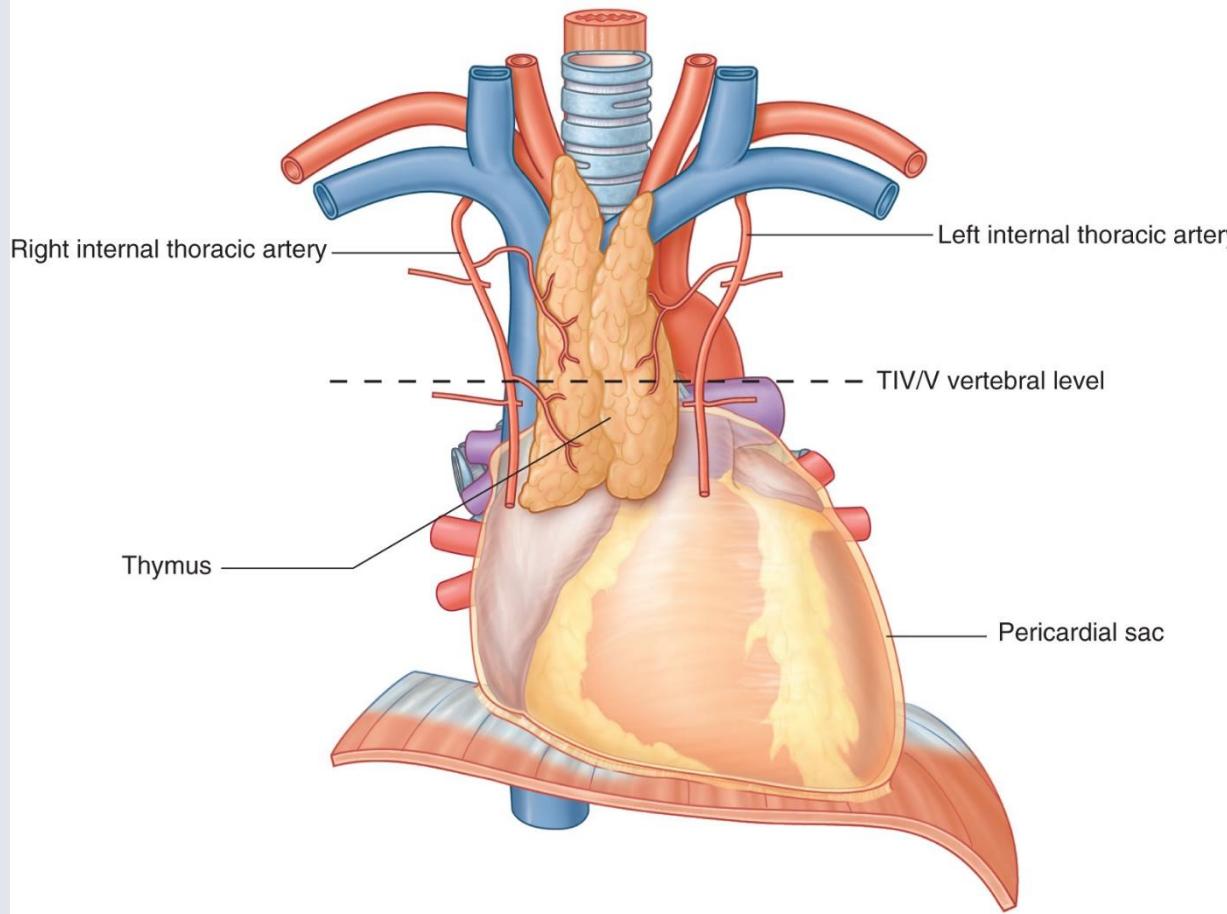
Superior Mediastinum: Contents

The superior mediastinum contains a vast number of structures and vessels that go on to the heart, lungs, GI system, and also vessels that pass through to exit towards the head, neck, and upper limb.

Contents: Thymus, trachea, oesophagus, thoracic duct, aortic arch (and associated branches), superior vena cava (and associated convergent veins), vagus nerve, phrenic nerve, recurrent laryngeal nerve, sympathetic trunk, lymphatics, muscles.



Anterior Mediastinum: Contents

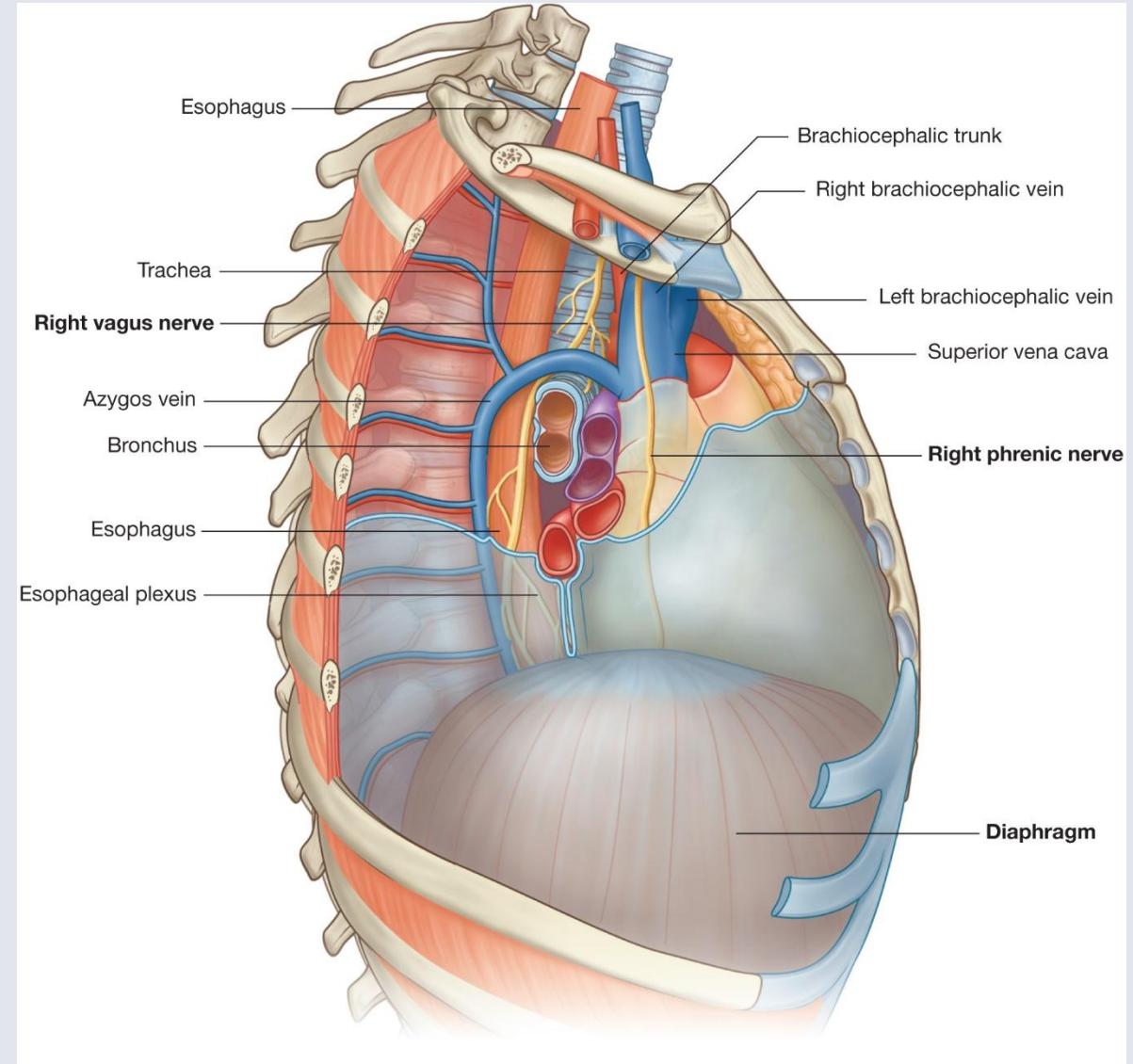
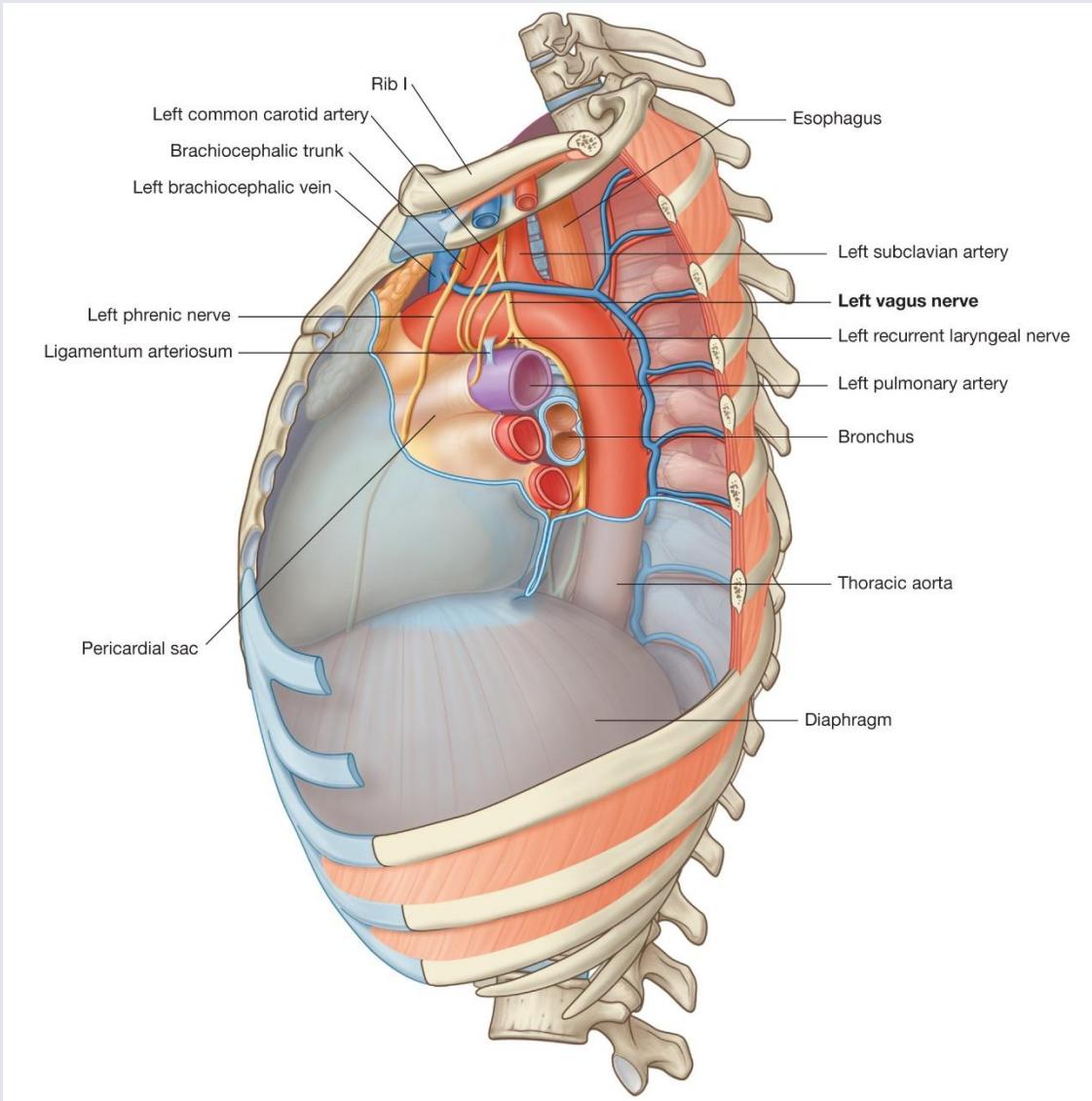


Often described as having nothing in it.

Important to know structures:

- Thymus extends from Superior mediastinum
 - In children – Thymus
 - In adults – Adipose tissue
- Internal thoracic vessels
- Lymph nodes – Main important structure

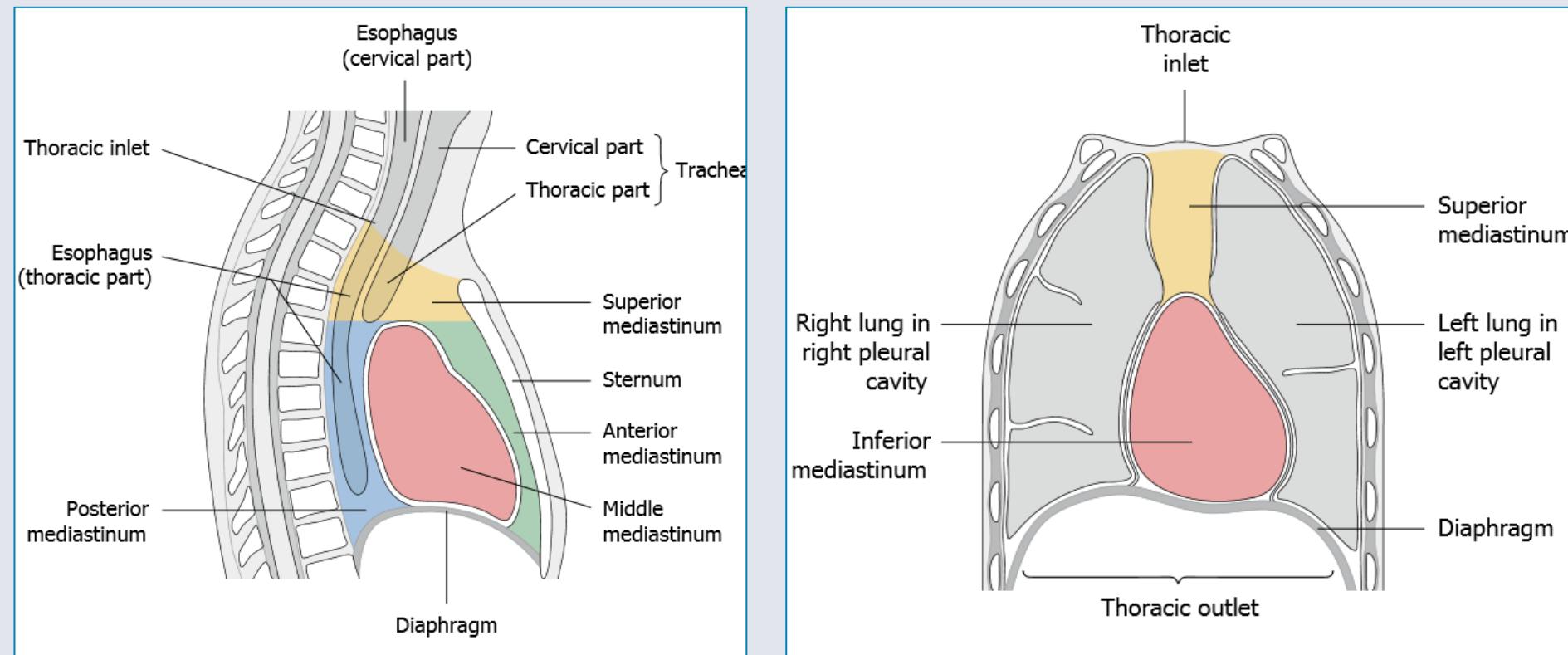
Middle Mediastinum: Contents



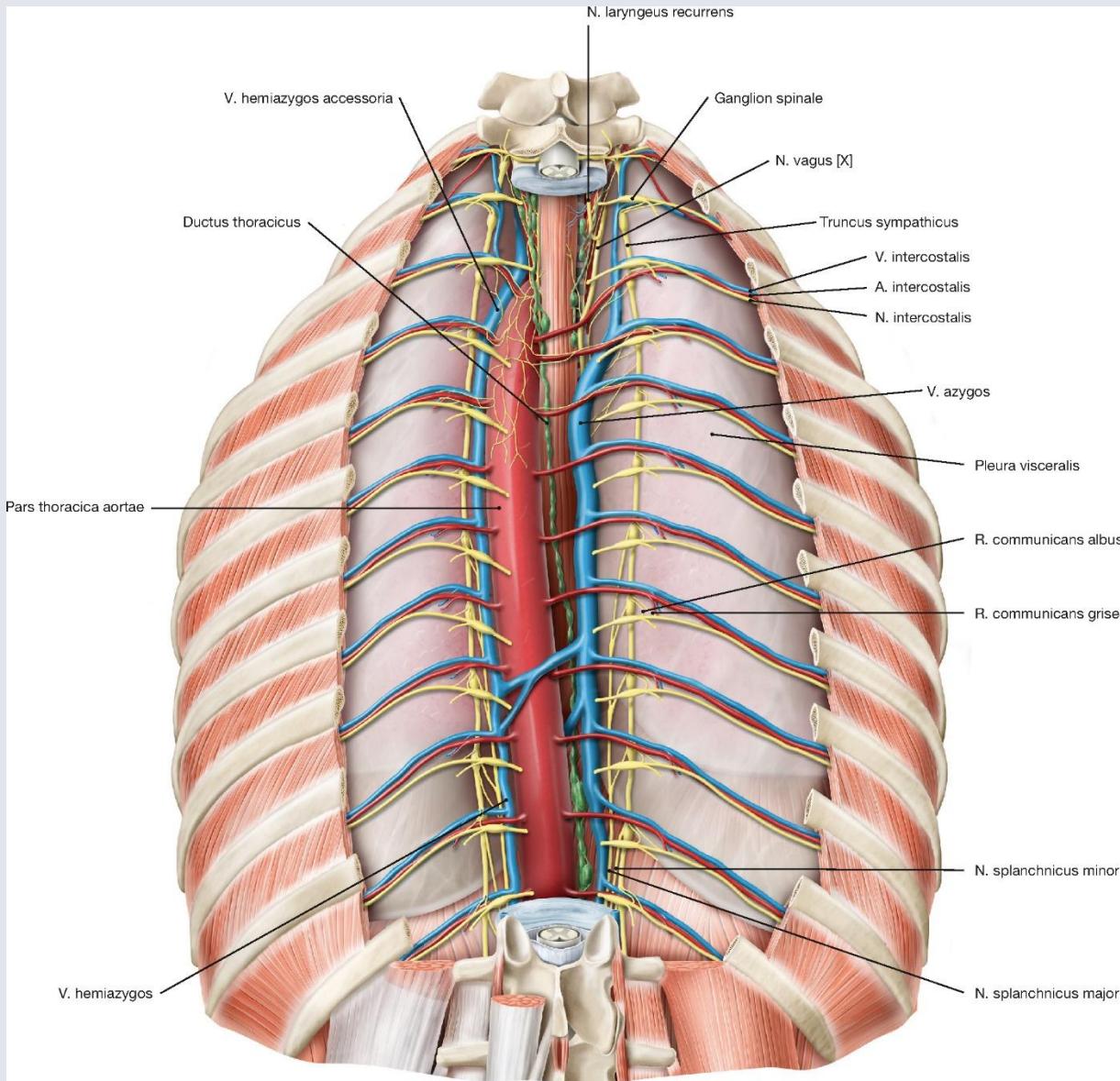
Middle Mediastinum: Heart

It is located within the pericardium in the middle mediastinum.

- Bordered anteriorly by the anterior mediastinum
- Bordered posteriorly by the posterior mediastinum.
- Bordered laterally by the pleura of each lung.
- Bordered superiorly by the sternal angle and superior mediastinum
- Bordered inferiorly by the diaphragm.
 - The pericardium attaches directly on to the diaphragm resulting in the heart moving during respiration.
 - In what way?



Posterior Mediastinum: Contents

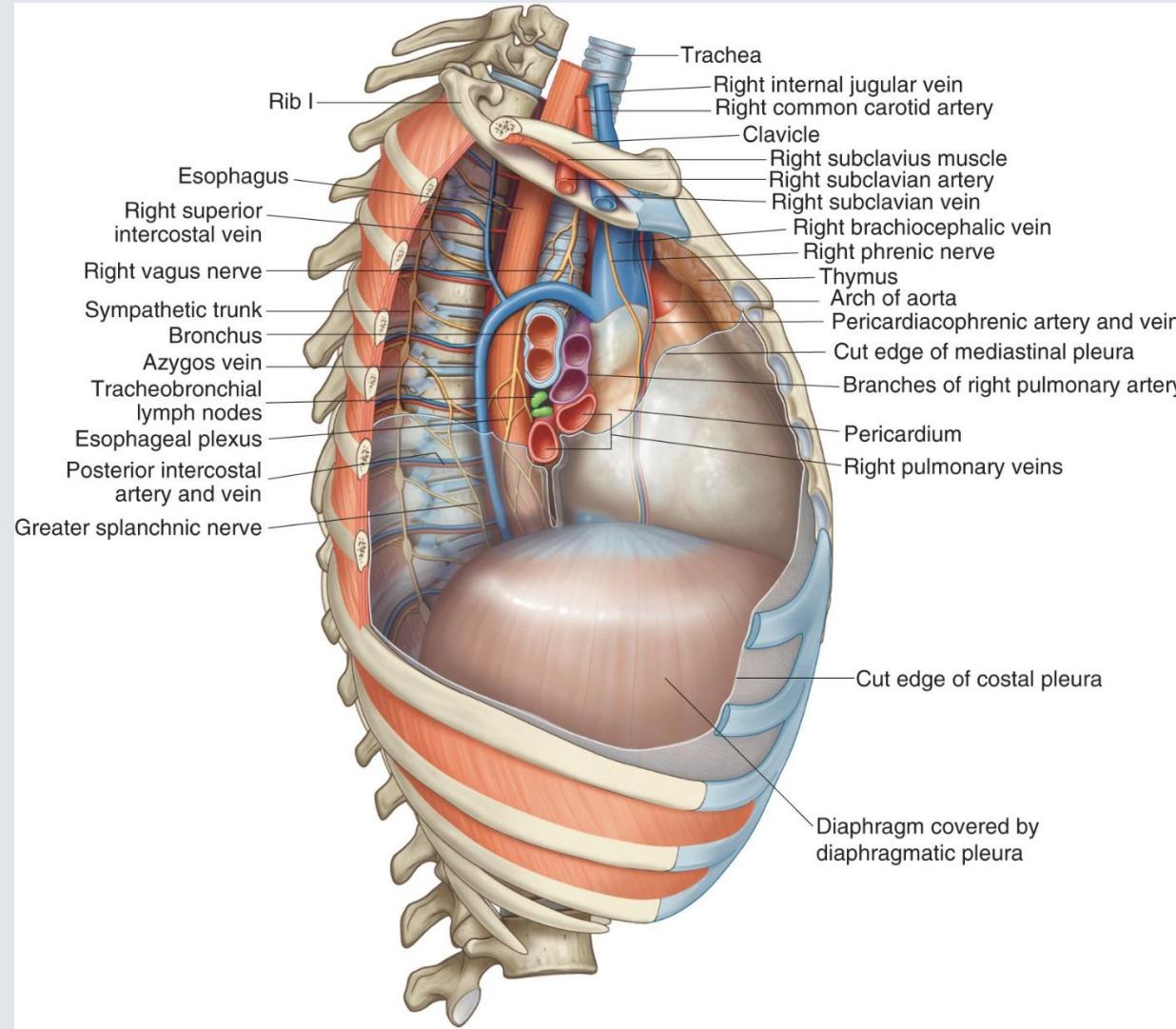


Posterior mediastinum contains lots of major vessels and structures, most of which will go to pierce its inferior border – the diaphragm.

Contents:

- Descending aorta and its branches
- Azygos venous network
- Thoracic duct (ascending)
- Oesophagus
- Sympathetic trunk
- Nerves:
 - Oesophageal plexus
 - Vagus nerve branches

Inferior Mediastinum: Contents



Important to remember that as the mediastinum has no concrete borders, there is room for anatomical variation.

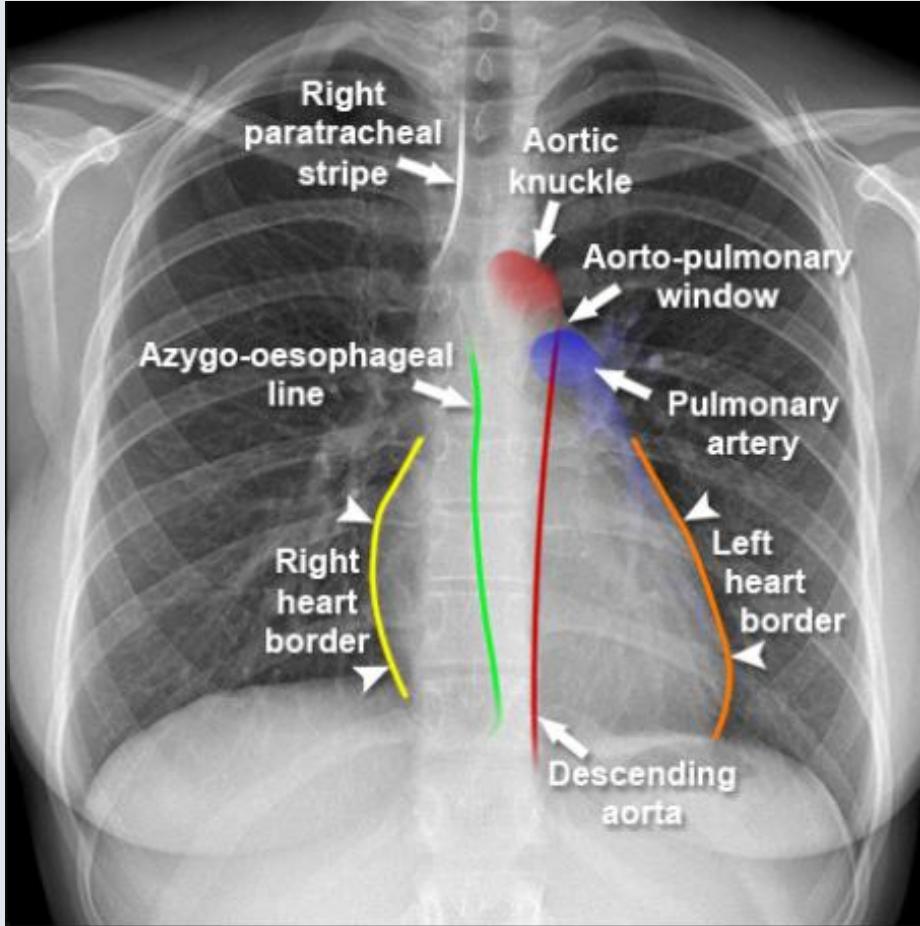
Some items may be present in certain areas and absent in others.

These contents are all the generally accepted locations.

Part 2 – Mediastinum

Clinical Relevance

Clinical: Mediastinal Masses



Many different reasons for mediastinal masses which displace structures in the mediastinum.

Examples include:

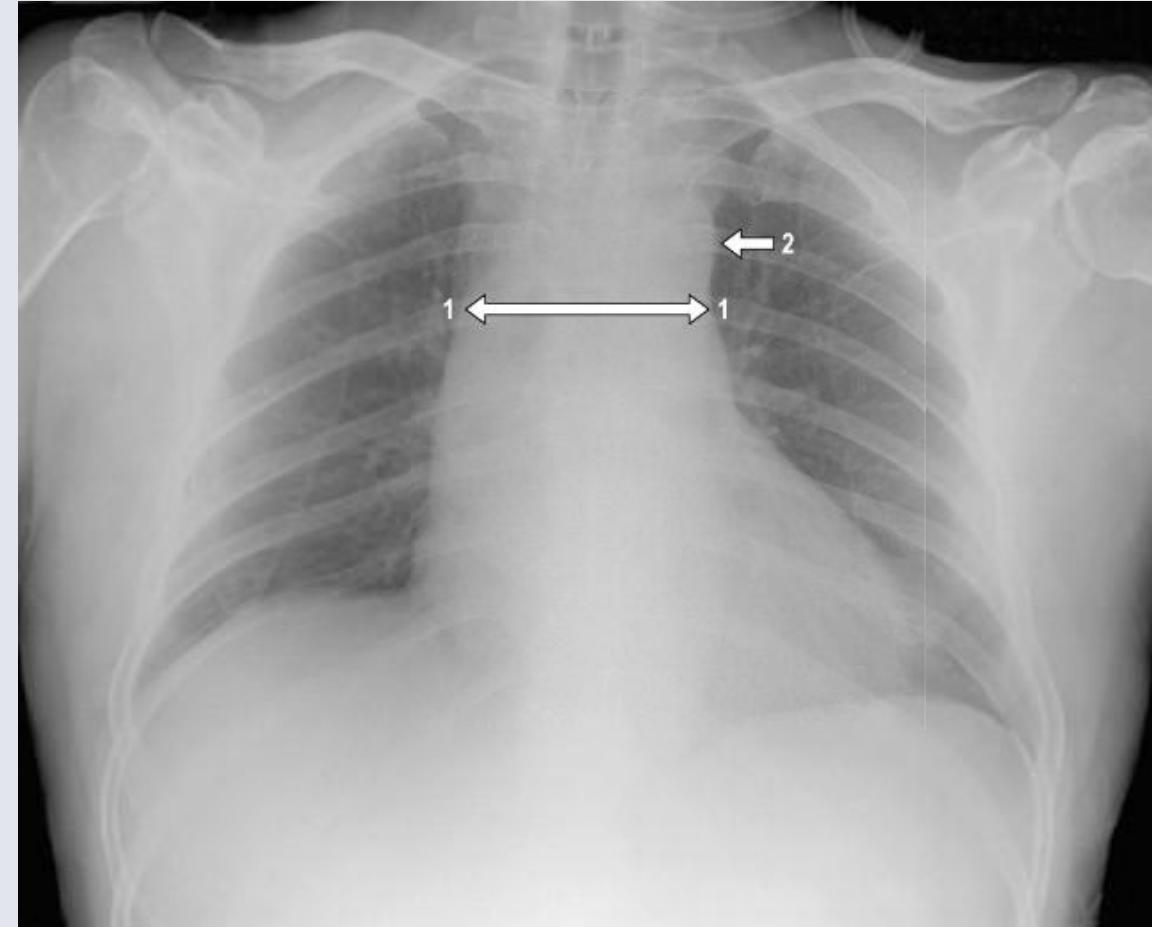
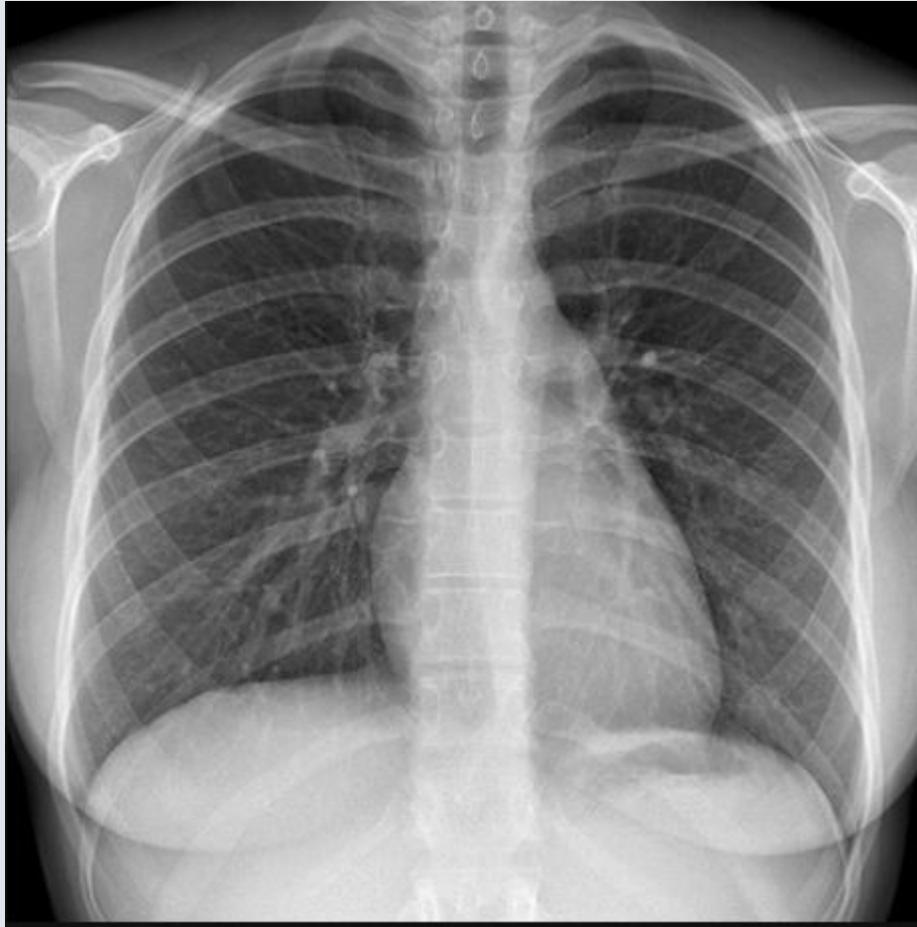
- Tumours (e.g. lymphoma, thymoma)
- Aortic aneurysms/dissections
- Hiatus hernias
- Pericardial effusion
- Vertebral fractures
- Mediastinitis

Awareness of contours of the mediastinal structures allows for identifying pathology.

Need to be aware of the mediastinum widening and in what location.

- Usually defined as wide if it is greater than 6-8cm

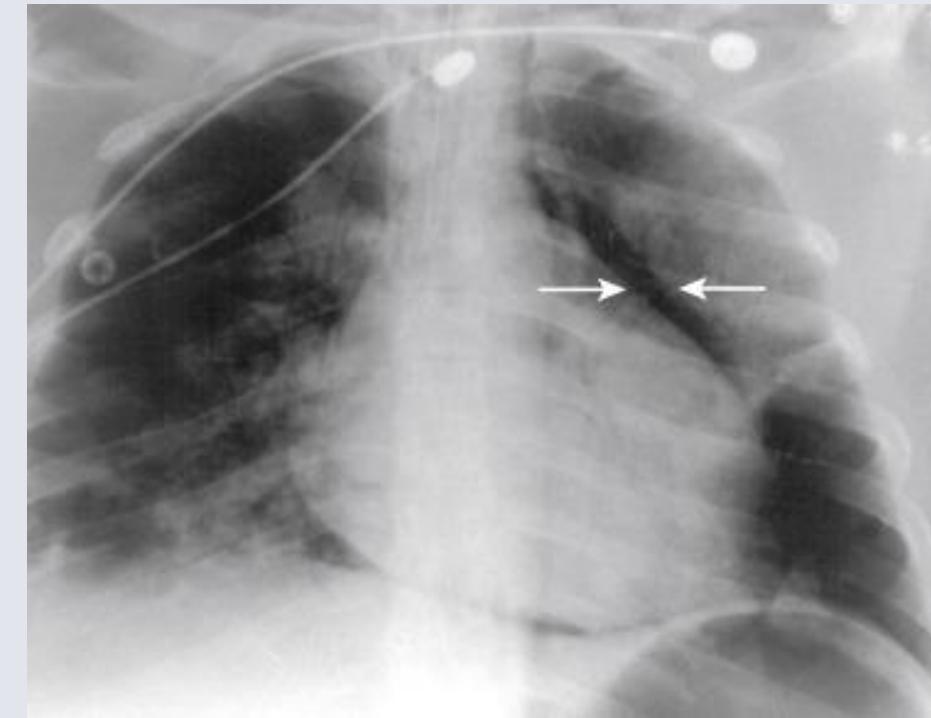
Clinical: View of Aortic Dissection



Clinical: Thymoma

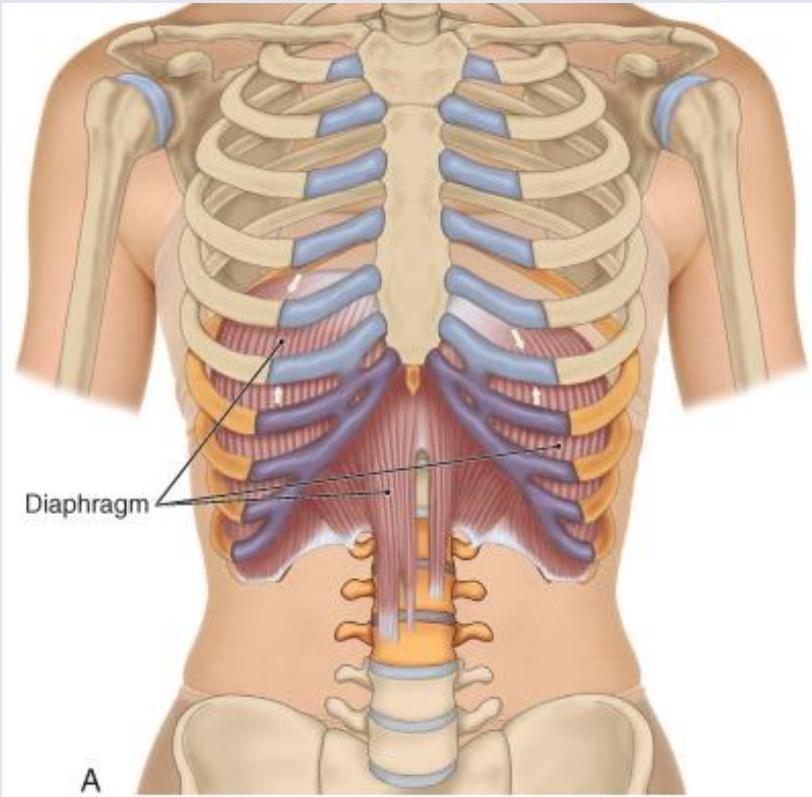


Clinical: Mediastinitis



Part 3 – Diaphragm Structure

Diaphragm: Attachments



Attachments:

- Superior: Xiphoid process
- Anterior/Lateral: Costal margin
- Inferior/Lateral: Ribs 11 & 12
- Posterior: Post. Abdominal wall & Lumbar region

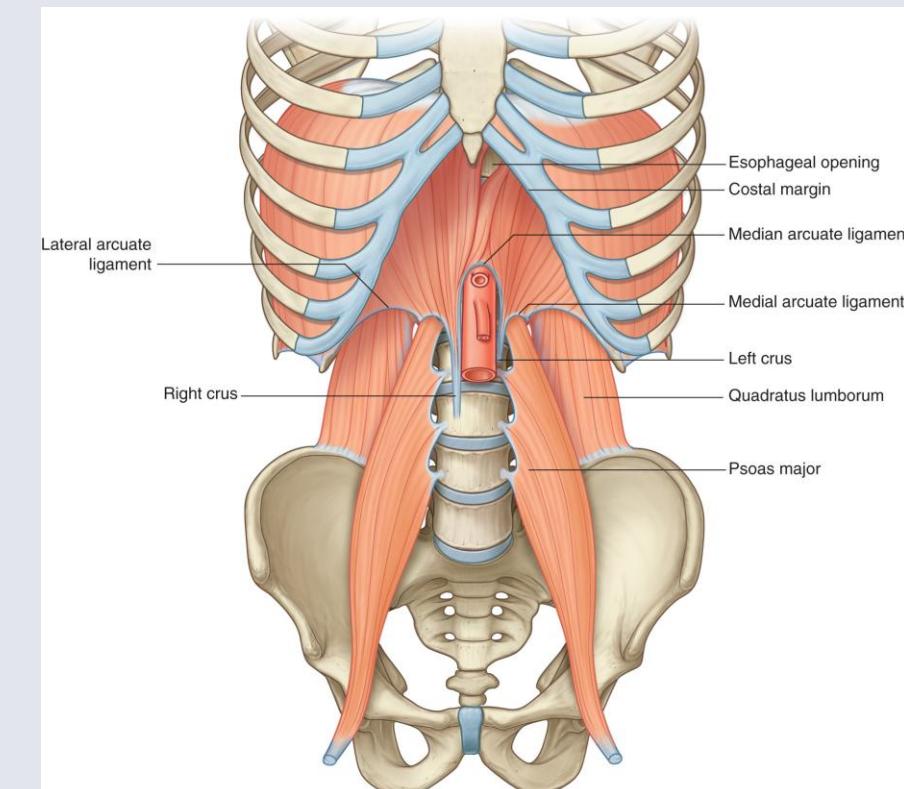
Right dome:

- Higher due to liver
- Can ascend as high as ant. aspect of rib 4

Left dome:

- Can ascend as high as ant. aspect of rib 5

Muscle fibres converge on large central tendon.

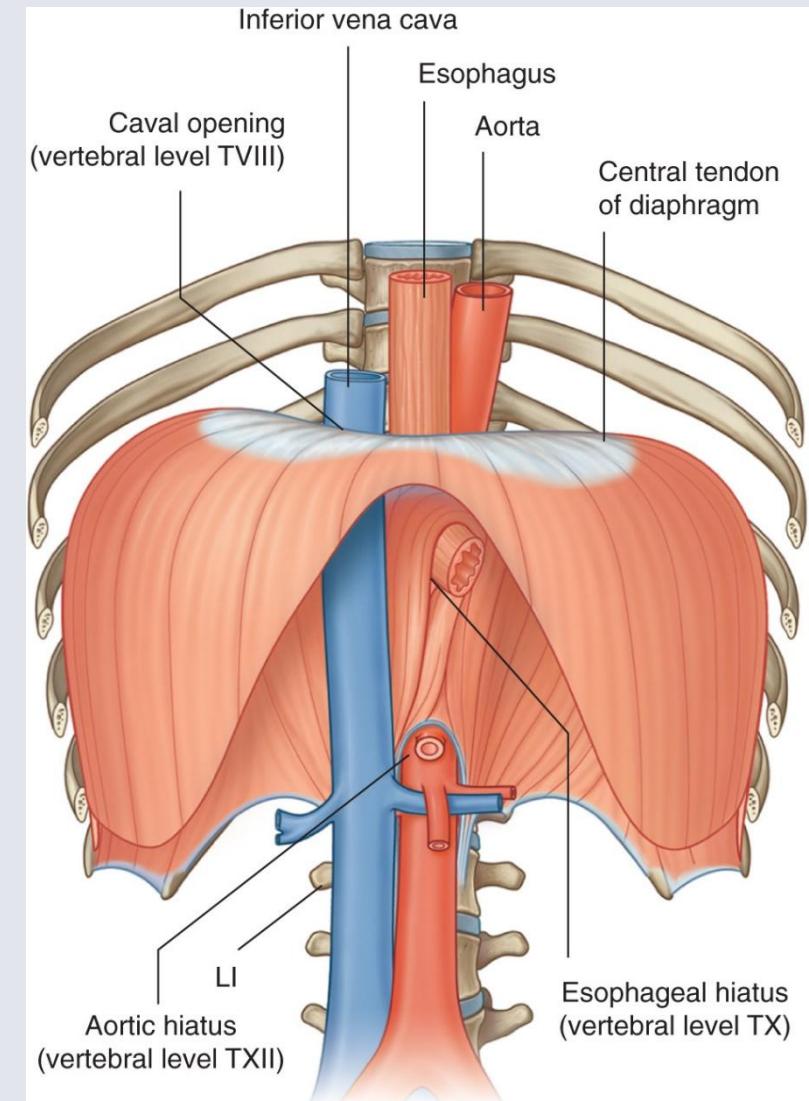
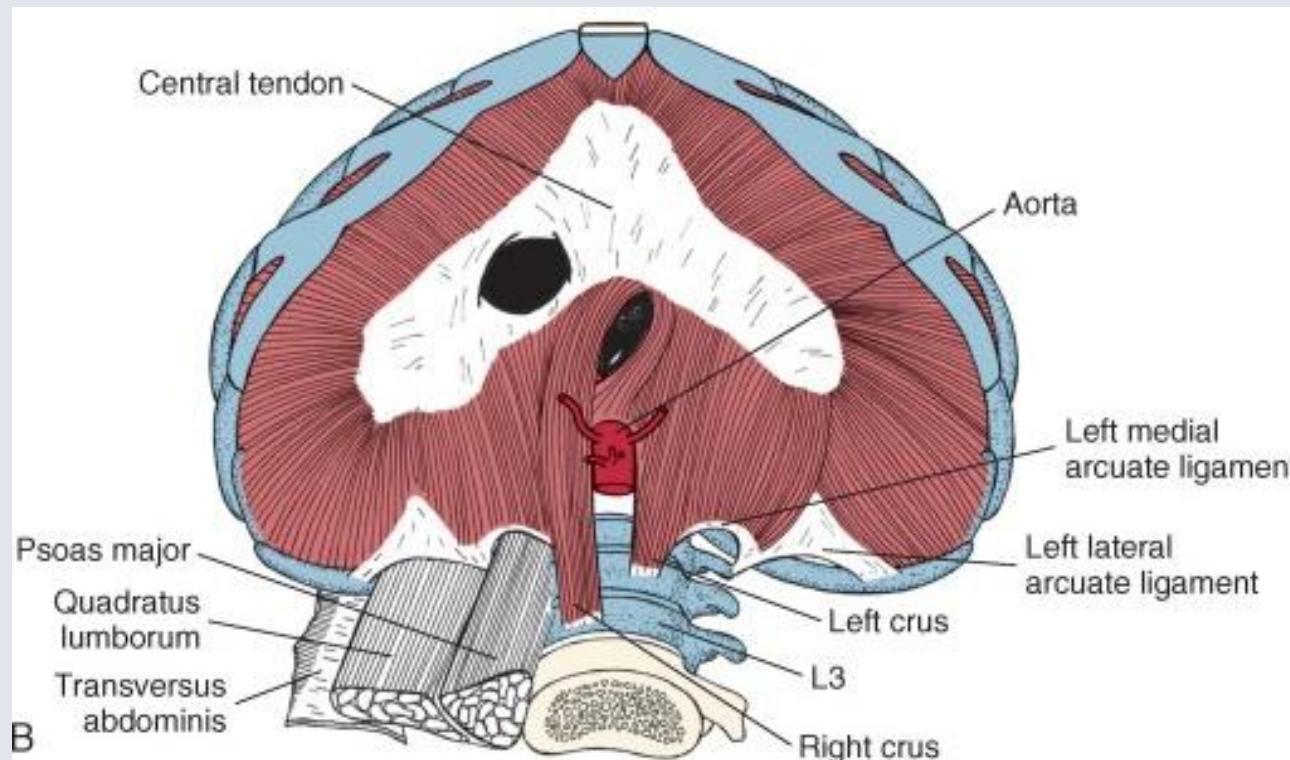


Diaphragm: Apertures/Openings

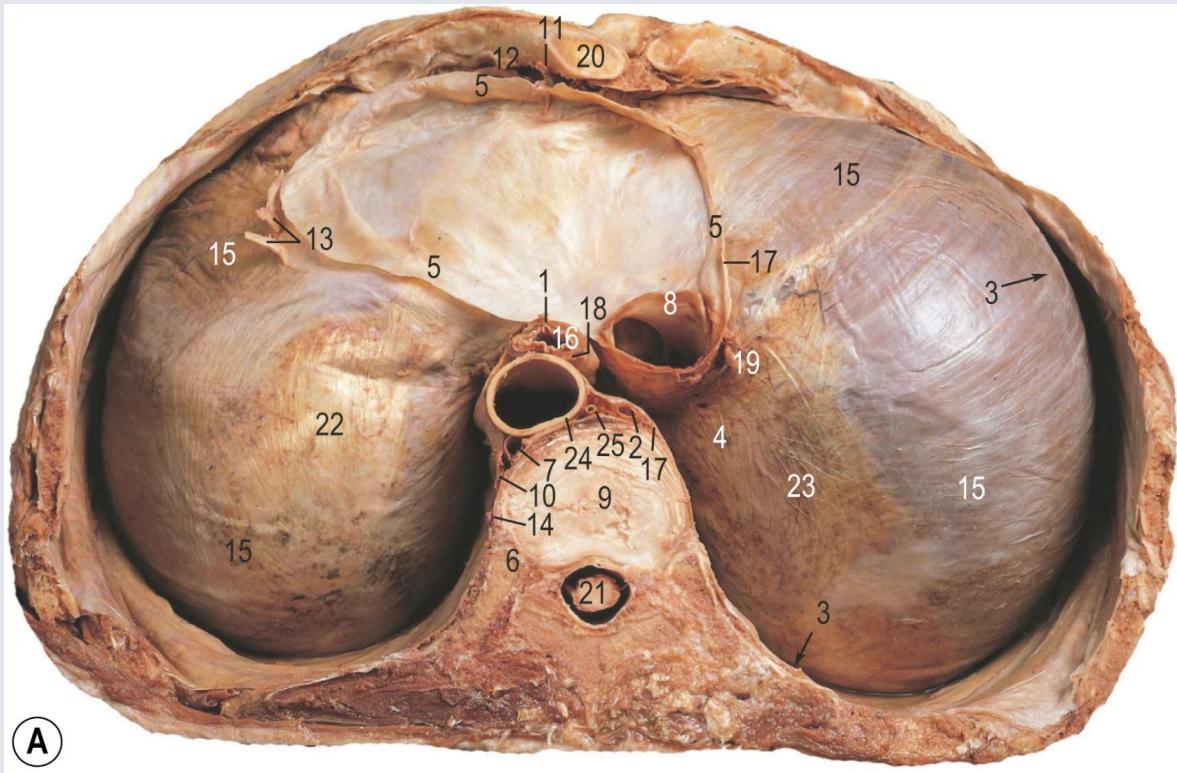
T8: Caval opening – Inferior Vena Cava

T10: Oesophageal hiatus – Oesophagus, vagus nerve

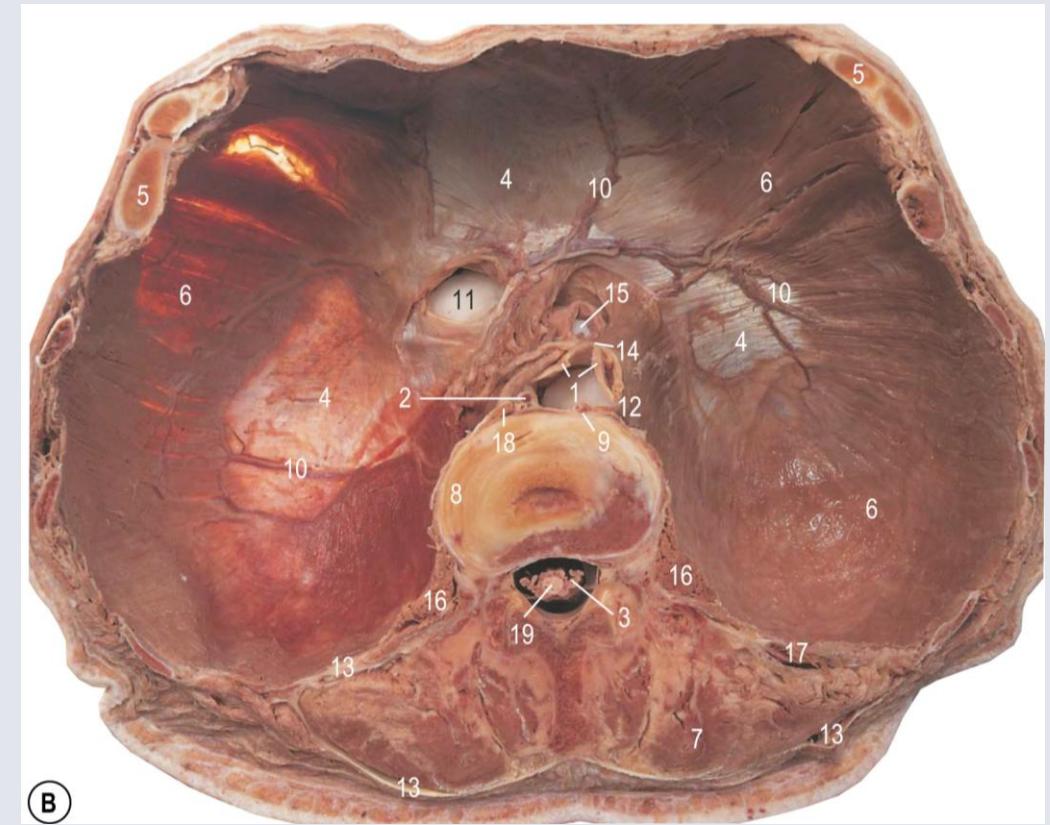
T12: Aortic hiatus – Descending aorta (thoracic to abdominal), thoracic duct, azygos system, sympathetic trunk, other nerves.



Diaphragm: Dissection

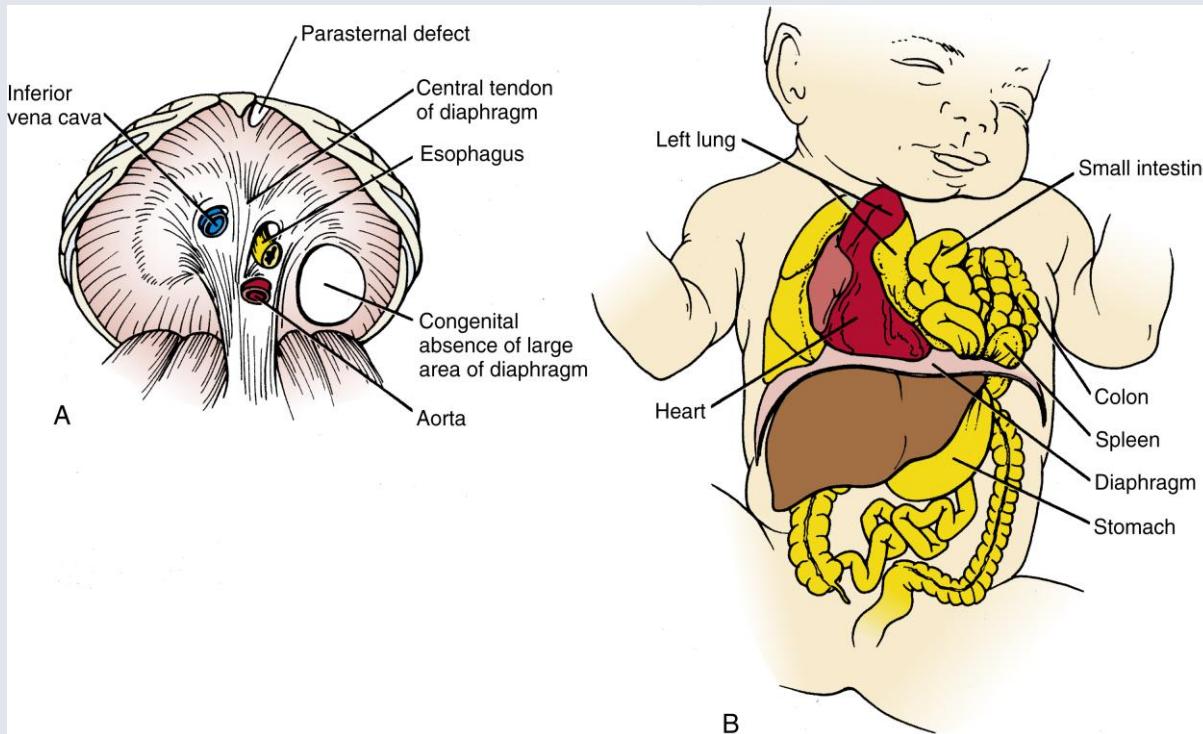


A



B

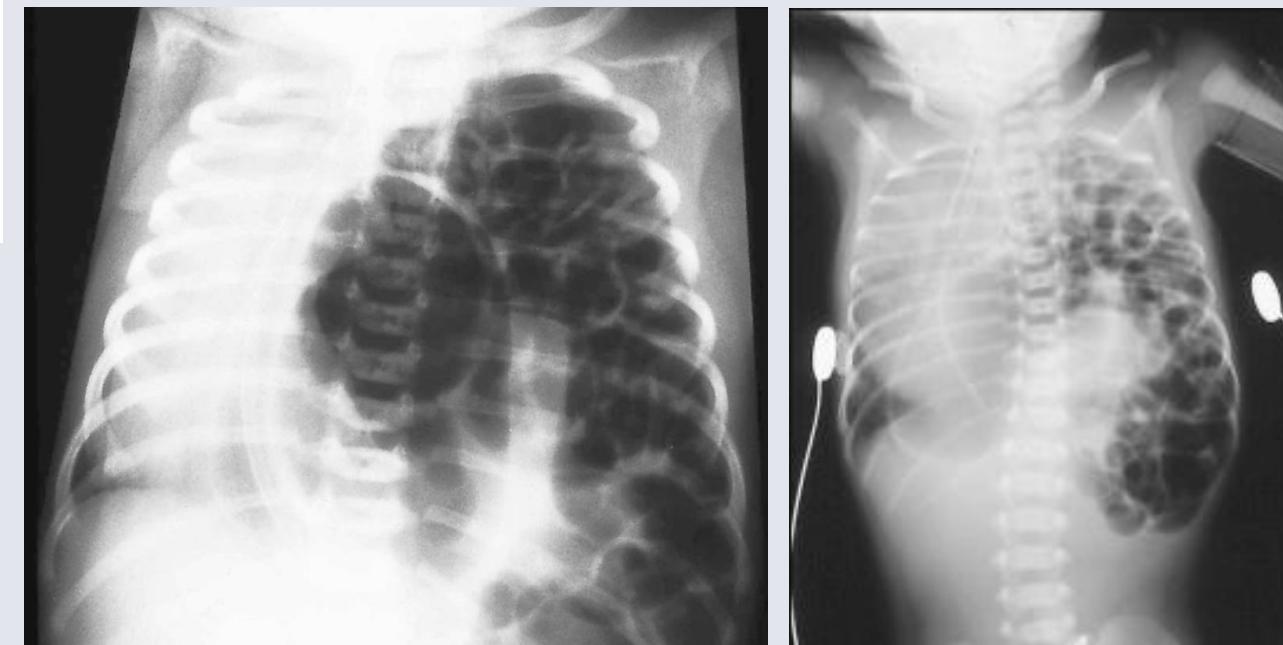
Clinical: Diaphragmatic Hernias



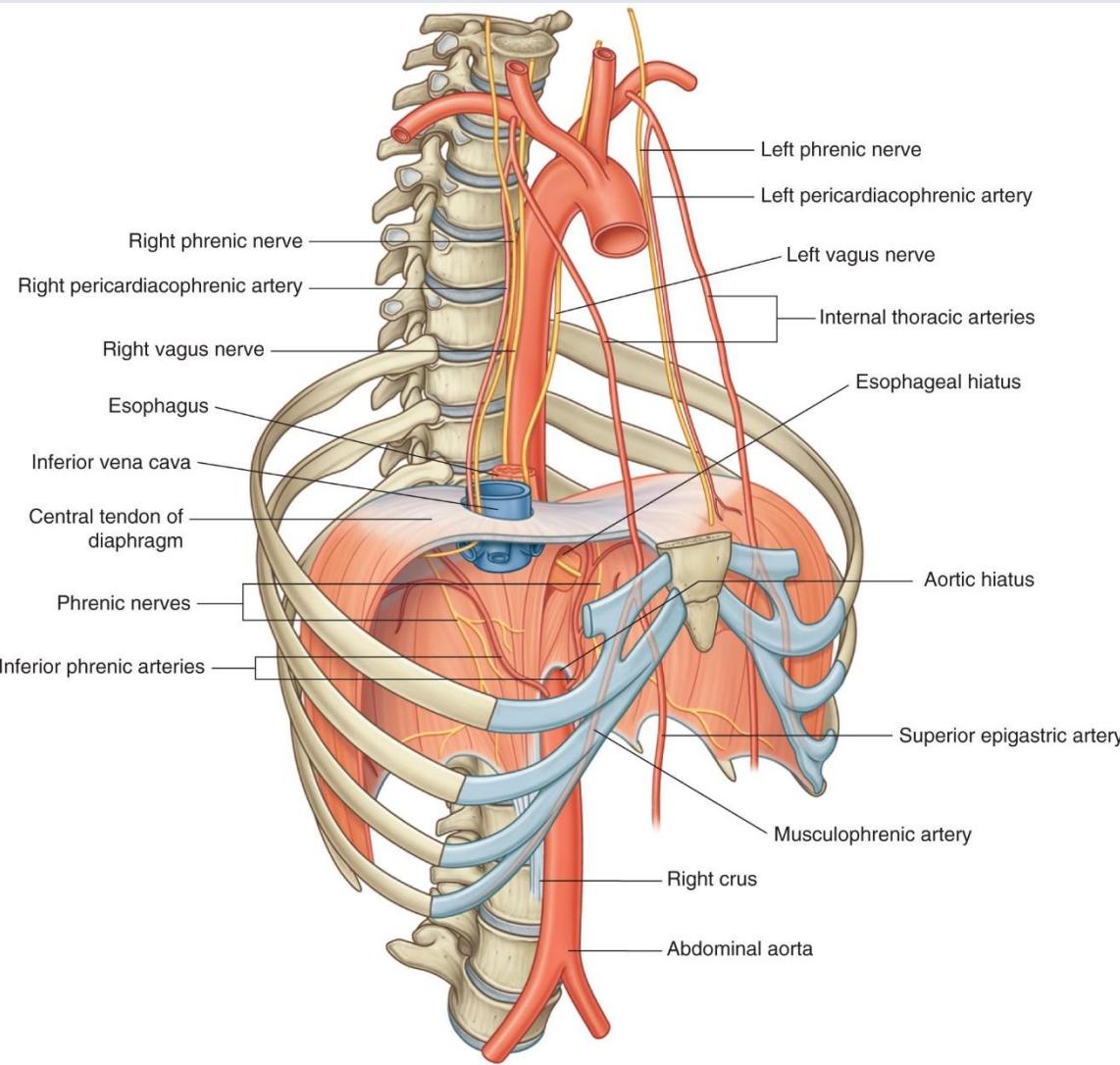
Caused by a failure of the pleuroperitoneal folds sealing off.

Most often occurs in the left hemidiaphragm.

Abdominal contents can pass to thorax – lungs only grow to fill available space.



Diaphragm: Neurovascular Supply



Arterial supply:

- Pericardiophrenic and musculophrenic a.
- Superior phrenic a.
- Branches of intercostal a.
- Inferior phrenic a. – Largest supply

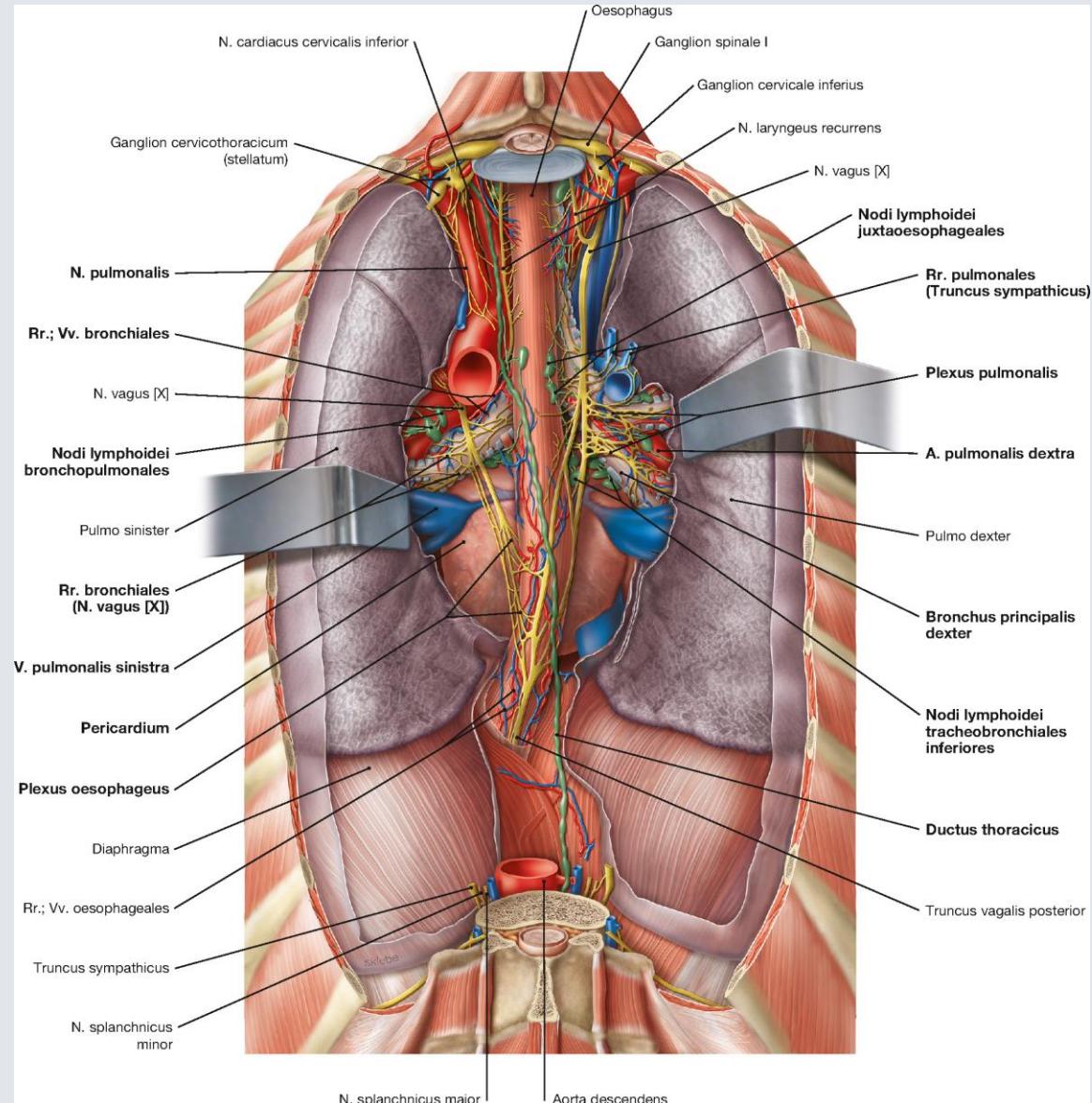
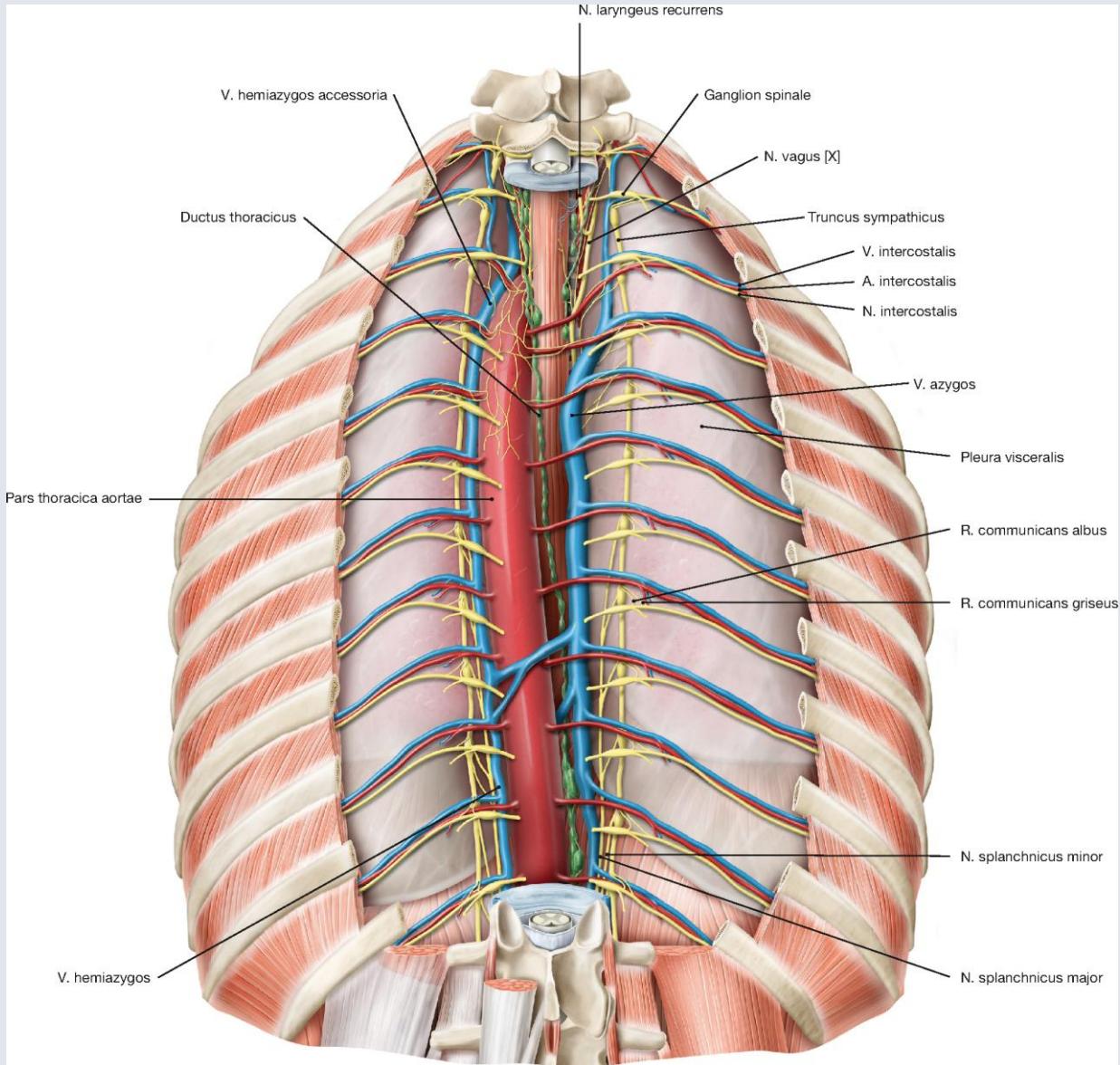
Venous drainage:

- Brachiocephalic veins
- Azygos system
- Inferior vena cava

Nerve supply:

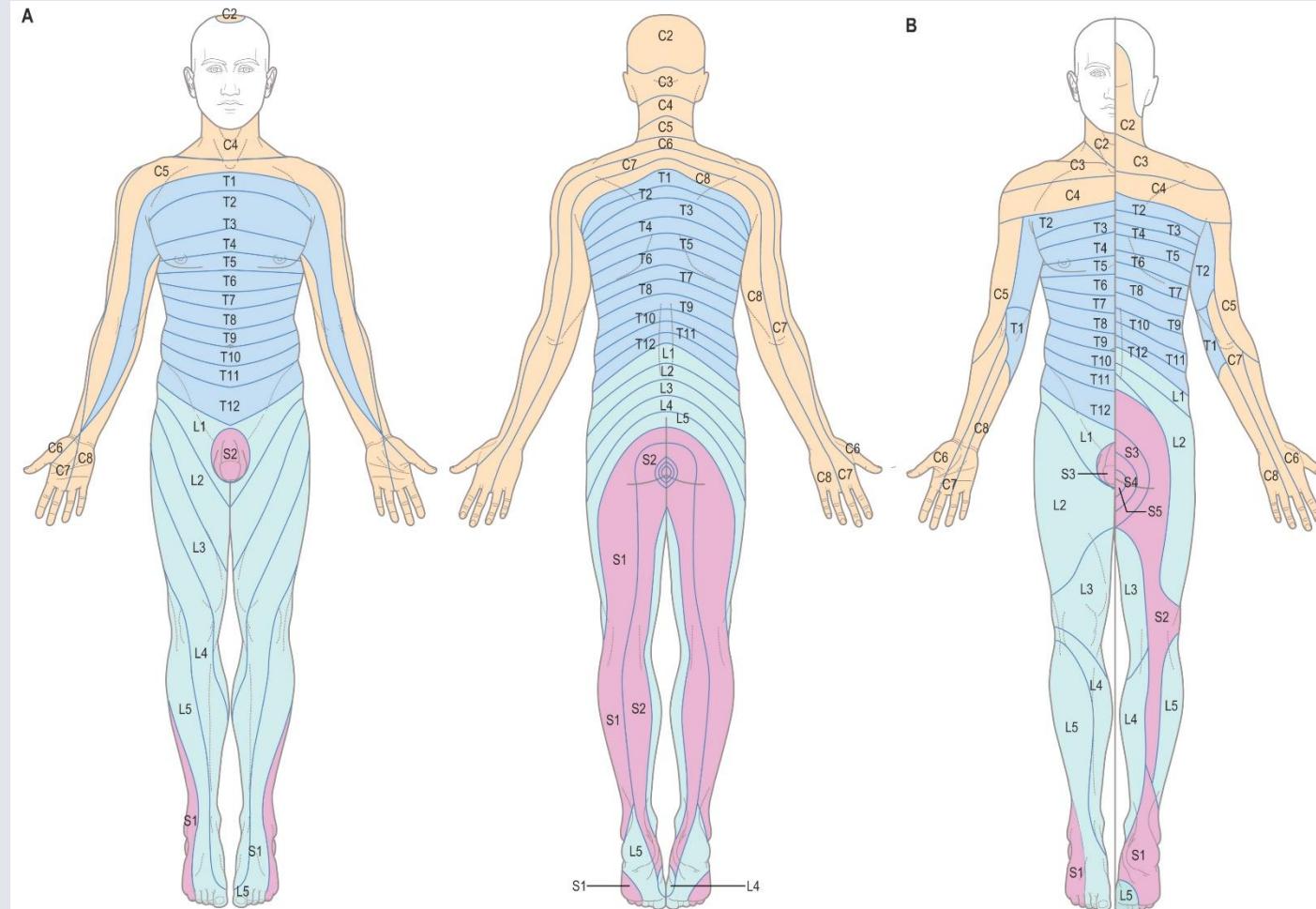
- Phrenic nerve (C3, C4, C5)

Diaphragm: Vessels



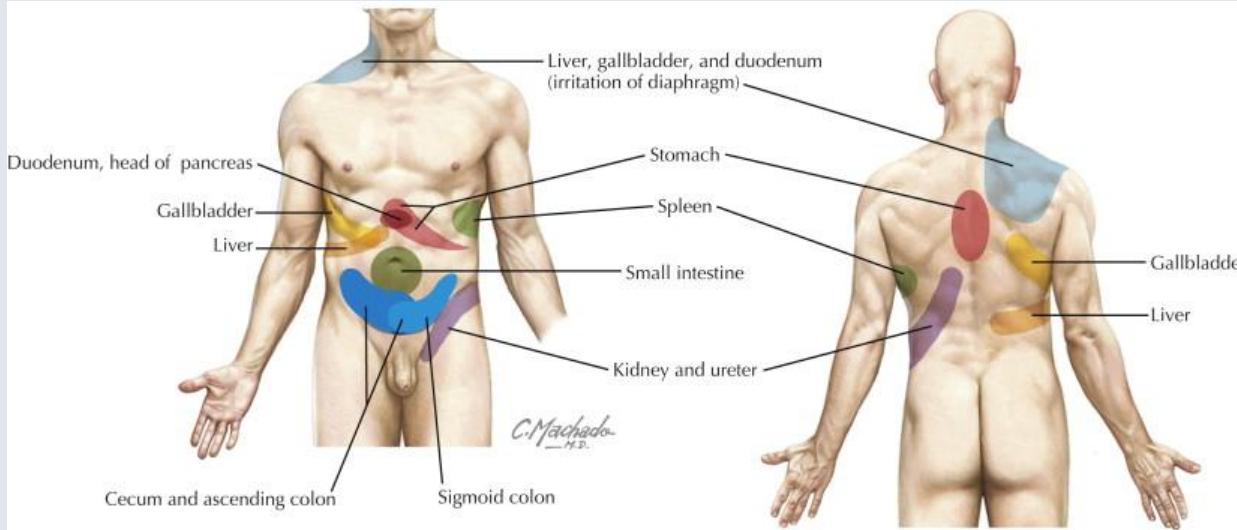
Dermatomes: Overview

Dermatomes are an area of skin where its sensory innervation is derived from a single set of spinal nerves.



Dermatome distribution can vary depending on the textbook/source – knowing the general area or where to test with no overlap is best.

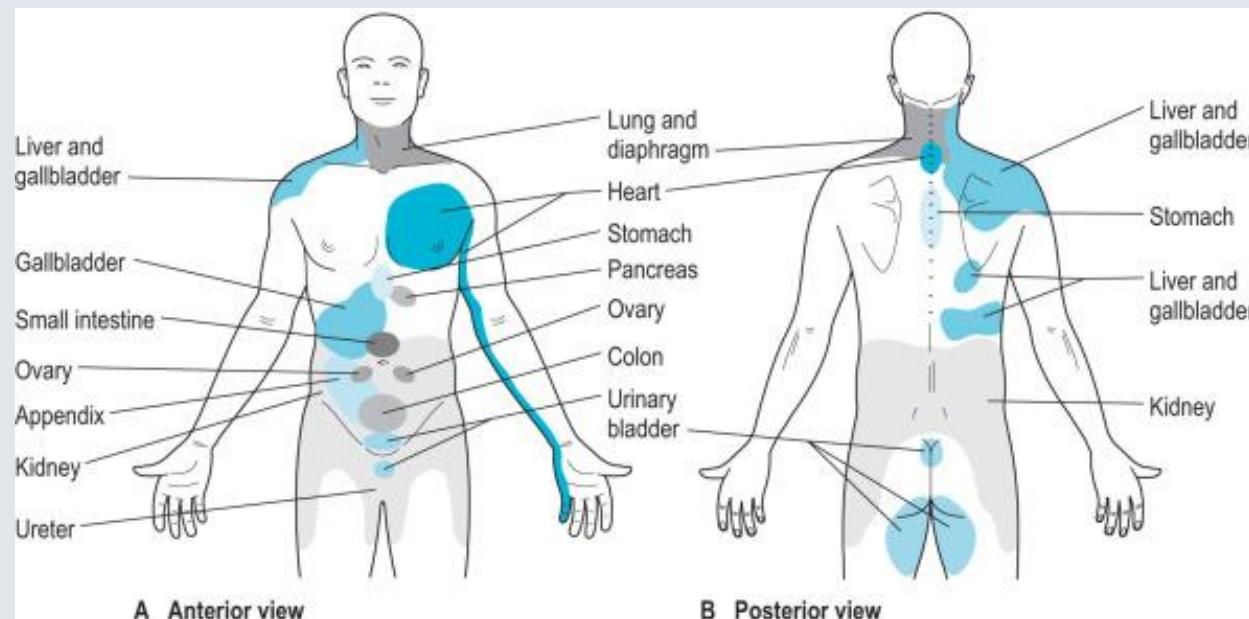
Referred Pain: Overview



Diaphragmatic irritation can be caused by other viscera including:

- Liver, gallbladder, stomach, small intestine, spleen

Causes referred pain in the shoulder.



➤ Macro Learning Outcomes:

- M2.I.COR.ANA1 – Describe the osteology, musculature, and neurovascular supply of the chest wall.
- M2.I.RES.ANA3 – Describe the contents and boundaries of the thorax and identify associated clinical abnormalities.

➤ Micro Learning Outcomes:

- Demonstrate knowledge of the surface landmarks associated with the thorax and relate them to underlying structures.
- Describe the structure of the thoracic cage, including associated muscles and neurovascular structures.
- Describe select pathology and treatments associated with the thoracic cage.
- Describe the divisions of the mediastinum and recall their contents.
- Describe select clinical conditions associated with the mediastinum and how changes in the mediastinum can be seen with imaging.
- Review the anatomy of the diaphragm and its movement during inspiration and expiration.
- Describe select clinical conditions related to the diaphragm, including referred pain.

Learning Outcomes