

INTERNATIONAL SURGICAL
ANATOMY TEACHING
SERIES



ISATS HANDOUT 2023/24

Thorax Anatomy

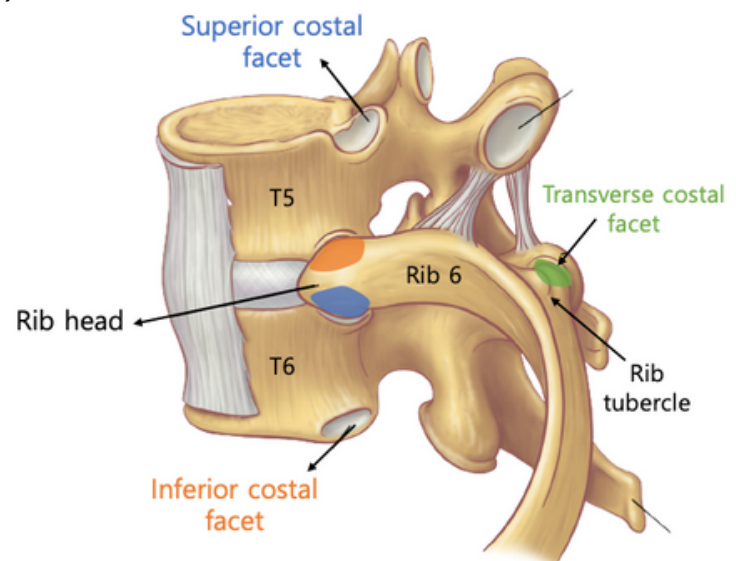
THORAX ANATOMY

Objectives: Understand the bony anatomy of the thorax, the neurovascular bundle, the gross anatomy of the lungs & pleura. Apply anatomical knowledge in the context of lung cancer resection surgery and chest drain insertion.

Bony Thoracic Anatomy

- The thorax extends from the **superior thoracic aperture** to the **inferior thoracic aperture**.
- Components of the thoracic wall:
 - 12 **thoracic vertebrae** & intervertebral discs (posteriorly)
 - 12 **ribs**
 - Sternum** (manubrium, body and xiphoid process)
- Anterior articulation of ribs:**
 - Articulate directly with sternum (ribs 1-7) – true ribs
 - Articulate with costal cartilages (ribs 8-10) – false ribs
 - No articulation (ribs 11-12) – considered 'floating ribs'!
- Each ribs possesses 3 articulations with thoracic vertebrae posteriorly:

- Superior costal facet** → part of head of own rib
- Inferior costal facet** → part of head of rib below
- Transverse costal facet** → tubercle of own rib

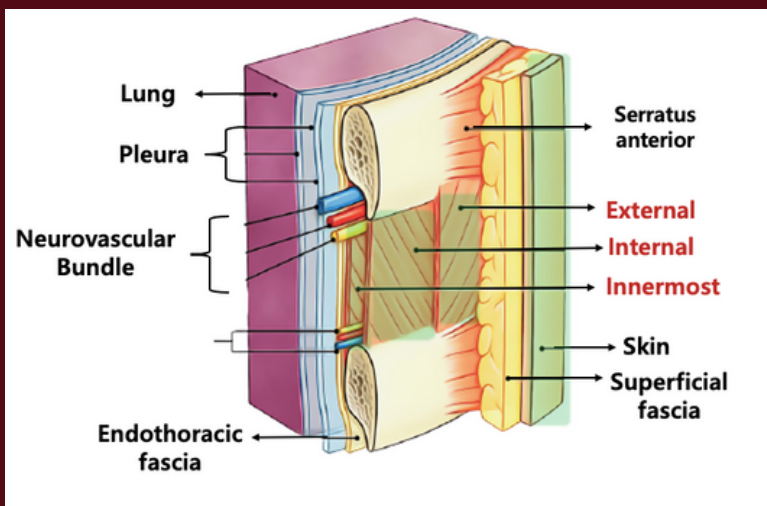


Neurovascular Bundle

- Intercostal spaces lie between ribs and contain intercostal muscles.
- The **neurovascular bundle** consists of an intercostal vein, artery and nerve (*superior to inferior – VAN*) lying in the costal groove of the inferior margin of the superior rib.

CONTENTS OF INTERCOSTAL SPACE:

- Skin
- Subcutaneous fat
- External intercostal m.
- Internal intercostal m.
- Neurovascular bundle
- Innermost intercostal m.
- Endothoracic fascia
- Parietal pleura

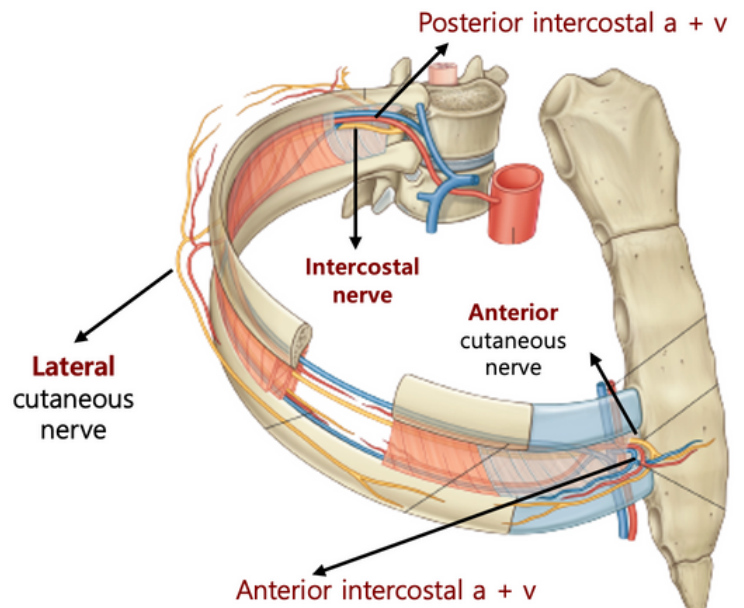


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Neurovascular Bundle

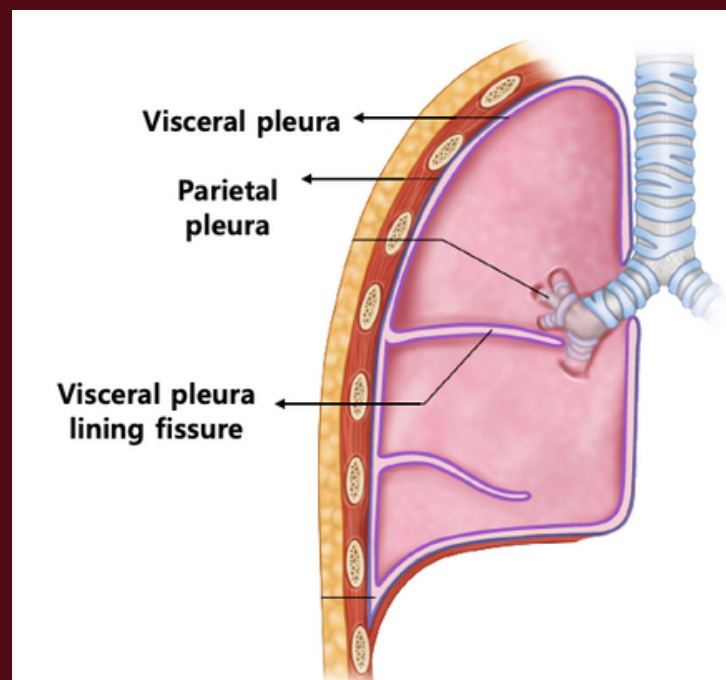
- **Intercostal artery**
 - Anterior intercostal a - from internal thoracic a.
 - Posterior intercostal a - from thoracic aorta.
 - **EXCEPT** – 1st and 2nd (originate from supreme artery)
- **Intercostal vein**
 - Drains into internal thoracic vein or azygous venous system
- **Intercostal nerve**
 - Lateral cutaneous nerve
 - Anterior cutaneous nerve



CLINICAL TIP: Intercostal Nerve Block
Needle should be inserted **superior** to the rib border to avoid damage to the neurovascular bundle!!

Parietal & Visceral Pleura

- **Pleura definition** – single layer of mesothelial cells with associated connective tissue
- **Parietal pleura** – associated with pleural cavity.
 - Innervated by somatic nerve fibres
 - Costal pleura innervated by intercostal nerves
 - Diaphragmatic & mediastinal pleura innervated by phrenic nerve
- **Visceral pleura** – tightly adhered onto the surfaces of the lungs
 - Innervated by visceral afferent nerve fibres which accompany bronchial vessels.
- Pleural cavity – potential space containing thin layer of serous fluid



T5-T7 – mediastinal parietal pleura continuous with visceral pleura to hilum/root of lung

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Gross Anatomy of Lungs

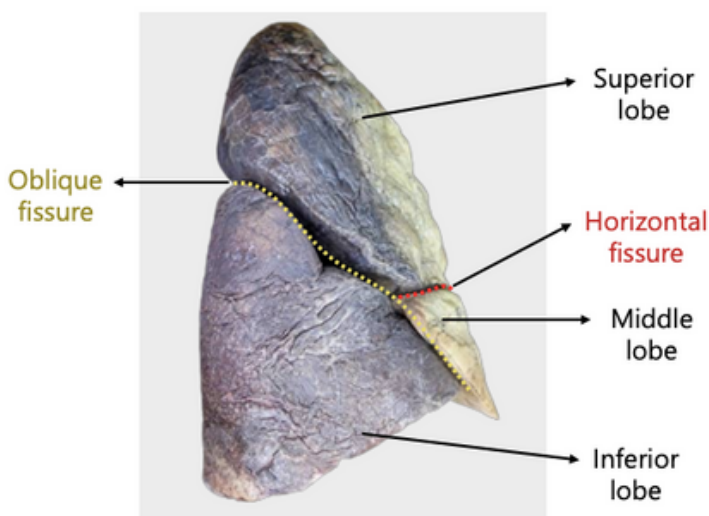
- Surfaces of the lung
 - **Diaphragmatic surface** – adjacent to diaphragm
 - **Costal surface** – adjacent to ribs
 - **Mediastinal surface** – adjacent to mediastinum
- Bronchial tree: trachea → right and left main bronchus (at carina, T4/T5) → lobar bronchi (right lobar branch to superior lobe originates from root of lung) → segmental bronchi → **bronchopulmonary segments**

RIGHT LUNG

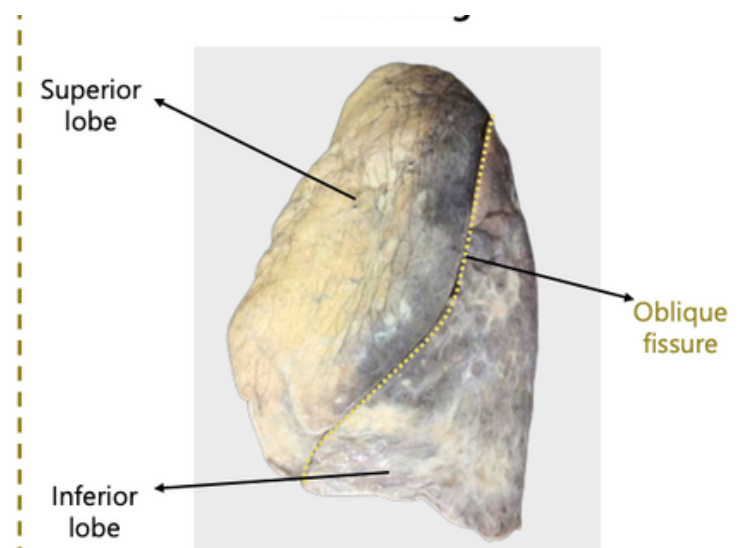
- **3 lobes** – superior, middle and inferior.
- **2 fissures:** oblique & transverse fissure:
 - Oblique fissure separates inferior FROM superior and middle lobes
 - Horizontal fissure separates superior FROM middle lobes
- Lung hilum lies posterior to SVC and right atrium
- Right main bronchus shorter, wider and more **vertical**.

LEFT LUNG

- **2 lobes** – superior and inferior lobes.
- **Lingula:** tongue-like extension from the lower part of the superior lobe which extends over the heart.
- 1 fissure – oblique fissure separates the superior and inferior lobes
- Lung hilum lies posterior to aortic arch.
- Left main bronchus is narrower and less vertical.



RIGHT LUNG



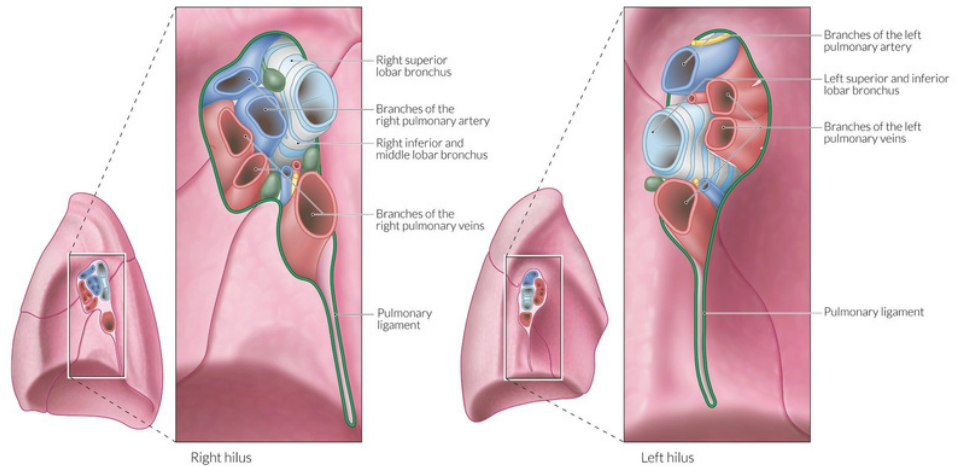
LEFT LUNG

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Lung Hilum

- Defined as the **pleural reflection** where structures enter & leave the lung.
- Pulmonary ligament: fold of pleura extending from root of lung, inferiorly from hilum to mediastinum
- **Structures passing through lung hilum:**
 - Pulmonary artery
 - 2 pulmonary veins
 - Main bronchus (left lung) and lobar bronchi (right lung)
 - Bronchial vessels
 - Lymphatics



- **LUNG ROOT** – Tubular collection of structures connecting lung to mediastinum.
- **LUNG HILUM** – region outlined by pleural reflection where structures enter + leave

Location of structures:

- PAS – pulmonary artery = superior
- PVI – pulmonary vein = inferior
- BP – bronchi = posterior
- Vagus nerve – **posterior** to lung hilum.
- Phrenic nerve – **anterior** to lung hilum.

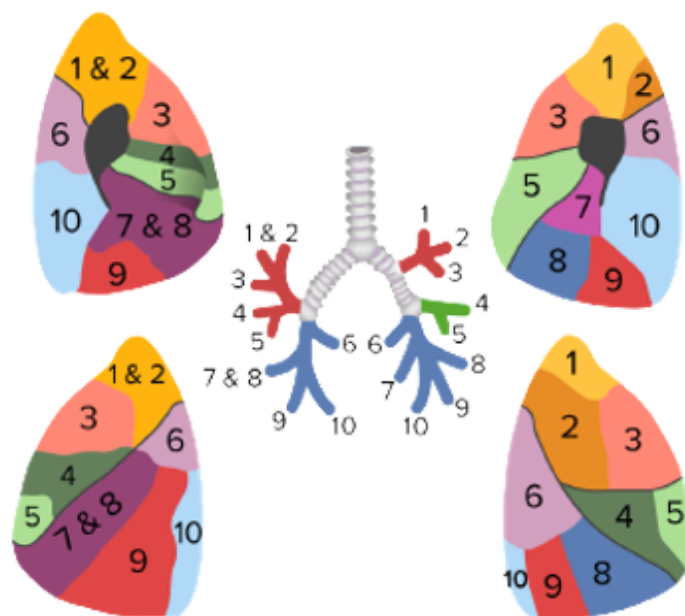
Tracheobronchial Tree

1. Trachea
2. Main bronchus
3. Lobar bronchi
4. Segmental bronchi
5. Bronchopulmonary segments

Bronchopulmonary Segments:

- Bronchopulmonary segments are the smallest functionally independent region of the lung and smallest area of lung that can be removed without affecting adjacent regions.
- Area of lung supplied by a segmental bronchus & pulmonary artery branch
- There are typically 10 bronchopulmonary segments in each lung!

Bronchopulmonary Segments

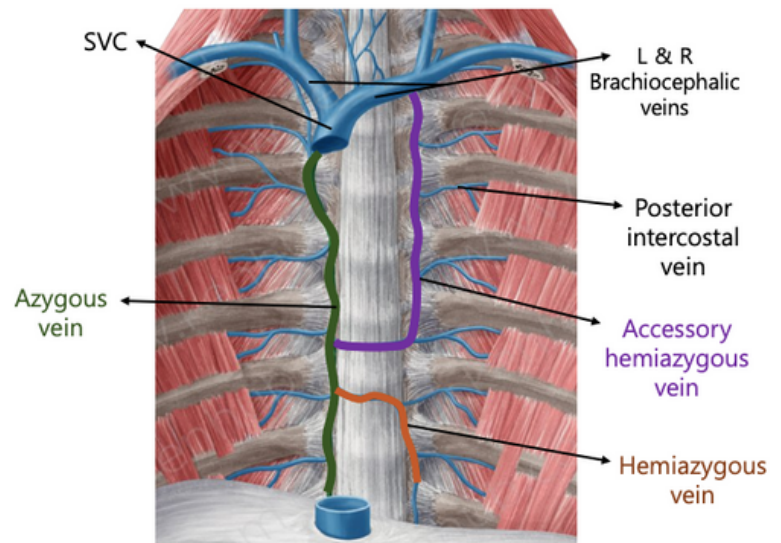


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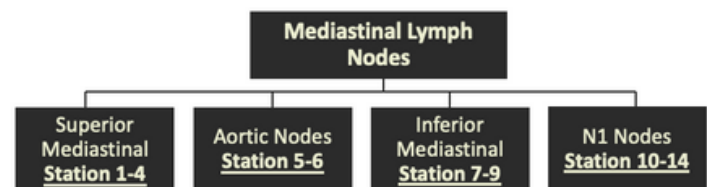
Azygous Venous System

- Drain blood of body wall (& some thoracic viscera) into SVC
- **Longitudinal vessels:**
 - **Azygous vein** (T12 aortic hiatus of diaphragm) → right posterior mediastinum → SVC
 - **Hemiazygous vein** (left crus of diaphragm) → left posterior mediastinum → azygous vein
 - **Accessory hemiazygous vein** → descends posterior mediastinum → azygous vein



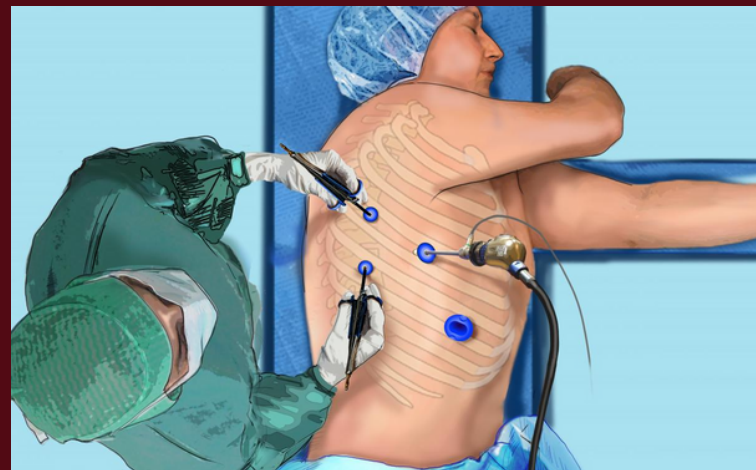
Mediastinal Lymph Nodes

- Divided into superior mediastinal, inferior mediastinal, aortic and nodal lymph nodes
- Clinically significant when sampling during lung resection (suspicion of lymph node metastasis)



Lobectomy Surgical Procedure

- A lobectomy involves surgical resection of a lobe of a lung, usually indicated for lung cancer e.g. early stage non-small cell lung cancer.
- This is now typically performed using a **Video-Assisted Thoracoscopic Surgery (VATS) technique** (image on the right). This technique is a minimally invasive approach and has been shown to reduce hospital admission.
- Incisions are made through the thoracic wall to access to the lungs.
- **Surgical complications** include: prolonged air leak, pneumonia, chylothorax, empyema, infection and haemorrhage due to injury of the pulmonary artery and its branches.

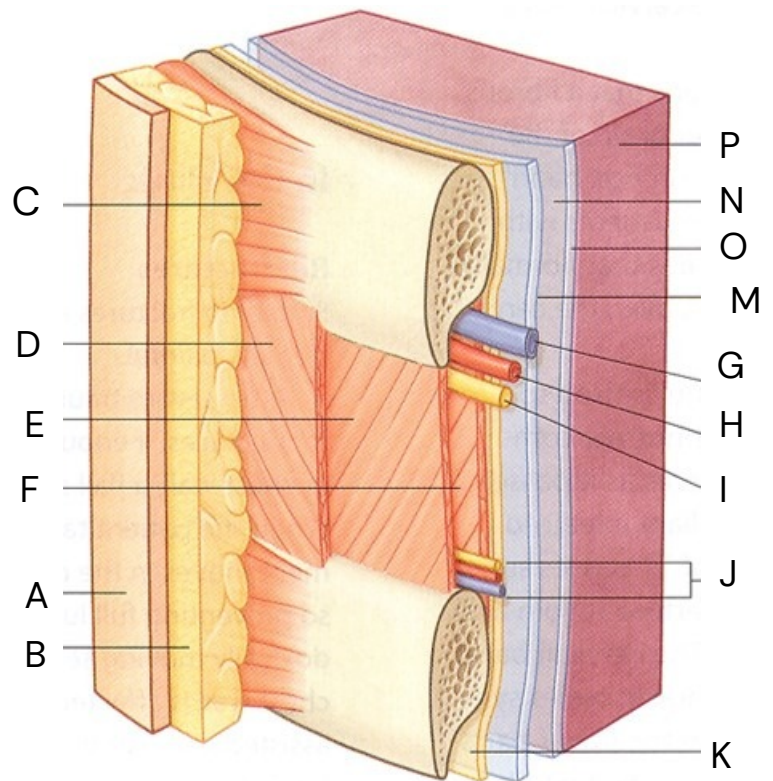


- Advancements in technology has led to the use of robotic-assisted and 3D VATS techniques which have become preferred over traditional thoracotomy approaches

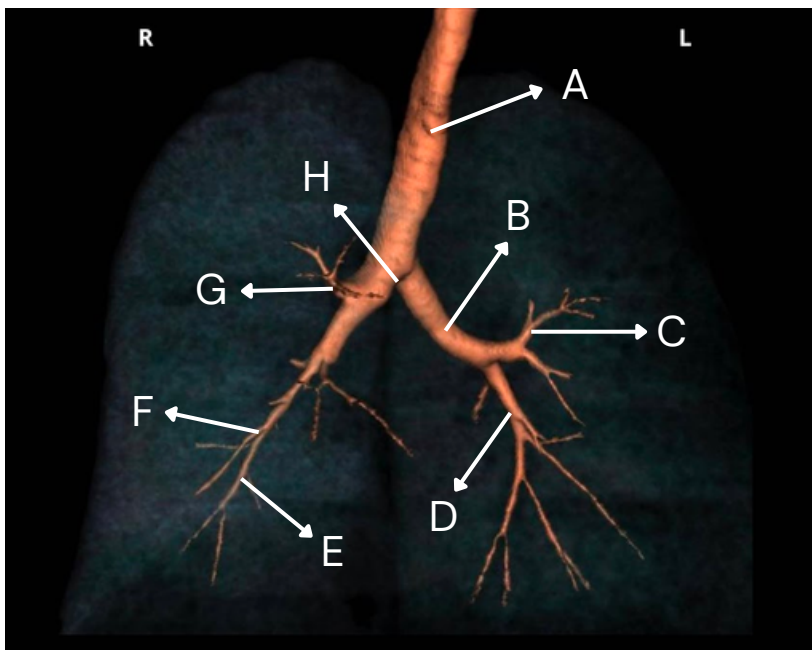
THORAX ANATOMY

Test yourself

1) Label the layers within the intercostal space:



2) Label the components of the tracheobronchial tree:



THORAX ANATOMY

Test yourself

MCQ 1

Mr Smith is involved in a gunshot injury to the chest, and presents to the emergency department. The bullet passes through the posterior mediastinum. Which of the following structures is least likely to be affected by this injury?

- A. Thoracic aorta
- B. Oesophagus
- C. Vagus nerve
- D. Azygous vein
- E. Thoracic duct

MCQ 3

A surgeon performs a right upper lobectomy in a 69 year old patient with non-small cell lung cancer. During the surgery, the surgeon performs lymph node sampling of station 7, which group of mediastinal lymph node does this correspond to?

- A. Paraoesophageal
- B. Lower tracheal
- C. Subcarinal
- D. Pulmonary ligament
- E. Upper tracheal

MCQ 5

A bronchoscopy is performed for biopsy assessment of a suspected bronchial cancer. Unfortunately, the bronchoscope is accidentally passed through the diaphragm at the level of T8. Which structure is most likely to be injured?

- A. Abdominal aorta
- B. Thoracic aorta
- C. Thoracic duct
- D. Inferior vena cava
- E. Oesophagus

MCQ 2

Anterior intercostal arteries from ribs 1-6 arise directly from which artery branch?

- A. Internal thoracic artery
- B. Subclavian artery
- C. Supreme intercostal artery
- D. Pericardiophrenic artery
- E. Thyrocervical trunk

MCQ 4

The parietal pleura is innervated by which type of afferent nerve fibres?

- A. Visceral afferent nerves
- B. Visceral efferent nerves
- C. Somatic afferent nerves
- D. Somatic efferent nerves
- E. Post-ganglionic sympathetic nerve fibres

MCQ 6

Which arteriovenous structure does the phrenic nerve travel with to innervate the diaphragm?

- A. Internal thoracic artery and vein
- B. Pericardiophrenic artery and vein
- C. Subclavian artery and vein
- D. Bronchial artery and vein
- E. Musculophrenic artery and vein

THORAX ANATOMY

Test yourself

OSCE Station – Case Based Discussion

A 56-year-old woman with a history of smoking presents to her GP with shortness of breath and cough for several weeks. She reports a chronic morning cough productive of white sputum, which has increased over the past 4 days. She has had similar episodes each winter for the past 5 years. She smokes 1 to 2 packs of cigarettes per day for the last 40 years. She denies haemoptysis, chills, or weight loss and has not received any relief from over-the-counter cough preparations.



Source: <https://bestpractice.bmj.com/topics/en-gb/7/case-history>

- Q1. What would be your most likely diagnosis from this presentation?
- Q2. Which investigations will be useful in confirming a diagnosis?
- Q3. Review the chest x-ray – which noticeable features are visible?
- Q4. The patient is commenced on medical management, but this seems to have little significance given the severity grade of her condition. Which surgical procedure could this patient be put forward for? How does this procedure work?
- Q5. Prior to surgery, the patient also undergoes a *Chartis Pulmonary Assessment* in the context of a possible endobronchial valve, what will this be used for?

Answers
 MCQs: 1) D, 2) A, 3) C, 4) C, 5) D, 6) B
 OSCEs: 1) COPD is the most likely differential given the chronic productive cough, shortness of breath, and significant smoking pack year history. Absence of red flags such as haemoptysis, chills or weight loss makes lung cancer, TB or infection less likely. 2) Spirometry is gold standard to diagnose COPD (FEV1:FVC < 0.7). The GOLD classification system is used to stage the severity of COPD (based on FEV1). 3) Hyperinflated lungs, flattened diaphragm, anterior border of the heart is also visible. In some patients, bullae may be present. 4) Lung volume reduction surgery can be used in severe, end-stage COPD to remove small wedges of lung tissue. This reduces residual volume and improves respiratory functionality, making ventilation more efficient. 5) An endobronchial valve is a minimally invasive surgery where a one way synthetic valve is placed in the bronchial wall. This works to prevent air inflow during inspiration but permits exit of air and mucus during expiration. This removes excess air from hyperinflated lungs, and improves lung function. A pre-operative assessment via Chartis assessment is performed to assess the presence of collateral ventilation (which will decide if an endobronchial valve is suitable in this patient). Find more information at: <https://www.nice.org.uk/guidance/tpg600/chapter/3-The-procedure>