

INTERNATIONAL SURGICAL
ANATOMY TEACHING
SERIES



ISATS HANDOUT 2025/26

Thorax Anatomy

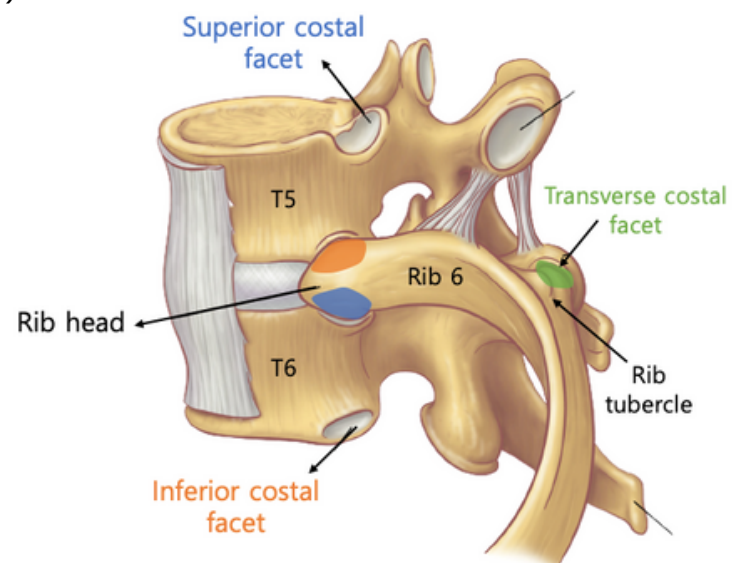
THORAX ANATOMY

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

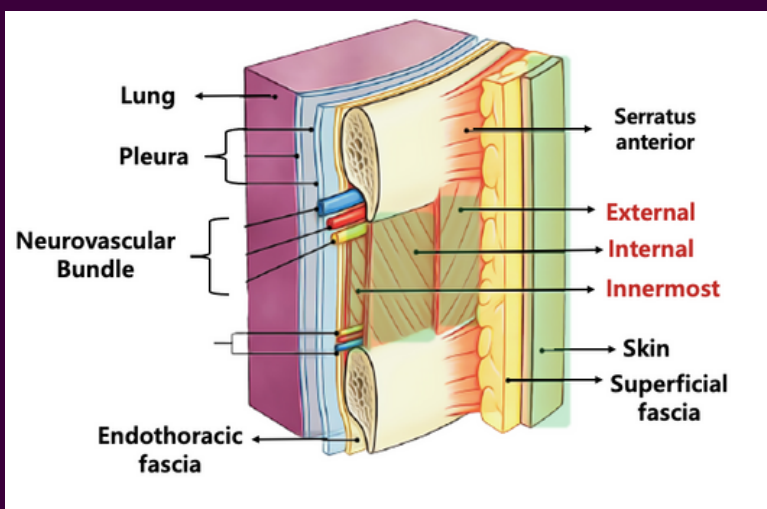


Neurovascular Bundle

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

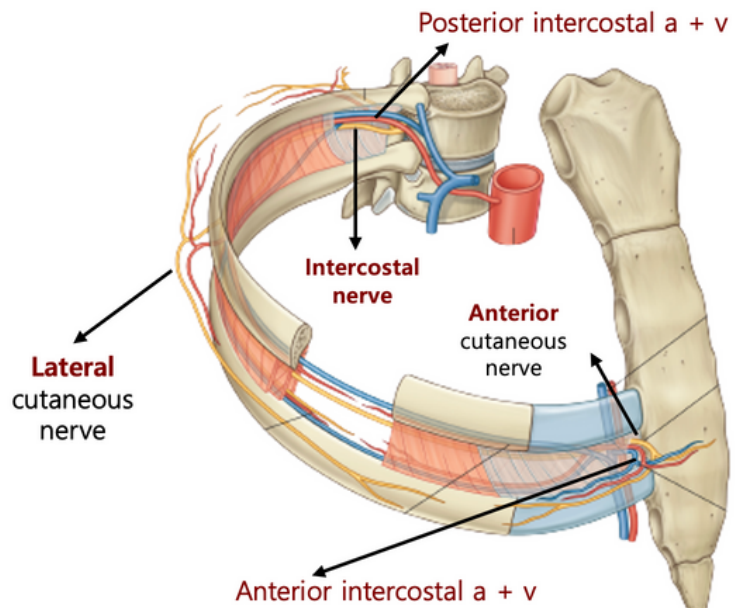


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Neurovascular Bundle

- **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

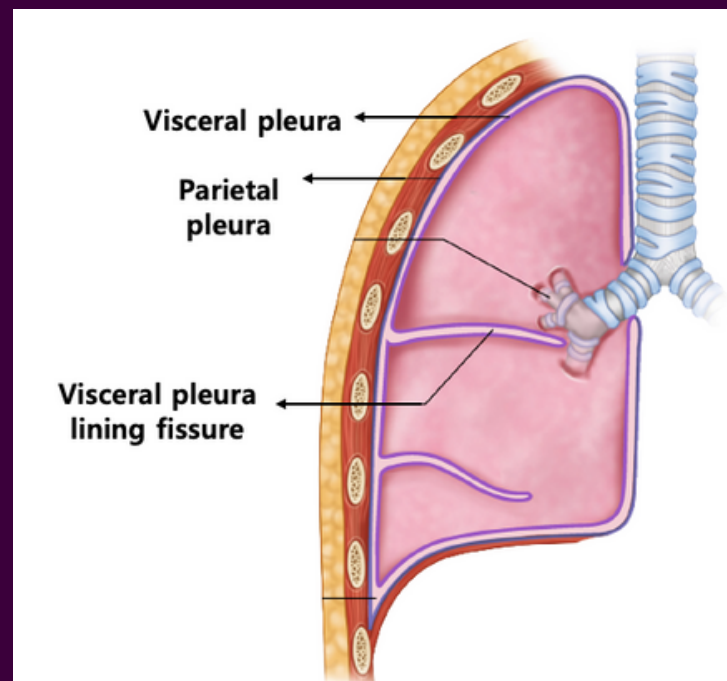


CLINICAL TIP: Intercostal Nerve Block
Needle should be inserted **superior** to the rib border to avoid damage to the neurovascular bundle!!

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

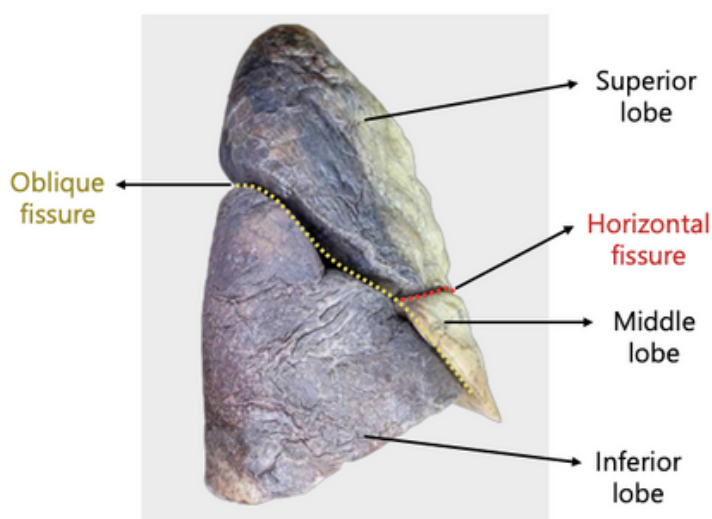
- Surfaces of the lung
 - Diaphragmatic surface – adjacent to diaphragm
 - Costal surface – adjacent to ribs
 - Mediastinal surface – adjacent to mediastinum
- Bronchial tree: trachea → right and left main bronchus (at carina, T4/T5) → lobar bronchi (right lobar branch to superior lobe originates from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

RIGHT LUNG

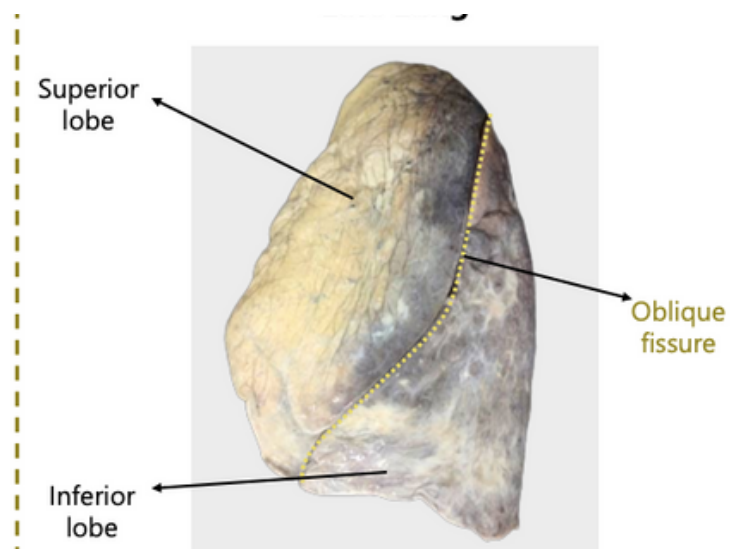
- **3 lobes** – superior, middle and inferior.
- **2 fissures:** oblique & transverse fissure:
 - Oblique fissure separates inferior FROM superior and middle lobes
 - Horizontal fissure separates superior FROM middle lobes
- Lung hilum lies posterior to SVC and right atrium
- Right main bronchus shorter,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



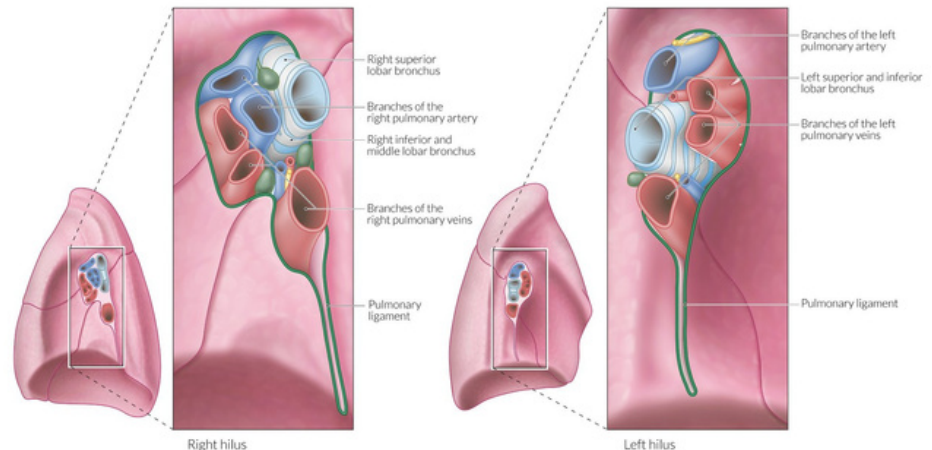
LEFT LUNG

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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



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

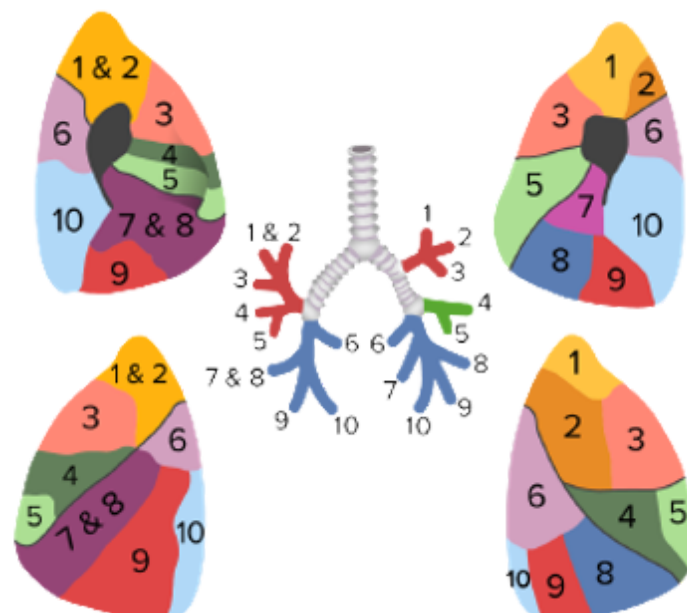
Tracheobronchial Tree

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

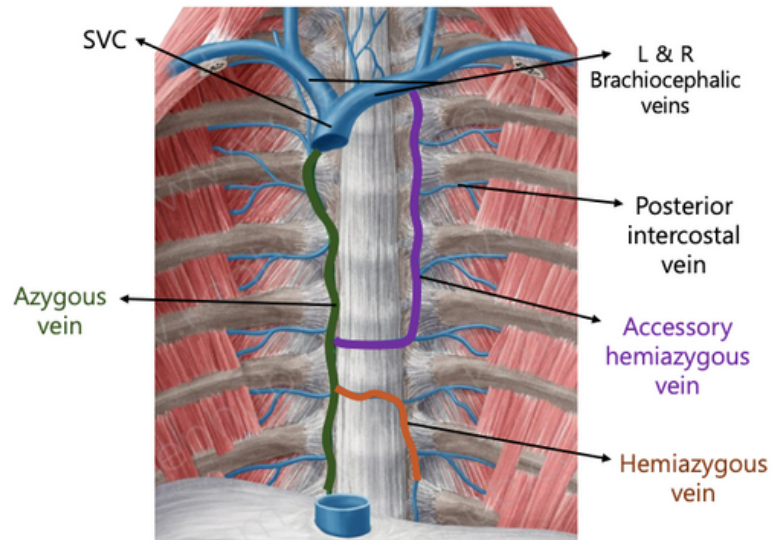


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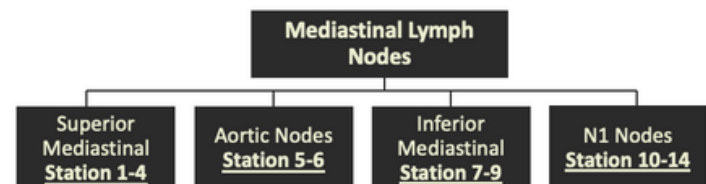
Azygous Venous System

- 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



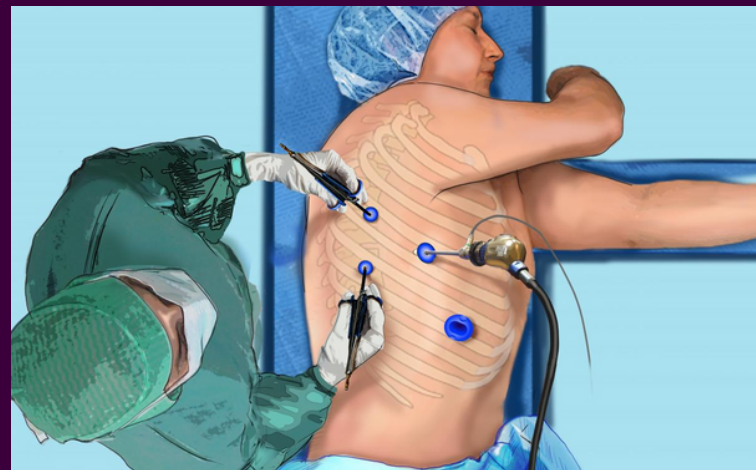
Mediastinal Lymph Nodes

- 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.



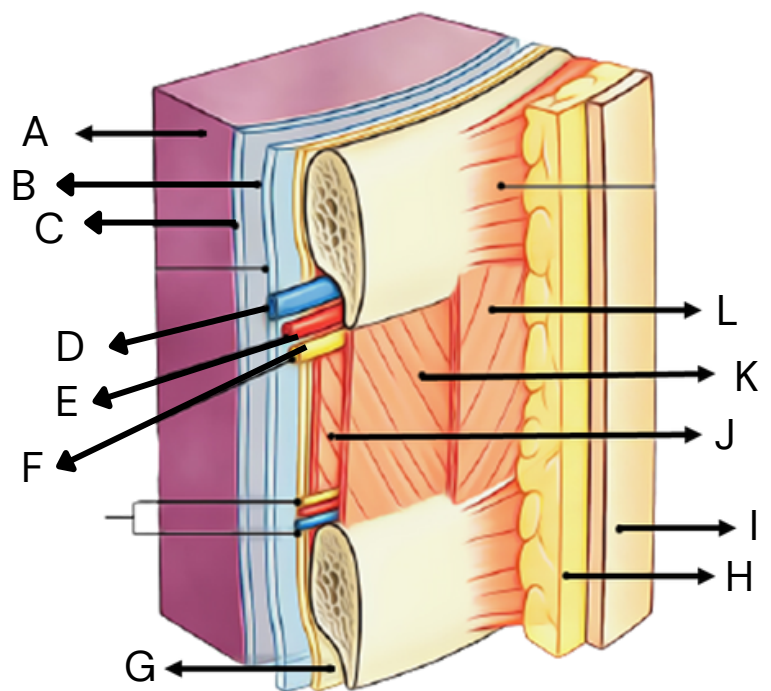
- Advancements in technology has led to the use of robotic-assisted and 3D VATS techniques which have become preferred over traditional thoracotomy approaches

THORAX ANATOMY

Test yourself

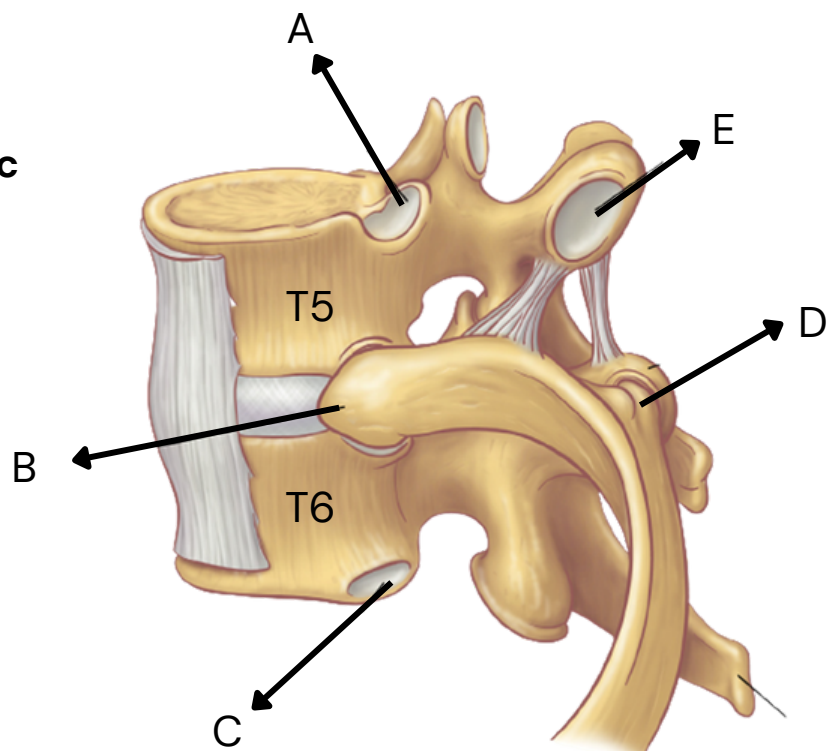
1) Label the components of the Intercostal space:

- A)
- B)
- C)
- D)
- E)
- F)
- G)
- H)
- I)
- J)
- K)
- L)



2) Label the articulating surfaces between the thoracic vertebrae and ribs:

- A)
- B)
- C)
- D)
- E)



THORAX ANATOMY

Test yourself

MCQ 1

A 65-year-old man has a compression fracture of T7. Which of the following structures articulates directly with the transverse process of T7?

- A. Head of rib 6
- B. Head of rib 7
- C. Tubercle of rib 7
- D. Body of rib 8
- E. Manubrium

MCQ 2

A 62-year-old man undergoes surgery to remove a left upper lobe lung tumor. During the procedure, the surgeon is careful to avoid injury to the nerve that runs posterior to the hilum. Which nerve is this?

- A. Phrenic nerve
- B. Left recurrent laryngeal nerve
- C. Intercostal nerve
- D. Sympathetic chain
- E. Vagus nerve

MCQ 3

A 45-year-old man presents with a large right-sided pleural effusion. The doctor plans to insert a chest drain in the mid-axillary line. To minimize the risk of injuring the intercostal neurovascular bundle, where should the doctor insert the needle?

- A. Above the upper rib border
- B. Below the lower rib border
- C. Midway along the rib
- D. Through the costal cartilage
- E. At the rib angle

MCQ 4

A 65-year-old man undergoes bronchoscopy. The bronchoscope reaches the carina. At which vertebral level is this structure typically found?

- A. T1
- B. T2/T3
- C. T4/T5
- D. T6/T7
- E. T8/T9

MCQ 5

A 70-year-old man undergoes a right-sided thoracotomy to remove a posterior mediastinal mass. During dissection, the surgeon identifies a large vein running along the right thoracic vertebrae, arching over the right main bronchus. Which statement about this vessel is correct?

- A. It receives the hemiazygous vein
- B. Drains into IVC
- C. Drains directly into brachiocephalic vein
- D. Passes anterior to oesophagus
- E. Lies anterior to trachea

MCQ 6

A 59-year-old woman is undergoing a left lower lobectomy for a localized tumor. During dissection, the surgeon notes a double fold of pleura extending inferiorly from the hilum to the mediastinum. Which structure is this?

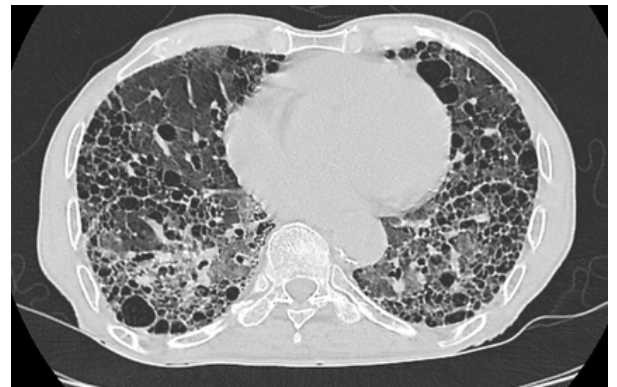
- A. Pulmonary vein sheath
- B. Pericardiophrenic ligament
- C. Pulmonary artery sheath
- D. Pulmonary ligament
- E. Visceral pleural reflection

THORAX ANATOMY

Test yourself

OSCE Station – Case Based Discussion

A 68-year-old woman presents with an 18-month history of progressively worsening shortness of breath and a persistent dry cough. She is a never smoker and works as teacher. She is unaware of any exposure to asbestos. She reports mild morning finger swelling and becomes easily fatigued with exertion. On examination, she has bibasal fine end-inspiratory crackles and digital clubbing, with oxygen saturations of 92% at rest, dropping to 87% after a 6-minute walk.



- Q1. What would be your most likely diagnosis from this presentation?
- Q2. Describe the typical pulmonary function test pattern in this condition.
- Q3. What key radiological features on a high resolution CT support this diagnosis?
- Q4. What are the main management options for this patient?
- Q5. What complications should you monitor for in this patient?

Imaging Source: <https://radiopaedia.org/articles/honeycombing-lungs?lang=gb>

Answers

Labelling: 1) A – Lung, B – Parietal Pleura, C – Visceral Pleura, D – Intercostal Vein, E – Intercostal Artery, F – Intercostal Nerve, G – Endothoracic fascia, H – Superficial fascia, I – Skin, J – Innermost intercostal muscle, K – Internal intercostal muscle, L – External intercostal muscle.

2) A – Superior costal facet, B – Head of rib, C – Inferior costal facet, D – Tubercle of rib, E – Transverse costal facet.

MCQs: 1) C, 2) E, 3) A, 4) C, 5) A, 6) D

OSCEs: 1) Idiopathic pulmonary fibrosis (IPF). The older age, progressive exertional dyspnea, chronic dry cough, bibasal fine end-inspiratory crackles, digital clubbing, and absence of smoking or occupational exposures are classic for IPF.

2) A restrictive pattern. IPF causes fibrosis, restricting lung expansion and impairing gas transfer. 3) Honeycombing and subpleural fibrosis are hallmark features distinguishing IPF from other ILDs. 4) Pulmonary rehabilitation: Assess at diagnosis, including 6-minute walk test and quality-of-life evaluation; repeat every 6–12 months; provide tailored exercise and education. Supportive care: Symptom relief, oxygen therapy if hypoxic, management of comorbidities, end-of-life planning, psychosocial support. Disease-modifying pharmacological therapy: Pirfenidone or nintedanib for FVC 50–80% predicted; nintedanib also for FVC >80%. Lung transplantation: Discuss and refer if eligible and no absolute contraindications. 5) Acute exacerbations, progressive respiratory failure, pulmonary hypertension, hypoxemia, secondary infection, and impact on quality of life. IPF can deteriorate unpredictably; early recognition of complications allows timely intervention.