Guide for use of these notes

First of all thank you for choosing to download these notes to study from I hope you find them useful, please feel free to email me if you have any problems with the notes or if you notice any errors. I don't promise to respond to all emails but I'll do my best.

For the Anatomy of The Thorax notes I used a mixture of Gray's, Netter's and Clinically Orientated Anatomy.

I organise my notes so that you should read the learning objectives on the left then proceed down the right hand side for a few learning objectives and then cross back over to the left and continue like that.

Anything in this highlighted green is a definition or explains basically something's function. Text highlighted in yellow or with a star is what I would deem important and key information. Italics and bold just help to make certain terms stand out.

The notes are a bit quirky but I hope you like them and find some of the memory aides strange enough so that they stick in your head.

I provide them to you in OneNote format as that is how I created them, they can be saved as PDF but the formatting is not as nice. The one caveat with this is that these notes are freely copy able and editable. I would prefer if you didn't copy and paste my notes into your own but used them as a reference or preferably instead embellished these already existing notes by adding to them.

Good luck with first year

Stuart Taylor
Learning Objectives

- Name the space between adjacent ribs
- Name and summarise the functions of the muscles which are found between ribs
- Identify a rib and be able to determine which part of the rib is placed posteriorly and which anteriorly.
- Name the structures with which a rib articulates.
- Name the contents of an intercostal space.

Thoracic skeleton and boundaries

- 12 thoracic vertebrae
- 12 pairs of ribs and costal cartilages
- Sternum

The Ribs

- 12 pairs
- 1-7 reach the sternum and are therefore called true ribs
- 8-10 reach costal cartilage above but do not attach to sternum (false)
- 11 and 12 are lacking anterior attachment (floating)

- Articulations are joints.
- With vertebral column (heads)
- With costal cartilages (tubercles - sticking out bit of bone)

The head is somewhat expanded and typically presents two articular surfaces separated by a crest. The smaller superior articular surface articulates with the inferior costal facet on the body of the vertebra above, whereas the larger inferior facet articulates with the superior costal facet of its own vertebra.

The tubercle projects posteriorly from the junction of the neck with the shaft and consists of two regions, an articular part and a nonarticular part:

- The articular part is smooth and has an oval facet for articulation with a corresponding facet on the transverse process of the associated vertebra.
- The nonarticular part is roughened by ligament attachments.

The shaft is generally thin and flat with internal and external surfaces. The superior margin is smooth and rounded, whereas the inferior margin is sharp. The shaft bends forward just laterally to the tubercle at a site termed the angle. It also has a gentle twist around its longitudinal axis so that the external surface of the anterior part of the shaft faces somewhat superiorly relative to the posterior part. The inferior margin of the internal surface is marked by a distinct costal groove.

Thoracic inlet (Superior Thoracic Aperture)

- Ring formed of:
  - 1st thoracic vertebra (T1)
  - 1st ribs
  - Manubrium

- Contents include:
  - Great vessels heading for upper neck and upper limb, oesophagus, trachea, nerves and lymphatic.

- Name the space between adjacent ribs
  - Intercostal space

- Name and summarise the functions of the muscles which are found between ribs
  - External intercostals –

Because ribs slope downwards T4 is on same plane as Sternal angle.
Name and summarise the functions of the muscles which are found between ribs

- **External intercostals** –
  - Downwards and laterally from lower border of rib above to rib below.
  - Replaced by anterior intercostal membrane at costo-chondral (rib-cartilage) junction
- **Internal intercostals** –
  - Attachments begin anteriorly at the sternum-from lower border of rib above to rib below - fibres directed at right angles to external intercostals. Replaced by membrane posteriorly
- **Innermost intercostals** – relatively trivial

**Muscles expanding chest and lung volume**

Name the contents of an intercostal space.

- **Intercostal Nerves**
  - 11 pairs of intercostal nerves plus one sub costal (underneath the 12th rib)
  - Come from the spinal cord and supply the costal muscles.

**Name the contents of an intercostal space.**

**Intercostal Nerves**

- 11 pairs of intercostal nerves plus one sub costal (underneath the 12th rib)
- Come from the spinal cord and supply the costal muscles.

**Axilla is the armpit. Reference back to ECG for mid-axillary line.**

**Intercostal Neuromuscular Junction**
Veins, artery and nerve run just below rib deep to internal intercostal closer together than shown.

Contents of Thoracic Cavity

Space between the pleural cavities = mediastinum

- Heart (lying in its pericardial sac)
- Great vessels
- Oesophagus
- Trachea
- Thymus
- Thoracic duct and other major lymph trunks
- Lymph nodes
- Phrenic and vagus nerves

Intercostal nerves and associated major arteries and veins lie in the costal groove along the inferior margins of the superior rib and pass in the plane between the inner two layers of muscles.

In each space, the vein is the most superior structure and is therefore highest in the costal groove. The artery is inferior to the vein, and the nerve is inferior to the artery and often not protected by the groove. Therefore, the nerve is the structure most at risk when objects perforate the upper aspect of an intercostal space. Small collateral branches of the major intercostal nerves and vessels are often present superior to the inferior rib below.

Deep to the intercostal spaces and ribs, and separating those structures from the underlying pleura, is a layer of loose connective tissue, called endothoracic fascia, which contains variable amounts of fat. Superficial to the spaces are deep fascia, superficial fascia, and skin. Muscles associated with the upper limbs and back overlie the spaces.

Each intercostal artery joins (anastomoses) with a major artery at each end of the intercostal space.
Identify the clavicle and demonstrate how it is positioned in the body.

Identify the scapula and demonstrate how it is positioned in the body.

Identify a thoracic vertebra.

Name the different parts of a thoracic vertebra.

Explain how ribs are related to the thoracic vertebrae.

Explain how vertebrae articulate with each other and how they support loads and absorb jolts.

Thoracic vertebrae:
- Characterised by articulation with ribs.
- A typical thoracic vertebra has two partial facets (superior and inferior costal facets) on each side of the vertebral body for articulation with the head of its own rib and the one below.
- The superior costal facet is much larger than the inferior costal facet.
- Each transverse process also has a facet (transverse costal facet) for articulation with the tubercle of its own rib.
- The vertebral body of the vertebra is somewhat heart-shaped when viewed from above.
- Vertebral foramen is circular.

Lumbar Vertebral:
- Distinguished from other vertebrae by their large size.
- Also they lack facets for articulation with ribs.
- Generally thin and long transverse process, with the exception of LV which are massive and somewhat cone shaped for the attachment of the iliolumbar ligaments to connect the transverse process to the pelvic bones.
- The vertebral body is cylindrical.
- The vertebral foramen is triangular in shape and larger than the thoracic vertebrae.

Sacrum:
- The sacrum is a collection of 5 fused bones which has 4 anterior sacral foramina which allow the passage of the spinal nerves S1-S4 to leave.
- It is triangular in shape with apex pointed inferiorly and is curved so that it has a concave anterior surface and convex posterior surface.
- Two large L-shaped facets for articulation with pelvic bone.

Coccyx:

Symphyses joints between vertebral bodies.

Synovial joints between articular processes.
- It is triangular in shape with apex pointed inferiorly and is curved so that it has a concave anterior surface and convex posterior surface.
- Two large L-shaped facets for articulation with pelvic bone.

**Coccyx**
- Small triangular bone that articulates with the inferior end of the sacrum and is formed by 4 fused coccygeal vertebrae.
- Characterised by absence of vertebral arches and therefore a vertebral canal.

**Clavicle:**
- Only bony attachment between the trunk and the upper limb.
- Palpable along its entire length and has a gentle S-shaped contour, with the forward-facing convex part medial and the forward-facing concave part lateral.
- Acromial (lateral) end is flat.
- Sternal (medial) end is more robust and quadrangular.

**The scapula has:**
- Three angles (lateral, superior and inferior)
- Three borders (superior, lateral and medial)
- Two surfaces (costal and posterior)
- Three processes (acromion, spinous and coracoid process)
Learning Objectives

1. Define the extent of the lungs.
2. State how the right and left lungs are normally distinguishable.
3. Identify the structures present at the hilum of the lung.
4. Define the pleura.
5. Name the layers of the pleura.
6. Define the extent of the pleura.

Bronchial tree

- **Trachea**
  - Extends from vertebral level C6 to T4/5
  - Held open by C-shaped cartilage rings.
  - Trachea bifurcates at the lungs.
  - Lowest ring has a hook - carina
  - Subcarinal lymph nodes falling prey to cancer can cause the carina to change shape, also the subcarinal angle can change.

- **Primary (main) bronchi (left and right)**
  - Formed at T4/5
  - Right wider and more vertical then left in terms of gradient.
  - Inhaled objects due to the wider nature of right bronchi usually end up in the right lungs.

- **Lobar (secondary) bronchi**
  - Formed within the lungs
  - Supply the lobes of the lungs

- **Segmental (tertiary) bronchi**
  - Supply the bronchopulmonary segments

Lungs

- **Bronchial arteries** carry oxygenated blood to the lungs (like coronary arteries).

Define the extent of the lungs.

- Essential organs of respiration which are conical in shape.
- Situated in the thorax
- Separated from each other by heart and other contents of the mediastinum.
- Each lies freely in its pleural cavity apart from its attachment to the heart (via pulmonary vessels) and trachea at the lung root (hilum).
- Bronchial arteries carry oxygenated blood to the lungs (like coronary arteries).

Apex

- Thoracic inlet oblique - apex rises 3-4 cm above level of first costal cartilage.

Base

- Concave
- Rests on convex surface of diaphragm

3 borders (edges): anterior, posterior, inferior
- The inferior border of the lung is sharp and separates the base from the costal surface.
- The anterior and posterior borders separate the costal surface from the medial surface and are both smooth.

3 surfaces - costal, mediastinal, inferior (diaphragmatic)
- The costal surface lies immediately adjacent to the ribs and intercostal spaces of the thoracic wall.
- The mediastinal surface lies against the mediastinum anteriorly and the vertebral column posteriorly and contains the comma-shaped hilum of the lung through which structures enter and leave.

Diaphragm separates
- Right lung from right lobe of liver
- Left lung from left lobe of the liver, stomach and the spleen.

Diaphragmatic impression

- The inferior border of the lung is sharp and separates the base from the costal surface.
- The anterior and posterior borders separate the costal surface from the mediastinal surface and are both smooth.

Mediastinal surface of the lungs

- Anterior part deeply concave. This accommodates the heart cardiac impression which is larger on L than R because of position of heart.
- **Above and behind** cardiac impression hilum of the lung where vessels, bronchi and nerves enter and leave the mediastinum.
- Vessels and heart both make an impression within the lungs.
- Reflection of parietal pleura back to anterior pleura is the hilum.

State how the right and left lungs are normally distinguishable.

- **Left lung**
  - Two lobes:
    - Superior and inferior which are separated by an oblique fissure
    - Superior lobe lies above the fissure and includes the apex and the anterior part of the lung.

- **Right lung**
  - Three lobes:
    - Superior, middle and inferior
    - Two fissures:
      - Oblique fissure - separates inferior lobe from the other 2 lobes.
      - Horizontal fissure - separates superior from middle lobe.
    - The right lung is usually slightly larger than the left due to heart predominantly

Thyroid cartilage is what we commonly refer to as the “Adam’s apple”
- Bronchopulmonary segments have their own nerve and oxygen supply which can be removed by a surgeon without causing damage to the rest of the lungs.
• Superior, middle and interior
• Two fissures:
  • Oblique fissure: separates inferior lobe from the other 2 lobes.
  • Horizontal fissure: separates superior from middle lobe.
• The right lung is usually slightly larger than the left due to heart predominantly being on the left hand side of the heart.

Define the pleura.

The pleura are a set of membranes that cover the lungs and line the pleural cavity.

Name the layers of the pleura.

• 2 layers
  • Visceral pleura: covers surface lungs and lines fissures between the lobes
  • Parietal pleura: lines inner surface of chest walls.

• The visceral and parietal layers of the pleura are continuous at the hilum.

Costodiaphragmatic recess is the part of the pleural cavity that is not filled by lung tissue.

Define the extent of the pleura.

• The pleural cavity can project about 3-4 cm above the level of the first costal cartilage but usually does not go above the neck of the first rib.
• Rib 8 is the most inferior part of the mid-clavicular line (anterior)
• Rib 10 is the most inferior part of the mid-axillary line (lateral)
• Thoracic level 12 is the most inferior and posterior part of the lungs (posterior).

Breathing

1. Controlled by nervous system and produced by skeletal muscle
2. Brings about inhalation and exhalation of air into/out of the lungs, to ventilate the gas exchange areas - alveolar sacs.
3. Capacity of thoracic cavity can be increased:
   ○ By movements of the diaphragm
   ○ By movements of the ribs.

Diaphragm

• Contraction of the diaphragm increases the volume of the thoracic cavity
• When it contracts, the diaphragm presses on the abdominal viscera which initially descend (because of relaxation of the abdominal wall during inspiration)
• Further descent is stopped by the abdominal viscera, so more diaphragmatic contraction raises the costal margin.
• Increased thoracic capacity produced by diaphragmatic and rib movements in inspiration reduces intrapleural pressure, with entry of air through respiratory passages and expansion of the lungs.

• The dome of the diaphragm bulges high inside the rib cage. Therefore some abdominal organs such as the liver can seem relatively superior within the body.
• Bucket handle action: raising the costal margin also raises drooping anterior ends of ribs, tilting sternum upwards to increase antero-posterior diameter of pleural cavities.
Pulmonary circulation refers to blood going from the heart to the lungs and back to the heart again. The pulmonary artery carries deoxygenated blood from the RA to the lungs where it is oxygenated. It then returns back to the heart via the pulmonary vein.

**Explain** the term “pulmonary circulation”.

**Demonstrate** the landmarks of the chest wall on a living subject.

**Demonstrate** the positions of the pleural cavities, lungs and lobes of the lungs in the living chest.

**Demonstrate** the position of the fissures of the lungs in the living chest.

**Describe and sketch** the lungs, using correctly the following terms: apex, costal surface, mediastinal surface, diaphragmatic surface, upper, middle and lower lobes, oblique and horizontal fissures, hilum of lung.

**Explain** the structural basis for breathing, including the differences between light, deep and forced breathing.

**Explain** the rationale for the insertion of chest drains in the pleural cavity.

**Demonstrate** the positions of the pleural cavities, lungs and lobes of the lungs in the living chest.

**Surface Landmarks – Lung & pleura**

**Right parietal pleura**

- Apex of the pleura is about 2-3 cm above the medial 1/3 of the clavicle.
- Just right of Anterior Midline at centre of sternal angle - level 2nd CC
- Just right of AML at 4th CC
- Just right of AML at 6th CC (xiphoid process)
- Mid clavicular line at level of 8th rib (just superior to costal margin)
- Mid axillary line at level of 10th rib (lowest point of costal margin)
- Scapular line (lateral margin of erector spinae muscles) crossing the 12th rib.
- Transverse process of L1 vertebrae (subcostal pleura below 12th rib)
- Transverse process of T1 vertebrae (first palpable spine of T1).

**Left parietal pleura**

- This is basically the same apart from the fact that due to the position of the heart points c and d are different.
- The pleura deflect sharply left to allow for the cardiac notch. The pleural deflection is shallower than the cardiac notch of the left lung.

**Lung Markings**

**Right Lung:**

- From the apex, the right lung closely follows the pleural reflection down to the level of the 6th costal cartilage.
- From here the lower border of the lung follows two ribs above the pleural reflection along the chest wall.
- MCL at 6th rib (anteriorly)
- MAL at 8th rib (laterally)
- Scapular line at 10th rib (posteriorly)

**Left Lung:**

- Same as for right lung except for the mediastinal reflection below the 4th costal cartilage.
- After 4th costal cartilage, the cardiac notch deviates by 2-3 cm lateral at the level of 5th costal cartilage.
- Lower border follows the same path as the right lung.

**Oblique fissures for R and L Lungs:**

- Anteriorly lower border of lung at 6th cartilage level.
  - Note: The oblique fissure of the lungs follows the medial border of the scapula when the arm is raised above the head.

**Horizontal fissure of the right lung**

- Palpate the 4th costal cartilage on the right side and draw a line along the 4th cartilage and rib backwards to meet the oblique fissure in the MAL.
  - This marks the horizontal fissure separating upper and middle lobes of the right lung. It passes above the nipple in males.

**Surface Landmarks – Lung & pleura**

**Posterior Chest Wall**

- C7 first palpable vertebrae at base of neck when it is flexed.
- T3 is vertebrae below C7.
- Superior angle of scapula at level of T2.
- Spine of scapula, travels medially to and ends at acromion. At the level of T3.
- Medial border of scapula all of which is palpable.
- Inferior angle of scapula at the level of T7 spine.

**Trachea**

- Can use index finger to feel above jugular notch - any significant deviation from the midline can be caused by pathology.
  - Deviation of trachea to same side of legion is upper lobe collapse or fibrosis.
  - Deviation to other side of legion is large pleural effusion or tension pneumothorax.

**Anterior chest wall**

- The first landmark is the sternal angle (manubrio-sternal joint) which is where the second rib attaches. This is located on me between about three fingers below my jugular notch.
- 2nd costal cartilage is lateral of sternal angle of Louis.
- Note in males and (pre-pubescent) females the nipple is about 1 cm lateral to the MCL overlapping the 4th ICS.
- Xiphisternum or xiphoid process is located at the base of T11 and can be felt next to medial border of costal margin.
- Costal margin is felt below the pectorals and is easiest to find if the subject is supine with legs flexed.
- Lateral lower border of costal margin is the 10th costal cartilage or L3. The lateral border of rectus abdominis muscle meets costal margin at top of 9th costal cartilage (L1). The outline of the rectus abdominis can be palpated if the subject is asked to fully extended legs at hip joint whilst lying supine.

**Surface Landmarks – Lung & pleura**

- Cardiac notch: rib 4 – 6 – left side
- 9th rib at lateral border of rectus abdominis rib
Oblique fissures for R and L Lungs:
   a. Posteriorly, lung border at the level of spine T3.
   b. Anteriorly lower border of lung at 6th cartilage level.
      • Note: The oblique fissure of the lungs follows the medial border of the scapula when the arm is raised above the head.

Horizontal fissure of the right lung:
   a. Palpate the 4th costal cartilage on the right side and draw a line along the 4th cartilage and rib backwards to meet the oblique fissure in the MAL.
      • This marks the horizontal fissure separating upper and middle lobes of the right lung. It passes above the nipple in males.
Learning Objectives

- Describe the position and relations of the aortic arch and descending aorta.
- Identify the origin of the brachiocephalic artery, the subclavian arteries and the carotid system of arteries.
- Explain how blood leaving the heart reaches (a) head and neck, (b) lungs, (c) thoracic and abdominal cavities.
- Identify the superior vena cava.
- Explain how blood returns from the head and neck to the heart.

The Mediastinum

Is a thick midline partition that separates the two pleural cavities.
- It extends from the superior thoracic aperture (inlet) to the inferior thoracic aperture and between the sternum anteriorly and the thoracic vertebrae posteriorly.
- It acts as a conduit for structures that pass through the thorax from one body region to another and for structures that connect thoracic organs to other body regions.

Principal contents of the mediastinum

- Trachea—from larynx to bifurcation into principal (right and left main) bronchi
- Oesophagus from pharynx- muscular tube pierces diaphragm at level of T10
- Heart and pericardium
- Thoracic duct- lymphatic drainage- terminal end of the lymphatic system
- Nerves
- Great vessels

Arteries of the Superior Mediastinum

- Ascending aorta
  - Right and left coronary arteries (end arteries supplying heart muscle)
- Arch of aorta
  - Brachiocephalic trunk- divides into right common carotid and right subclavian arteries.
  - Left common carotid artery
  - Left subclavian artery
  - Since aorta is travelling left and backwards it can give off the individual arteries rather than the need for a brachiocephalic trunk.
- Descending aorta

Veins are generally anterior to the arteries.

Relations of aorta and great arteries to the airway

- Aortic arch arises anterior to trachea.
- Arches over the left main bronchus at the lung root.
- Trachea lies behind and between brachiocephalic and left common carotid arteries.

Arteries of the Mediastinum

- Brachiocephalic trunk
- Right common carotid artery
- Right subclavian artery
- Left common carotid artery
- Left subclavian artery

The left brachiocephalic vein rises above the superior border of the manubrium and is therefore less protected.

Superior Mediastinum

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Stuart's Anatomy of the Thorax Page 11
Explain how blood leaving the heart reaches (a) head and neck, (b) lungs, (c) thoracic and abdominal cavities.

- Via common carotid arteries which then split into internal and external.
- Via the bronchial arteries which branch off from the thoracic aorta
- Via the descending aorta and abdominal aorta.

Qu. 5: The azygos vein joins the superior vena cava...

- To the left of the oesophagus
- Posterior to the oesophagus
- Superior to the root of the lung
- Inferior to the root of the lung
- Via the internal jugular vein

Best Option: Superior to the root of the lung

The azygos veins ascend along the right side posterior to the oesophagus but then arches anteriorly superior to the root of the lung to join the superior vena cava.

Distribution of common carotid arteries:

- Divide into external (supplying most of the face - extracranial apart from meninges), and internal is the artery of the brain. Circle of Willis is where vertebral arteries and internal carotid arteries join.
- They are the main arteries of the head and neck

Pulmonary trunk:

- Outflow of right ventricle.
- Carries deoxygenated blood via left and right pulmonary arteries.
- Ligamentum arteriosum connect PT to aortic arch. Is remnant of the ductus arteriosus which bypasses lungs in foetal life. Foramen ovale is a hole between the atria.
- One of the branches of the vagus wraps back around the aorta at the level of Ligamentum arteriosum.

Phrenic nerves

- Formed in the cervical plexus from C3, 4,5 keeps your diaphragm alive!
- Motor to the diaphragm.
- Sensory to:
  - Medial pedalura
  - Pericardium
  - Peritoneum of central diaphragm
  - Central tendon of the diaphragm.

Right phrenic nerve reaches diaphragm lying on surface of:

- Right brachiocephalic vein
- Superior vena cava
- Right side of the heart and pericardium- in front of lung root.

Phrenic nerves go back to spinal cord of spinal cord level C3, 4, 5 therefore diaphragmatic pain is referred to shoulders.

Positioning:

- Each vagus nerve supplies a hemi-diaphragm (half the diaphragm).
- Vagus nerves lateral to common carotids.
- Left vagus passes anterior to aortic arch.
- Left phrenic crosses vagus to cross aortic arch more anteriorly.

Left phrenic and vagus nerves:

- Cross arch of aorta
- Left phrenic descends in front root of lung
- Left vagus crosses behind root lung gives off left recurrent (turns back) laryngeal nerve around ligamentum arteriosum and aortic arch.
- Breaks up into many branches round the oesophagus.

Right vagus nerve:

- Lies on the trachea
- Crosses behind the root lung
- Recurrent laryngeal branch – recurs (turns back) around right subclavian artery
- Breaks up into branches on oesophagus
Learning Objectives

- Use chest wall landmarks to define the cardiac outline.
- Locate the apex beat.
- Locate suitable sites for auscultation of each heart valve and demonstrate correct stethoscope technique.

Palpation of the Apex Beat

In adults: left 5th intercostal space around midclavicular line
In children: slightly higher on the 5th rib

Suggestion: If you do “jogging on the spot” your heart will beat stronger so that you can palpate the apex beat easily

Heart Valve Locations & Auscultation Positions

Heart – Surface Projection

Vessels in the Neck

Pulses in the Head & Neck

Arterial Pulse – Upper Limb

Palpate in the red circles

Arterial Pulse – Lower Limb

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Arterial Pulse – Upper Limb

- Radial pulse
- Ulnar pulse
- Brachial pulse
- Cubital fossa
- Subclavian pulse
- Supracalvicular fossa

Arterial Pulse – Lower Limb

- Posterior tibial pulse
  - Behind medial malleolus of tibial bone
- Dorsalis pedis pulse
  - Lateral to flexor hallucis longus tendon
- Femoral artery pulse
  - Mid point between ant. supr. iliac spine & pubic symphysis
The female breast base or footprint extends from the 2nd to the 6th rib in the pectoralis major muscle and laterally, extends to lie on serratus anterior and external oblique muscles.

An axillary tail of breast tissue sometimes extends into the medial wall of the axilla and lies in the subcutaneous fat. The medial and lateral extents vary according to the size of the breast, from the midline medially to the mid axillary line laterally.

**Embryology**

Read the link that was on the slide.

- The breast is a modified sweat gland under hormonal control to produce milk post-partum. It is made up of glandular, fatty and fibrous tissue.
- More fatty tissue with age.

**Lymphatics**

- Lymphedema of the arm can occur after surgery (axillary clearance) or radiotherapy to the axilla due to blockage of the lymphatics or as a result of impairment of venous drainage.
- Between 15-40% after axillary clearance more common if combined with radiotherapy.
- Lymph capillaries make a rich anastomosing network within the breast and overlying skin.
- The superficial parts of the breast drain to the sub-areolar plexus and the deep parts to the submammary plexus that lies in the deep fascia overlying pectoralis major and serratus anterior.
- Sentinel node biopsy. Radiographic and blue dyes. Geiger counter to see where radiation has gone.
- There is free communication between the nodes and above and below the clavicle and between the cervical and axillary nodes.

- From the sub-areola and submammary plexuses lymph from most of the breast drains to:
  - The infradacivus group of axillary nodes.
  - But there is drainage of the adjacent parts of the breast to:
    - The infradacivus group
    - To nodes along the internal thoracic artery (parasternal nodes) and then to the mediastinal nodes (inferiorly through the abdominal wall, and diaphragm)
    - To the opposite breast

**Blood Supply**

- The blood supply is derived from branches of the lateral thoracic artery, internal thoracic artery, thoraco-acromial artery, thoraco-dorsal artery, and intercostal artery.
- The skin is supplied by the subdermal plexus which communicates with the deep parenchymal vessels. The nipple areola receives a branch from the internal thoracic artery in most cases.
- Venous return follows the arteries.

**Nerve Supply**

- Sensory innervation is dermatomal, mainly from the anterolateral and anteromedial branches of thoracic intercostal nerves T3-T5. There is also innervation from the supraclavicular nerves to the upper and lateral parts of the breasts.
- The nipple has a dominant supply from the lateral cutaneous branch of T4.

**Congenital abnormalities**

- Supernumerary breast tissue
- Accessory nipples - especially if in the midline
- Accessory breast tissue
- Underdevelopment or absence of one breast (may coexist with muscle/ribcage anomaly) Poland's syndrome.
  - Hypoplasia of Pectoralis major and Latissimus dorsi
- Caucasian population: 5% of women.
Learning Objectives

- Summarise the main functions and anatomical organisation of the lymphatic system.
- Describe the lymphatic drainage of the chest viscera (particularly the lungs and bronchi) and outline the implications of this pattern for the spread of lung cancer.
- Describe the lymphatic and venous drainage of the breast and relate these to the pathways of metastasis of breast cancer.
- Define the roles of breast examination and imaging within the epidemiological context of breast cancer incidence.
- List the imaging techniques used in the diagnosis of breast cancer and outline their value and limitations.

Anatomy of a lymph node

- Small (<2.5 cm long).
- Found along lymph vessels.
- Contains lymphocytes and macrophages.
- Can act upon foreign bodies in the lymph.
- Drainage from infected regions detectable in enlarged lymph nodes.
- Armpit, groin, neck: palpated to determine infection.

Lymphatic Drainage of the Thoracic Duct

- Lacteals help to carry pathogens, hormones, cell debris and fats. Also can be responsible for metastases.
- Fats absorbed into small intestine packaged into chylomicrons (protein covered lipids).
- Released into interstitial fluid.
- Drain into lacteals.
- Return to venous system in the neck.
- See Microcirculation for more detail.

Lymph Fluid Characteristics:

- Lymph is usually odourless and clear in most vessels. However it is opaque and milky from the small intestine due to the chylomicrons called chyle.
- Cisterna-chyli is a major draining vessel.
- Lymph is maintained by action of adjacent structures.
  - Skeletal muscles and the pulses in the arteries.
  - Valves ensure flow is unidirectional

Lymphatics of the breast

- Breast
- Thoracic wall
- The thoracic duct
- Lungs
- Heart

- More fluid leaves blood capillaries than returns to them.
- Hydrostatic pressure > oncotic pressure at arteriole end.
- Uncompensated fluid movement from blood to the extracellular fluid would result in oedema and loss of blood volume.
- Lymphatic vessels drain excess extracellular fluid back into the blood.
- It also ensures that foreign particles come into contact with the immune system.
**Lymphatics of the thoracic wall**

- Lymph travels posteriorly back to collection of nodes found in the intercostal spaces.
- Internal thoracic arteries empty into the parasternal lymph nodes.
- Diaphragm (diaphragmatic)
  - Parasternal-Bronchomediastinal trunks
  - Intercostal (upper)-Bronchomediastinal trunks
  - Intercostal (lower)-Thoracic duct
  - Diaphragmatic-Brachiophecalic and aortic/lumbar
  - Superficial-Axillary or parasternal.

**Lymphatics of the lungs**

- Begins at cisterna chyli which drain the abdomen, pelvis, perineum and lower limbs.
- Begins at L2 vertebral level, enters behind oesophagus and into diaphragm via the aortic hiatus which is at T12.
- Ascends on right of midline, between aorta and azygos vein.
- Crosses over onto left at T5.
- Empties into left subclavian vein just before formation of brachiophecalic vein.

**Tracheobronchial**

- Around bronchii and trachea
- From within lung through hilum
- Unite with vessels from parasternal and brachiophecalic nodes anterior to brachiophecalic veins to form:

  - Bronchomediastinal (left and right)
    - Formed from
      - Tracheobronchial
      - Parasternal
      - Brachiophecalic

**Lymphatics of the heart**

- Follows the coronary arteries and drain into brachiophecalic and tracheobronchial lacteals.

**Posterior Mediastinum**

- Nodes on aorta receive lymph from oesophagus, diaphragm, liver and pericardium and drain into:
  - Thoracic duct
  - Posterior mediastinal.
**Learning Objectives**

**Somatic Spinal Nerves**
- Motor to skeletal muscle only
- Skeletal muscle cannot function without them.
- Sensory to body wall but not to viscera.
- Segmental nerves may combine to form plexi supplying specialised areas (cervical, brachial, lumbosacral)
- Efferent nerve fibres = anterior horn of the spinal cord.
- Dorsal root ganglion

**Intercostal nerves**
- 11 pairs + 1 subcostal
- Mixed consist of both motor and sensory nerves.
- Spinal or segmental nerves (anterior primary rami)
- Supply the intercostal spaces
- Lateral cutaneous branch
- Anterior cutaneous branch - medial and lateral

**Phrenic nerves**
- Derived from anterior rami of spinal nerves C3-C5.
- Somatic nerves- no autonomic function or visceral distribution.
- Motor fibres supply skeletal muscle of the diaphragm.
- C3, 4 and 5 keeps the diaphragm alive.
- Sensory fibres supply central tendon of the diaphragm, its pleural covering, mediastinal pleura and pericardium.
- Also supply peritoneum on inferior surface of central diaphragm.

**Autonomic Nerves**
- Motor to cardiac muscle, smooth muscle and glands.
- Sensory to visceral organs.
- Divided into parasympathetic and sympathetic divisions.
- Different origins and distributions.
- Often but not always opposite in motor actions.

**Dermatome**
- An area of skin which is supplied by a single spinal nerve on one side or from a single spinal segment.
- Clinical testing for spinal cord injury.

**Myotome**
- Part of a skeletal muscle supplied by a single spinal nerve on one side or from a single spinal cord level.

**Parasympathetic Nerves**
- Five sets of nerves contain parasympathetic fibres:
  - Oculomotor (III) cranial nerves
  - Facial (VII) cranial nerves
  - Glossopharyngeal (IX) cranial nerves
  - Vagus (X) nerves cranial nerves
  - Sacral (S2-5) spinal nerves.
- Most important is vagus supplying the viscera of the thorax and most of the abdomen.

**Sympathetic Nerves**
- Sympathetic nerves to the lungs and heart.
Sympathetic Outflow from the spinal cord.

- All autonomic motor pathways involve preganglionic and postganglionic neurones.
- Pathways to body wall synapse in ganglia of sympathetic trunk.
- Visceral pathways synapse in unpaired ganglia.
- Trunks take fibres up or down.

Sympathetic Outflow from the spinal cord.

- Mainly from spinal nerves T2-T4 passing through cervical and upper thoracic ganglia of sympathetic trunk.
- Many of their synapses are in micro-ganglia in the pulmonary and cardiac plexuses rather than in trunk ganglia.

Pulmonary plexus:
- Sympathetic nerves dilate the bronchioles.
- Parasympathetic (vagus) nerves constrict the bronchioles.

Cardiac plexus:
- Sympathetic efferents increase heart rate and force of contraction.
- Sympathetic afferent relay pain sensations from the heart.
- Parasympathetic efferents (vagus) increase heart rate via the pacemaker tissue and constrict coronary arteries.
- Parasympathetic afferents (vagus) relay blood pressure and chemistry information from the heart.

Oesophageal plexus:
- Sympathetic afferents relay pain sensations from the oesophagus.
- Parasympathetic afferents sense normal physiological information from the oesophagus.

**Course of the Vagus Nerves**

- Cranial nerve X- arises from Medulla and leaves skull through jugular foramina.
- Descend neck posterolateral to common carotid.
- Left vagus crosses anterior to aortic arch then posterior to left lung root.
- Right vagus passes posterior to right lung root.
- Both vagi form a plexus around the oesophagus.
- Separate to form anterior and posterior oesophageal/ gastric nerves.

**Vagus nerves and their branches**

- Branches to chest and abdomen are parasympathetic (control smooth and cardiac muscle and glands of gut and airways).
- Also large sensory (enteroreceptor) content from gut and lungs.
- Unlike the sympathetic they provide no autonomic supply to the body wall (e.g. arterioles and sweat glands).
- Recurrent laryngeal branch of vagus nerve is not parasympathetic - runs back up neck to supply most skeletal muscles of larynx.

**Sympathetic Trunks**

- Receive branches from spinal nerves T1-L2.
- Distribute sympathetic nerves to smooth muscle glands throughout the body.
- Nerves to body wall synapse in unpaired ganglia.
- Also bring pain fibres back to CNS from viscera.
- Fibres from lower T5-T12 reach abdomen in bundles called splanchnic nerves.

**The Vagi in the Posterior Mediastinum**

- This posterior view of the oesophagus shows mainly the right vagus contributing to the oesophageal plexus.
- Remember that these nerves also acquire many sympathetic fibres.
- The inferior continuation of this nerve is the posterior oesophageal nerve, taking right vagal fibres through the diaphragm to the abdominal viscera.
- In a similar way, the left vagus provides fibres to the oesophageal plexus then continues as the anterior oesophageal nerve.
- Left vagus- anterior oesophageal nerve
- Right vagus- posterior oesophageal nerve

**Intrinsic nerves of the oesophagus**

This plexus of ganglia and axons within the oesophageal wall coordinates its activity.

This can be up-or down-regulated by the autonomic nerves.

It is part of the enteral nervous system.
Intrinsic nerves of the oesophagus

This plexus of ganglia and axons within the oesophageal wall coordinates its activity. This can be up- or down-regulated by the autonomic nerves. It is part of the enteric nervous system.
### Learning Objectives

- **Define the posterior mediastinum**
  - The posterior mediastinum is a section of the inferior mediastinum.
  - It is bordered laterally by the parietal pleura.
  - Superiorly by the transverse plane passing from the sternal angle to the intervertebral disc between TIV and TV.
  - Inferiorly by the diaphragm.

- **Describe the relative positions of the descending aorta, the oesophagus, the vagus nerves and the thoracic duct as they descend through the posterior mediastinum**
  - Oman: the descending aorta, the oesophagus, the vagus nerves, sympathetic and lymphatic drainage of the oesophagus.
  - Azygos vein feeds into SVC and leaves an impression in the right lung.
  - Vagus behind and phrenic in front of the lung root.
  - FFIfRenic front

- **Describe the relative positions of the descending aorta, the oesophagus, the vagus nerves and the thoracic duct as they descend through the posterior mediastinum**

- **Describe how and at which vertebral levels the inferior vena cava, the oesophagus and the descending aorta pass through the diaphragm**

### Contents of the posterior mediastinum

- **Oesophagus:**
  - Begins at level of C7: vertebral prominenes.
  - Ends at stomach, level of T11
  - At T7:
    - Bends more anteriorly
    - Is right of aorta
    - Deviates to left
    - Progressively anterior to aorta below T7
  - Passes through diaphragm at T10
  - Has constrictions at four locations
    1. Junction of oesophagus with pharynx
    2. Aortic arch
    3. Left main bronchus
    4. Esophageal hiatus

### Azigos Venous System

- Arises opposite T1 or L1.
- Formed by right lumbar and subcostal veins.
- The azigos system of veins serves as an important anastomotic pathway capable of returning venous blood from the lower part of the body to heart if the IVC is blocked.
- Enters thorax via aortic hiatus.
- Drains posterior wall of chest and upper abdomen + posterior mediastinal organs.
- Hemiazygos vein and accessory hemiazygous veins which empty into azigos vein.
- One cross vertebral column and empty into azigos vein.
- Azygos vein arches over right lung root to enter SVC just above right atrium.
- Cases of liver disease - portal system is blocked or restricted the blood will try to take another route. Caval system becomes engorged with blood and may flow of returning venous blood from the lower part of the body to heart if the IVC is blocked.
- Azygos vein feeds into SVC and leaves an impression in the right lung.
- Hematemeses: caused by blood in oesophagus
- Haemorrhoids.
- Caput medussae: enlarged abdominal wall with engorged vessels

- **Veins of the oesophagus**

- For nerves please look at Nerves of the Thorax

### Sympathetic Trunks

- Receive branches from spinal nerves T1-L2.
- Distributes sympathetic nerves to smooth muscle and glands throughout the body.
- Nerves to body wall synapse in ganglia of trunks.
- Also can receive blood supply from.
- Fibres from lower T5 - T12 reach abdomen in bundles called splanchnic nerves.
- Pressing on certain nerves can cause Horner’s Syndrome: damaged to T1 sympathetic outflow to the head- pupil constriction, drooping of an eyelid

### Thoracic Duct

- Lymph duct returning lymph from lower limbs, pelvis abdomen and left thoracic wall to blood.
- Begins below diaphragm at cisterna chyli.
- Starts between oesophagus and aorta on right.
- Crosses behind oesophagus to left side at T5.
- Drains into left subclavian vein just before brachiocephalic vein is formed.
- Passes through aortic hiatus.
Explain how and at which vertebral levels the inferior vena cava, the oesophagus and the descending aorta pass through the diaphragm.

TVIII - Inferior vena cava, right phrenic nerve.
TX - Oesophagus, left gastric artery, vagus
TXII - Descending limb of the aorta, thoracic duct and azygos venous system