

INTERNATIONAL SURGICAL
ANATOMY TEACHING
SERIES



ISATS HANDOUT 2026/27

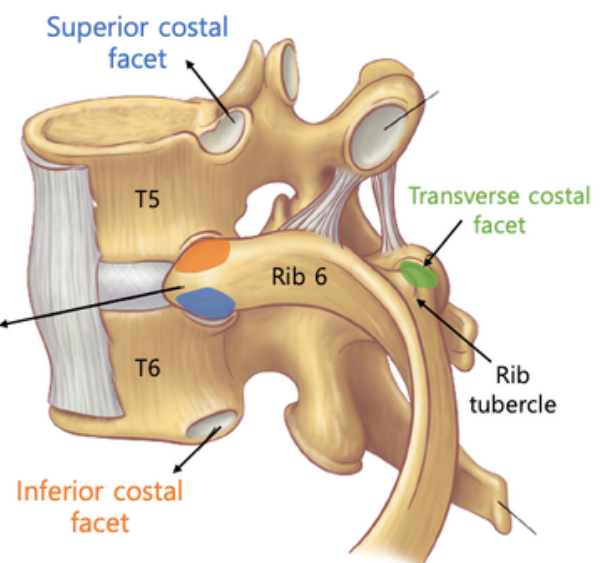
Thorax Anatomy

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:



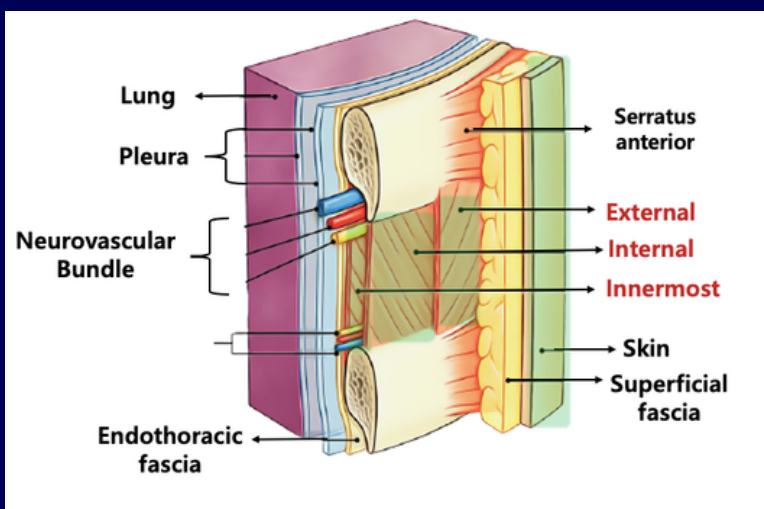
1. **Superior costal facet** → part of head of own rib
2. **Inferior costal facet** → part of head of rib below
3. **Transverse costal facet** → tubercle of own rib

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 | • Neurovascular bundle |
| • Subcutaneous fat | • Innermost intercostal m. |
| • External intercostal m. | • Endothoracic fascia |
| • Internal intercostal m. | • Parietal pleura |

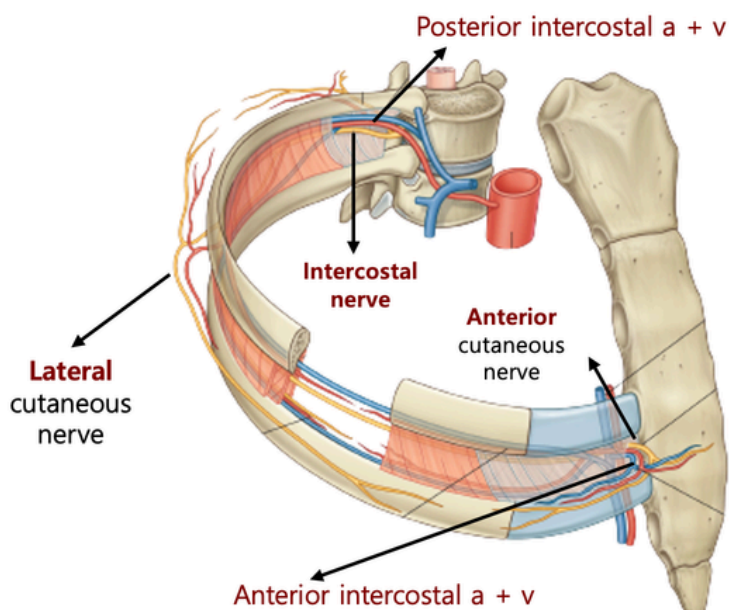


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Neurovascular Bundle

- **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

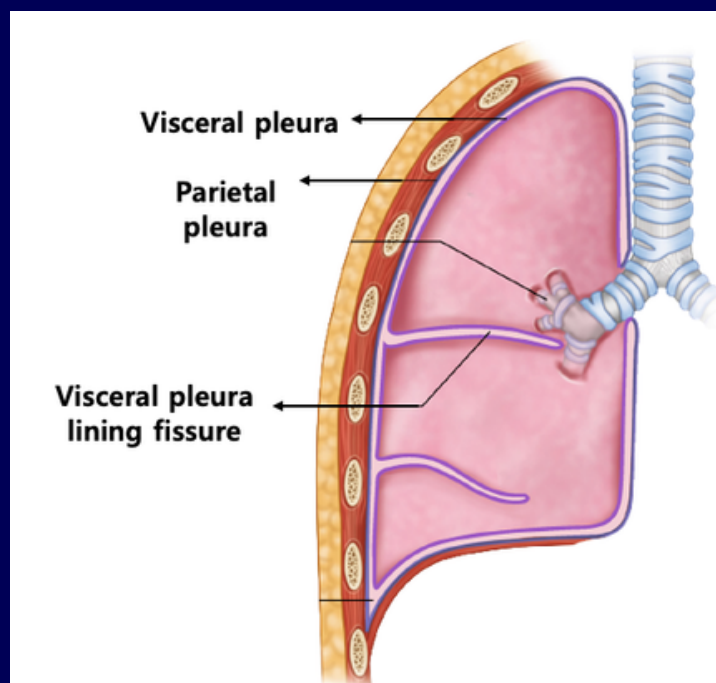


CLINICAL TIP: Intercostal Nerve Block
Needle should be inserted **superior** to the rib border to avoid damage to the neurovascular bundle!!

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



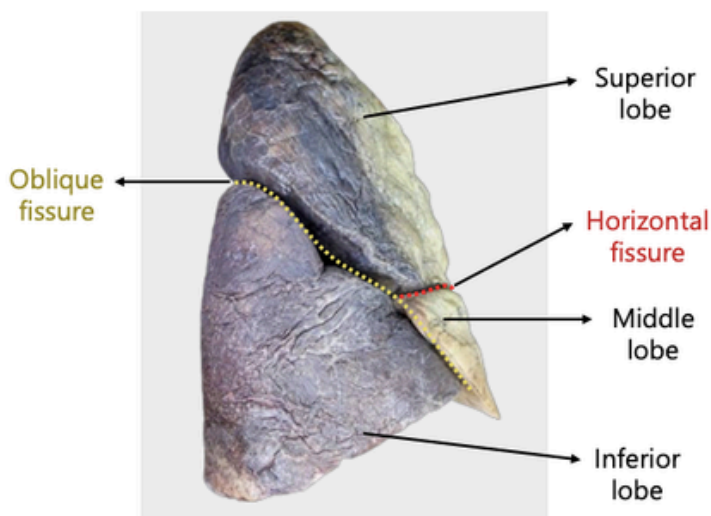
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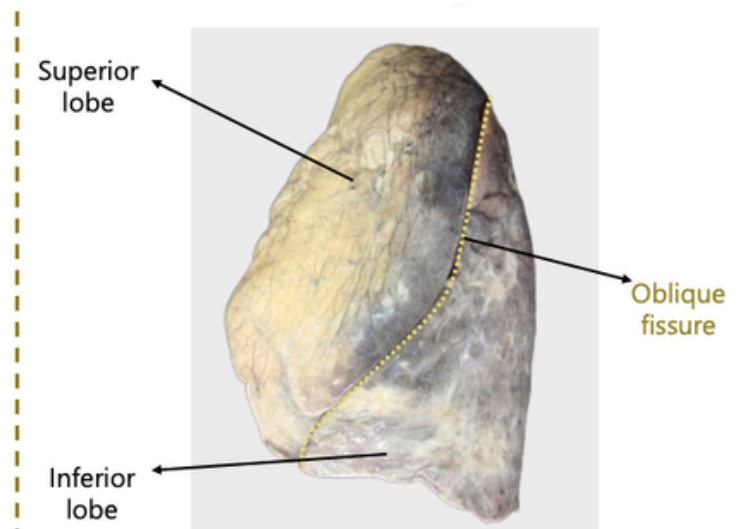
Gross Anatomy of Lungs

- 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	LEFT LUNG
<ul style="list-style-type: none"> • 3 lobes – superior, middle and inferior. • 2 fissures: oblique & transverse fissure: <ul style="list-style-type: none"> ◦ 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. 	<ul style="list-style-type: none"> • 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



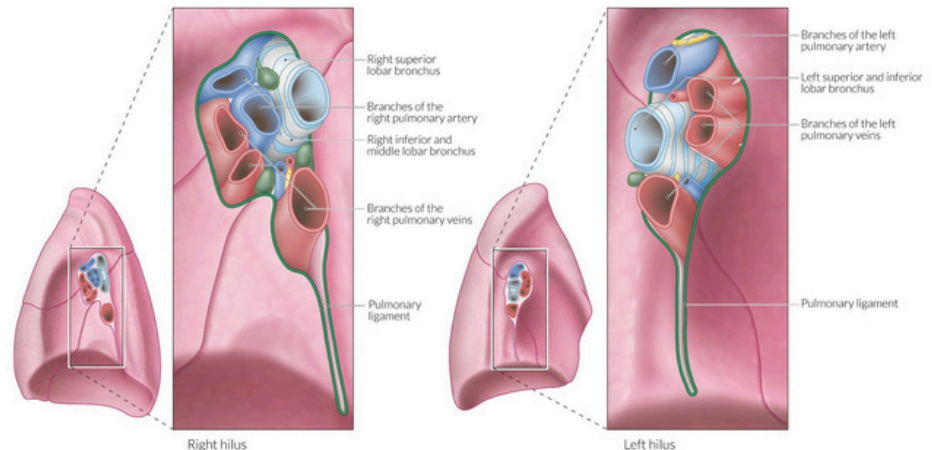
LEFT LUNG

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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



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.

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

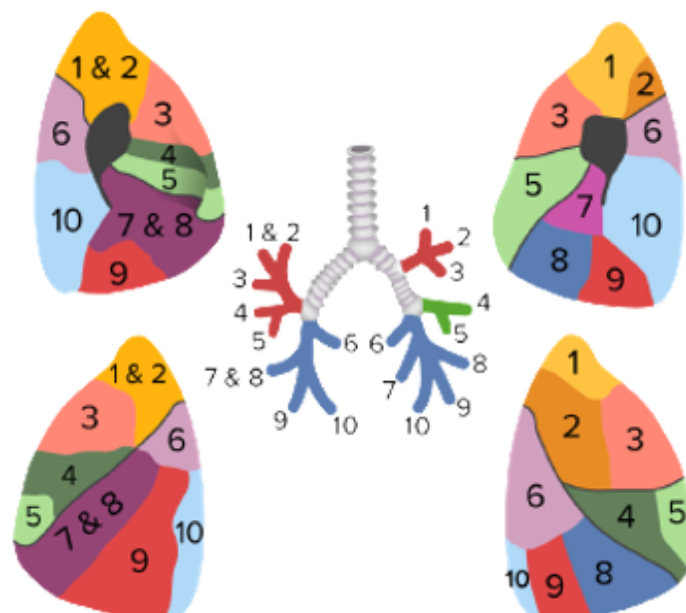
Tracheobronchial Tree

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

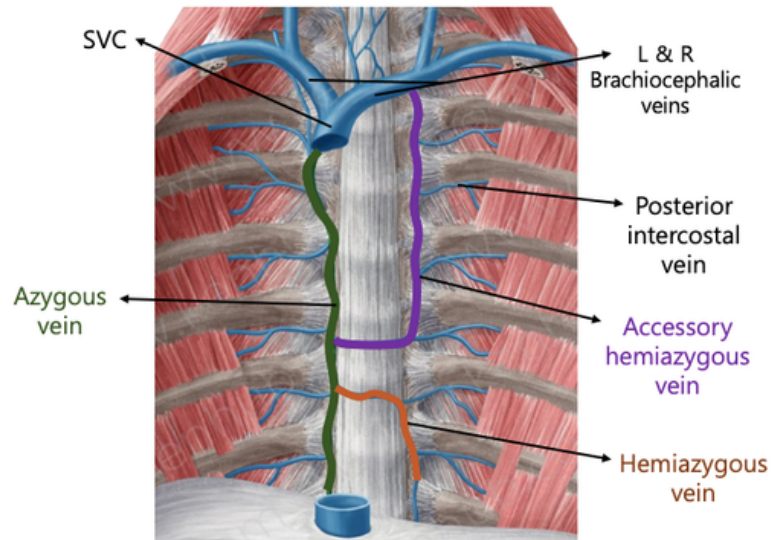


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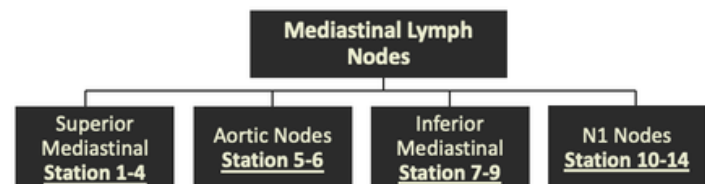
Azygous Venous System

- 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



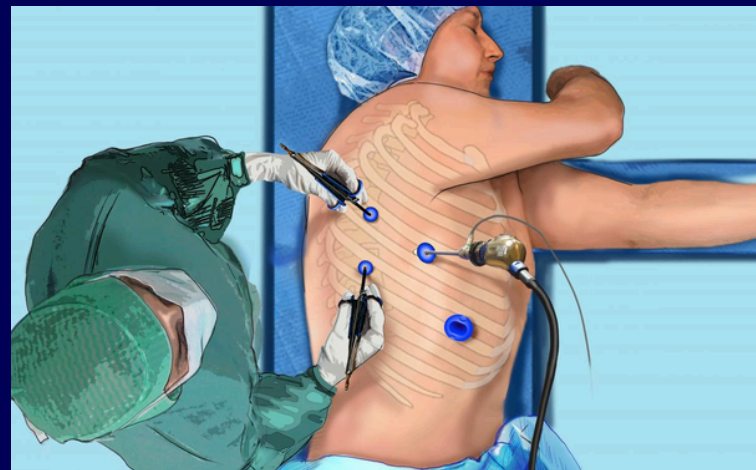
Mediastinal Lymph Nodes

- 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.



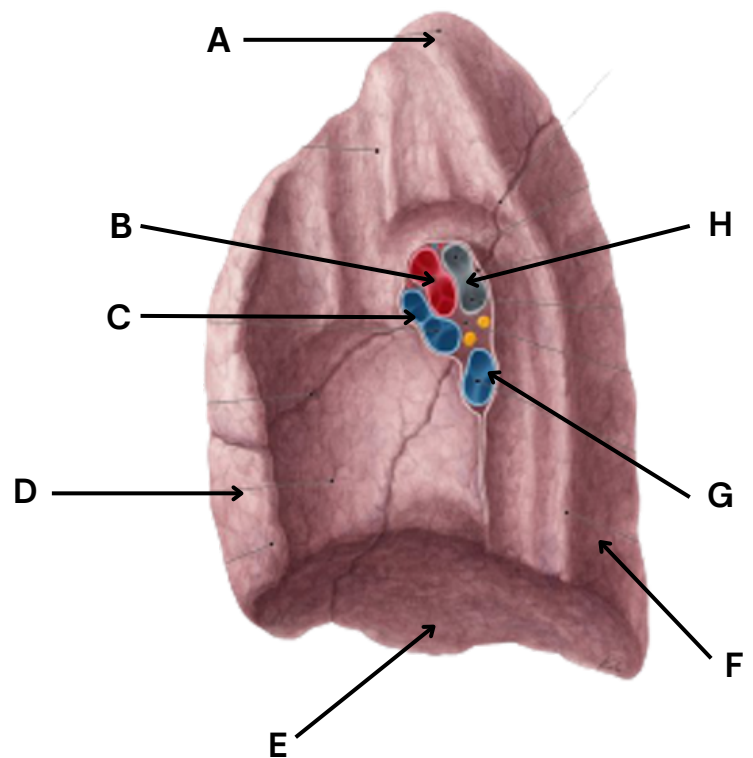
- Advancements in technology has led to the use of robotic-assisted and 3D VATS techniques which have become preferred over traditional thoracotomy approaches

THORAX ANATOMY

Test yourself

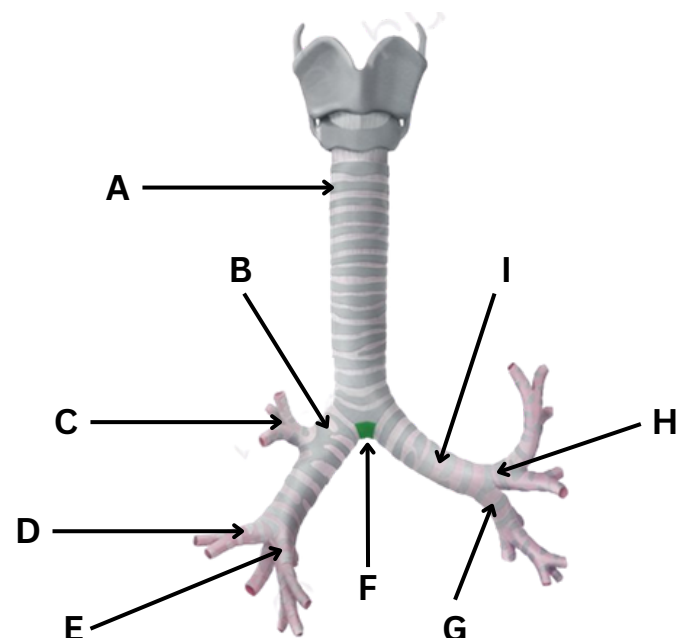
1) Label the structures within the right lung hilum:

- A)
- B)
- C)
- D)
- E)
- F)
- G)
- H)



2) Label the components of the tracheobronchial tree:

- A)
- B)
- C)
- D)
- E)
- F)
- G)
- H)
- I)



THORAX ANATOMY

Test yourself

MCQ 1

Following a left pneumonectomy, a patient is found to have an elevated left hemidiaphragm on postoperative chest X-ray. Which spinal nerve roots contribute to the nerve most likely injured?

- A. C1–C3
- B. C2–C4
- C. C3–C5
- D. C4–C6
- E. T1–T3

MCQ 2

During chest drain insertion, the innermost intercostal muscle has been traversed. Which layer is encountered immediately before reaching the parietal pleura?

- A. Endothoracic fascia
- B. External intercostal muscle
- C. Internal intercostal muscle
- D. Parietal pleura
- E. Visceral pleura

MCQ 3

During hilar lymph-node dissection, a nerve is identified running posterior to the root of the lung. Which nerve is most at risk?

- A. Greater splanchnic nerve
- B. Intercostal nerve
- C. Recurrent laryngeal nerve
- D. Sympathetic trunk
- E. Vagus nerve

MCQ 4

A CT scan shows a left lung tumour directly abutting the descending thoracic aorta. Which surface of the lung is involved?

- A. Costal surface
- B. Diaphragmatic surface
- C. Mediastinal surface
- D. Superior surface
- E. Visceral surface

MCQ 5

During right hilar surgery, a vein arching superiorly over the lung root is accidentally damaged. Which vessel has been injured?

- A. Accessory hemiazygous vein
- B. Azygous vein
- C. Hemiazygous vein
- D. Internal thoracic vein
- E. Right brachiocephalic vein

MCQ 6

A patient with a right lung tumour develops facial swelling and distended neck veins due to compression of a major vessel related to the medial surface of the lung. Which vessel is most likely affected?

- A. Azygous vein
- B. Inferior vena cava
- C. Pulmonary artery
- D. Superior vena cava
- E. Thoracic aorta

THORAX ANATOMY

Test yourself

OSCE Station – Case Based Discussion

A 62-year-old man presents to the GP with a 3-month history of worsening right shoulder pain radiating down the medial aspect of his arm, associated with weakness and numbness in his right hand. He has also noticed drooping of his right eyelid. He has a 40-pack-year smoking history and reports unintentional weight loss. On examination, there is right-sided ptosis and miosis, with reduced sensation over the medial forearm and hand and weakness of the intrinsic muscles of the hand.



- Q1. What is your most likely diagnosis from this presentation?
- Q2. What abnormality can you identify on this imaging, and where is it located?
- Q3. What paraneoplastic syndromes may be associated with the underlying condition?
- Q4. Which structure is affected to produce the patient's ptosis and miosis?
- Q5. What further investigations would you arrange in this patient?

Imaging Source: <https://doi.org/10.53347/rID-27303>

Answers

Labelling: 1) A – Apex, B – Pulmonary Artery, C – Superior Pulmonary Vein, D – Inferior Pulmonary Vein, H – Main Bronchus.
 2) A – Trachea, B – Right Main Bronchus, C – Right Upper Lobe Bronchus, D – Right Middle Lobe Bronchus, E – Right Lower Lobe Bronchus, F – Carina, G – Left Lower Lobe Bronchus, H – Left Upper Lobe Bronchus, I – Left Main Bronchus.
 MCQs: 1) C, 2) A, 3) E, 4) C, 5) B, 6) D
 OSCEs: 1) Pancoast tumour. This is suggested by the smoking history, unintentional weight loss, pain, numbness and weakness in the upper limb, and Horner syndrome, reflecting an apical lung malignancy with local invasion of the apex of the right lung. 2) A mass at the apex of the right lung. 3) Paraneoplastic syndromes depend on the underlying histology of the malignancy. Pancoast tumours are most commonly non-small cell lung cancers (NSCLCs), with adenocarcinoma now the most frequent histological subtype. Adenocarcinoma and other NSCLCs may be associated with digital clubbing and hypertrophic pulmonary osteoarthropathy. Squamous cell carcinoma is classically associated with PTHrP-mediated hypercalcaemia. Small-cell lung cancer is associated with SIADH, ectopic ACTH production and Lambert-Eaton myasthenic syndrome. 4) Invasion of the sympathetic chain causes Horner syndrome, while involvement of the lower trunk of the brachial plexus (C8–T1) causes pain, sensory disturbance and weakness affecting the medial upper limb and hand. 5) Contrast-enhanced CT of the chest to define the tumour, MRI of the thoracic inlet to assess brachial plexus/chest wall involvement, PET-CT for staging, and tissue biopsy for histological diagnosis.